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ABSTRACT

i. Metros appear on the investment agendas of most large cities in developing countries, where they are seen as effective responses to problems linked to increasing motorization, poor road infrastructure and chaotic spatial patterns. The World Bank has financed very few such projects, which is reflected in a relative dearth of internal policy documents on the subject. The objective of the note is to provide guidance on how metros and similar urban transport options might be approached as development projects.

ii. Metros are analyzed as representative of a family of mass rapid transit modes, and also as a functional analogue and competitor of limited-access urban roads. Featuring a considerably higher combination of passenger volume and speed per unit of travelway space than any other mode, metros are able to sustain a correspondingly high level of corridor activity, and are also conducive to polynuclear urban development patterns. Added to this is a potential for a high quality of service in terms of punctuality, comfort and safety. The flip side of these advantages is high construction cost per km of line, particularly associated with the travelway when it has to be underground or elevated. In that the provision of metros also involves important indivisibilities, as well as high fixed element in operational costs, their economical use is limited to corridors with high and sustained traffic flows.

iii. Evaluation of metro proposals involves technical difficulties due to requirements for long range forecasting and the presence of pervasive externalities, is frequently complicated by inadequate problem formulation, and tends to become intensely political. Financing such projects is even more difficult, given weak financial bases and credit worth of most urban governments in developing countries. Above all the longevity, physical scale and complexity of metros make them risky. The paper suggests that by recognizing the nature of these risks it is possible to design a study and appraisal process for mass rapid transit projects which will be essential to decision makers in helping them choose the most appropriate investment for any specific local circumstances, as well as show that the preferred option is financially and institutionally feasible. Moreover, risks may be advantageously shared between the sponsoring government, the private sector and institutional investors, and development agencies. The project planning process for metros must therefore reconcile the different ways that major investment decisions are approached by the diverse public and private partners, and suit local conditions in developing countries. To this end, the paper proposes changes in the content and sequencing of planning studies when they address metros.

iv. The rationale for Bank involvement in metro projects is seen as being threefold: (1) contribute to the technical quality of the project selection and implementation; (2) use metro investments as catalysts and leverage for the adoption of a coherent and sustainable urban transport strategy, linked to reforms in other aspects of urban government; and (3) facilitate public/private partnership as a means to improve the project. The key strategic agenda in most cities is likely to include pricing and other forms of congestion management for urban roads; state-city relations with regard to jurisdiction and financing of local infrastructure and services; and real estate taxation. The concluding recommendations set out a series of guidelines for task managers to assist in the formulation of metros in the context of development lending.

1. The first part of the report is a general introduction to the subject.

2. The second part is a detailed description of the methods used.

3. The third part is a discussion of the results obtained.

4. The fourth part is a conclusion and a list of references.

5. The fifth part is a summary of the main points.

6. The sixth part is a list of the authors' names.

7. The seventh part is a list of the titles of the papers.

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9. The ninth part is a list of the dates of the papers.

10. The tenth part is a list of the names of the publishers.

11. The eleventh part is a list of the names of the editors.

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20. The twentieth part is a list of the names of the cleaners.

21. The twenty-first part is a list of the names of the cooks.

22. The twenty-second part is a list of the names of the waiters.

23. The twenty-third part is a list of the names of the bartenders.

24. The twenty-fourth part is a list of the names of the musicians.

25. The twenty-fifth part is a list of the names of the dancers.

26. The twenty-sixth part is a list of the names of the singers.

27. The twenty-seventh part is a list of the names of the actors.

28. The twenty-eighth part is a list of the names of the actresses.

29. The twenty-ninth part is a list of the names of the comedians.

30. The thirtieth part is a list of the names of the clowns.

31. The thirty-first part is a list of the names of the jugglers.

32. The thirty-second part is a list of the names of the magicians.

33. The thirty-third part is a list of the names of the acrobats.

34. The thirty-fourth part is a list of the names of the circus performers.

35. The thirty-fifth part is a list of the names of the circus animals.

36. The thirty-sixth part is a list of the names of the circus trainers.

37. The thirty-seventh part is a list of the names of the circus managers.

38. The thirty-eighth part is a list of the names of the circus owners.

39. The thirty-ninth part is a list of the names of the circus promoters.

40. The fortieth part is a list of the names of the circus sponsors.

41. The forty-first part is a list of the names of the circus patrons.

42. The forty-second part is a list of the names of the circus fans.

43. The forty-third part is a list of the names of the circus collectors.

44. The forty-fourth part is a list of the names of the circus donors.

45. The forty-fifth part is a list of the names of the circus benefactors.

APPROACHING METROS AS POTENTIAL DEVELOPMENT PROJECTS

THE ISSUE

1. Metros combine a fully exclusive travelway and a rail-based vehicle technology to provide scheduled services along a sequence of on-line stations. Compared to other urban public transport modes, those where road- or rail-based vehicles operate in mixed traffic, or enjoy varying degrees of segregation from other traffic streams, metros feature substantially higher and sustained levels of passenger-carrying capacity, travel speed, punctuality, and other quality of service factors. These characteristics translate into high levels of accessibility in the corridors and areas served, which in turn contribute to various economic processes, whether it be access to work and other activities for individuals, or manufacture, trade and service processes in case of business enterprises.

2. New metro lines have been constructed or are being proposed in many large cities in developing countries. At present, the most common and the most challenging context for their application is that of rapid population growth and spatial expansion of cities. This is accompanied by rising incomes and increasing motorization of some and persisting poverty of others, all this against the backdrop of scarce and not efficiently used road infrastructure, wherein public transport vehicles are shackled by congestion. This description fits many client cities of the World Bank, but in its twenty years of urban lending, the Bank has financed only a handful of projects involving metros or similar public transport options. Most involved rehabilitation and/or extension, rather than new lines. The timing of these projects shows a small batch in the early stage of lending to cities, in Tunis (1973) and Porto Alegre (1980), followed by a 13-year hiatus. More recently, the projects in Rio de Janeiro (1993), Pusan (1994), Belo Horizonte (1995), Recife (1995), and others still in preparation (Sao Paulo, Bombay) show a revival of Bank interest in larger-scale public transport modes. Bank recommendations against metro proposals, notably in Singapore (1978) and Warsaw (1992), may be better known than the projects it helped finance.

3. Metros in Bank client countries have been typically financed by their governments, especially as concerns the construction costs, essentially as a capital subsidy from states to cities, paid out of the general budget. Rolling stock and other equipment is often provided through supplier credits, with bilateral financial arrangements and guarantees (for example, France in Mexico City and Cairo, Italy in Lima). In recent years, the role of private investors has been on the rise, particularly in large cities of South-East Asia. These joint ventures combine commercial banks, equipment manufacturers, and operators, with varying local government contributions and guarantees. Overall, the tendency has been to plan and execute metro projects as narrowly conceived investment operations, with the private partners largely focused on getting works contracts, and selling equipment and/or the operational know-how. An emerging approach is to involve real estate developers, as has for long been standard practice in Japanese cities.

4. The Bank's sparse experience with financing metros is nearly matched by that of financing limited-access urban roads. This is the flip side of having adopted a deliberate focus on the provision of rudimentary infrastructure and services to low-income populations, street-based public transport modes, and (generally) low-cost methods to improve the use of existing systems. Whether it dealt with traffic management, road rehabilitation and maintenance, or public transport operations, this has been a commendable approach given a severe scarcity of capital in developing countries, as well as a rampant neglect of low-cost and regulatory methods by many client cities. This limited focus,

however, has involved a relative neglect of strategic road and public transport investments needed to maintain and accelerate economic development processes in large cities, while responding to their explosive growth, perhaps even helping to shape it. Moreover, low-cost projects have not provided a sufficient leverage to introduce major transport reforms, such as traffic restraint or public transport priority for example, badly needed in most client cities. Bank participation in large-scale urban transport projects, on the public transport or road side, would add a strategic dimension to its role, as well as improve the development content of these projects, both with potentially high payoffs.

5. In line with its lack of financial involvement, Bank policy documents have not done justice either to the potential of metros and similar project as a means for improving urban transport and economies in developing countries, or to the complexities involved in their preparation. The objective of this note is to provide a framework and a set of guidelines for approaching such projects within the context of development lending. The note should be seen as one of companion pieces to the recent statement of policies for the transport sector [World Bank, 1996]. The text focuses nominally on metros as a stand-out case, but most of its ideas apply to any and all urban public transport modes, whatever their vehicle technology, when they require infrastructure fully or largely segregated from urban roads. In terms of the project cycle, the paper favors planning and pre-construction stages, eschewing topics which come downstream, i.e. tendering and supervision of construction, ownership, organization, fare structure, subsidy issues, and market relations vis-à-vis other service providers and modes.

THE CONSIDERATIONS

Characteristics of Metros

6. **Defining features.** Metros belong to a family of mass rapid transit (MRT) modes, characterized by a segregated travelway. The exclusive use of the travelway permits that the system be designed and operated so as to satisfy explicit performance, safety and other criteria, within the constraints imposed by the vehicle technology and budgets. In addition to the exclusive travelway, the key features of metros include a rail-based vehicle technology, and an operating regime based on scheduled service to fixed-location, on-line stations. Scheduled services permit the passengers to time their arrival so as to reduce the waiting and transfer times to a minimum. The essential features of the rail technology include laterally-guided wheels, capability to form trains, and electrical propulsion provided on each vehicle, typically through a third rail. Standard metros involve a wide-body, multiple-door vehicle configuration, and floor-level platforms for rapid boarding and alighting of passengers; a combined effect of these is to minimize the station dwell time. Stations are typically spaced at about 0.5 to 2.0 km, the choice depending on the demand pattern and a desired operating speed. The control system is centralized, permitting any desired degree of safety and automation, as well as minimizing deviations from schedule. Passenger-holding capacity depends on the platform length, train size, vehicle width and configuration, and the loading standard for standees. The most common operation is by 6-10 car trains, the largest ones capable of carrying about 2,500-3,000 passengers in conditions of relative comfort.

7. **Performance.** Metros are best known for their sustained capacity in volume/speed terms, typically in the range of 20-40 trains per hour, at travel speeds between 25 and 40 km/h, without stop skipping. Maximum frequencies approach 60 trains per hour (Moscow). Whereas the cruise speed and the time to accelerate/stop are determined by the hardware features and passenger safety and comfort, travel speed is heavily influenced by station spacing and dwell time at stops. In US

applications, the design capacity is cited at 40,000 passengers per hour per direction in the most loaded section, implying a high level of comfort for passengers. The maximum actual loads as observed in some Asian and South American systems are twice that high, in very crowded conditions but retaining punctuality and safety. The highest that the competing modes have achieved, as seen on some bus- or light rail-based systems in South America and East Asia, are crush loads on the order of 20,000-25,000 passengers per hour, lane and direction, at a slower, uncomfortable, less punctual and potentially unsafe service. Design capacities for these modes would be substantially lower.

8. The rapidity of within-system travel on metros is offset somewhat by longer access time. The proximity of metro stations to actual origins or destinations tends to vary along a given line. In high-density central areas, stations are spaced closely, providing for efficient collection and distribution, with walking typically the only connecting mode necessary. Underground metros are in fact planned to have stations coincide with major activity centers. The converse is true in peripheral, low-density parts of urban areas, where using a metro tends to require transferring to feeder modes (perhaps extra fare also), or at least long walks. Taken together, these characteristics point at the particular suitability of metros for medium and long trips, where the relative importance of access time is lower, as well as for short trips in central cities.

9. **Investment cost and implications.** Construction and equipment costs of metros per km of line are high, in absolute terms, and vary widely depending on local conditions, design features, procurement procedures, and financial arrangements. The key factor is the vertical alignment of the travelway. The all-inclusive investment costs (financial costs included) of rail-based MRT projects built in the 1980s varied roughly in the ratio of 1:2:6 according to whether the travelway was at grade, elevated, or underground [Fouracre et al (TRL), 1990]:

at-grade(1987) US\$8 million to US\$27 million per km of line
elevated(1987) US\$22 million to US\$60 million per km of line
underground(1987) US\$50 million to US\$165 million per km of line

10. Because today's metros tend to be introduced after urban development has created a sufficient demand pressure, the scarcity of at-grade and aerial space makes underground alignment most common, at least for line sections located in central areas of cities. Moving a metro line from an elevated travelway to a subway along the same itinerary may bring about a multifold increase in costs without any corresponding increase in benefits. Likewise, geo-mechanical properties of the terrain may double or triple construction costs without any effect on performance (and benefits). In most developing countries, metro construction tends to be import-intense, and the equipment is almost always imported. Finally, there are important indivisibilities, especially for new metro projects (as opposed to extensions); these tend to have a minimum threshold length, typically along a radial, center-to-periphery itinerary, linked to a depot. It is quite common for a mixed-placement, 10-km long line to cost \$500 million to \$700 million. Benefits, of course, being mostly in terms of travel time savings, rely entirely on the volume of passengers carried, the degree of street congestion, and the strength of the local economy, the latter tending to be low in many developing countries. For investments at this scale of costs to be justified in economic and financial terms, high levels of patronage are needed, preferably combined with high wage levels. Indeed, large metro networks like in Paris, Tokyo and Mexico City carry 5-8 million passengers per line-km per annum. Some systems (for example, Hong Kong) and some individual lines (for example, in Mexico City) reach up to 18 million annual passengers per line-km.

11. **Operating costs.** Adding to high investment costs due to metro line placement and threshold size, fixed part of direct operating costs is also high. This is because a six-car train is typically the smallest unit of operation and because stations, track and the power system must be maintained whatever the frequency of service. Average costs are therefore quite high at low volume levels. Contrariwise, marginal costs are low and well under average costs over a wide range of train-km operated, so average costs continuously fall as the output increases up to system capacity. This also implies a particular suitability of metros for high passenger volumes. Actual costs are very much affected by staffing ratios, wage levels, and energy prices. Given that the majority of metros are owned and operated by governments, operating costs may be more sensitive to politics than market factors and/or managerial and technological capabilities. Data on actual operating costs are scarce, and tend to lack rigor, typically not distinguishing between short-run and long-run costs, or between average and marginal costs. For illustrative purposes only, for direct operating costs only, the TRL study cites a range of US\$0.08 to US\$0.35 per passenger trip (\$0.010 to \$0.046 per passenger-km), in 1987 terms, with seven out of the ten systems in the cross-sectional sample studied falling into a narrower range US\$0.10 to US\$0.20 per passenger trip (\$0.012 to \$0.030 per passenger-km); the difficulty, acknowledged by the study team, is that the sample included different utilization levels and systems at different developmental stage.

12. **Cost recovery.** Given the above cited scale of investment costs, the relative independence of costs and benefits, and the commonly found tendency to set fares at less than economic levels, it is difficult for metros to recover costs. The TRL study indicates that only Seoul, Santiago de Chile, and Hong Kong metros covered the direct operating costs plus depreciation (Singapore metro would likely belong in this group, but data for it were not available at the time). No metro other than Hong Kong covered its total costs. Given substantial differences in accounting for depreciation and financial costs between metros in different countries, it is more meaningful to look at direct operating costs only. The recovery of these showed much variation, reflecting diverse combinations of operator-internal efficiency, fare policy, and capacity utilization. Together at the low end of the cost recovery range were a low-use metro in Porto Allegre (19 percent) and the high-use metro in Mexico City (40 percent); metros at the high end of the range, for example, in Hong Kong (219 percent) and Seoul (176 percent), appeared to have achieved high levels of internal efficiency and capacity utilization. The contrast between the underlying social policies (and passengers' ability to pay) for Mexico City and Hong Kong metros, both known for internal efficiency and capacity utilization, is quite striking. Direct operating costs are much lower in Mexico City (US\$0.012 per passenger-km) than in Hong Kong (US\$0.020 per passenger-km), for the same average trip length (about 9 km). Yet, the two systems are at opposite ends of the cost recovery range.

13. **Institutional set-up.** Early metros had often been built and operated as private ventures, typically in connection with real estate development, only to be taken over later by the public sector. Metros built in the second half of this century tended to be built and operated as public enterprises, even in countries with strong market economies, mainly because metros were invariably loss-making ventures in financial terms. This has made them vulnerable to ailments common to cases where there is political interference with managerial prerogatives, i.e. in policies regarding hiring and firing, salaries, fare, and purchasing. Only in Japan, where the link between urban transport infrastructure and large-scale urban development has continued to be strong, did the private sector maintain its partnership in metro construction and operation. At present, the private sector interest in metros is undergoing a revival. This has first taken the form of operating public-owned metros under short-term management contracts (French cities outside Paris), then bidding for minimum-subsidy longer-

term concessions (Buenos Aires). More recently, paralleling the experience with urban toll expressways, the private sector is showing an increasing interest to become a partner in all aspects of metro projects: planning, design, financing, construction and operation. This is particularly evident in large East Asian cities, which are emulating the Japanese rather than the US and West European models of urban infrastructure development.

14. **Urban public transport alternatives to metros.** Any given public transport mode can be defined in terms of three key features: the degree of exclusivity of the travelway (mixed traffic, exclusive and intermediate), the type of vehicle technology (rail- or road-based), and the operating regime (station spacing, type of service). Each of these features of course offers a number of possible sub-choices. In rail-based systems, for example, different performance profiles can be obtained by varying vehicle and train size, the configuration of vehicle interior in terms of seats and standees, door size and number, boarding/alighting height (platform or street level), and even the type of propulsion (electric or diesel). In theory, there are numerous possible design options. In practice, however, the variety is lower, since only a few designs have seen wide application.

15. Within the MRT category itself, regional/suburban rail lines or even networks can be seen as a variant on metro design. These often appear in the form of commuter lines running on urban/regional sections of the mainline track in countries where the national railroads are well developed and/or there are regional agglomerations (Germany, France, Eastern Europe, Japan, India). Most run on electric power, but diesel or diesel-electric propulsion are also in use. Some regional/suburban networks are the work-horses of the transport system; in Bombay, for example, this is at the level of above 5 million passengers per day. New, purpose built regional lines (for example, the RER in Paris) have been built to complement an existing metro system. Such lines specialize in longer trips, using larger cars, higher seat-to-standees ratios, longer trains, and longer inter-station spacing than metros. The result, in the case of RER/Paris is a higher travel speed and comfort to long-distance passengers, traded off against longer access time/cost at the point of trip origin or destination.

16. Most often, alternatives to a proposed metro are drawn from a category of modes, hereafter called intermediate rapid transit (IRT), featuring bus or light-rail vehicle technology, different degrees of travelway segregation, and a variety of operating regimes. At one end, IRTs can be simple, street-based reserved lanes with or without priority at traffic signals. At the other end, they may enjoy nearly full segregation. The trend in upper-scale IRT modes has been to combine a fully exclusive, often underground travelway in centers of cities with an at-grade, partially segregated street placement in the non-central sections of the line. The underlying flexibility of IRT modes points at the potential for staged construction of exclusive travelways, with or without a shift from bus to rail-based vehicles, a highly desirable feature in budget-constrained developing countries. Investment costs vary widely, depending on the alignment. When a street-based travelway can be provided, the costs per km of line based on the light-rail technology can be as low as \$4 million to \$5 million, but have been known to rise as far as \$20 million to \$25 million when large civil works and particularly tunneling were involved. In bus-based IRT options, the threshold costs of construction are even lower than for light-rail, since buses do not require lateral guidance, complex signal systems or central power supply. It may take less than \$1 million to transform a portion of a city street into a simple bus-only lane, but an independently constructed, all-exclusive busway at grade may involve a cost of \$20 million or higher, depending on the number of off-grade structures.

17. Light-rail vehicles are smaller than metro cars, often use articulation, and are capable of being operated individually or in short trains (2-4 cars). They may be boarded from street level or platforms. The lines typically involve shorter inter-station distances and less complex signal systems than metros. Low investment cost per unit of line and the option of extending lines onto ordinary streets in the collection/distribution areas are the main strong sides of the bus technology in IRT applications. Major constraints include the low capacity of on-line stations, as well as emissions from internal-combustion engines. In elevated alignments, the absence of lateral guidance is also a handicap for buses, tending to increase the minimum lateral clearance and/or decrease the speed required for safe operation. While emissions and noise become a factor only at high volumes in open-air applications (for example, Avenida Caracas Busway in Bogota), the ventilation requirements limit the use of this vehicle technology to short tunnels only. Capacity and travel speed of bus-based IRTs can be increased by using larger, articulated vehicles, different door configurations, even metro-like boarding/alighting arrangements (as in Curitiba). Platoon operation has been tried as a means to increase station capacity, but is difficult to sustain. Unlike the light-rail based IRT, whose typical line design resembles that of metros, the most successful bus-based IRT design may be an exclusive busway with fan-like network of feeder lines converging on its terminals.

18. More recently, there have been several instances of using the light-rail and even bus vehicles on fully segregated travelways. Such are the lines in Ankara (Turkey) and Manila (Philippines), which use light-rail vehicles, and the trunk lines of the all-bus system in Curitiba (Brazil), this last featuring a carefully managed transfer of passengers from feeder lines to trunk lines. According to our definition, these are also MRT modes, but there is a deep divide between their capabilities and those of metros. When they can be provided at-grade, or with partial tunneling and/or elevation, they can provide attractive combination of cost and performance up to peak volumes of about 20,000 passengers per hour per direction. For higher volumes, and if substantial civil works are required, the risk is that short-term cost advantage may turn into an inflexible long-term constraint.

19. Whereas the rail vehicles are dominant in MRT applications, and the bus vehicles are dominant in street-based operations with little or no priority, the two vehicle technologies are fully competitive in the IRT category. For most at-grade IRT applications, bus-based systems have the advantage of lower initial investment costs, and being able to leave the exclusive travelway to operate in mixed-traffic lanes, whenever the operating environment is favorable or the budget dictates it. Light-rail systems combine high throughput with high performance, are more environmentally friendly, and can be operated in tunnels.

20. Vehicle technologies keep evolving as manufacturers attempt to reduce costs, improve performance, and/or emulate their competitors' successful features thus hoping to expand their market niches. Metro technology is evolving by pushing upwards the limits of capacity, safety and the quality of service. For the light-rail, the trend has been toward low-floor vehicles, dual boarding (steps or ramps), dual power supply, articulation, and longer trains. All of these improve performance toward that of metros, while retaining the capability to operate on-street in competition with bus vehicles. Trends in bus technology are also toward low floors and wide doors, to improve the boarding/alighting process, but significantly also towards dual mode capability (lateral guidance, electric propulsion).

21. **Metros and urban roads.** Underlying the preceding discussion was a hierarchical view of urban public transport systems, with each level of the hierarchy playing a different combination of movement and access roles. At the lowest rung are found ordinary public transport lines operating in

mixed traffic, stressing access to adjacent land uses at the expense of travel speed and other movement factors. Modes such as metros and regional rail systems occupy the highest rungs, with high speeds achieved by limiting access. An analogous hierarchy is evident in urban road networks, starting from local roads and collectors, and culminating in limited-access roads (urban/regional expressways). When the two modal hierarchies are laid side by side, metros appear functionally analogous to urban expressways. This relation has been obscured for long by an institutional separation between the two modes, and a common absence of financial analysis from road planning studies. Recent years have brought new perceptions, due to a growing experience with urban toll expressway projects. These require financial analyses and show some of the phenomena commonly linked to metros, for example, construction cost overruns and optimistic demand forecasts. The practical importance of the metro-expressway analogy is that evaluation studies tend to pit metros only against other public transport alternatives. Given their functional roles, external and cumulative impacts, and the scale of investments necessary, it may well be that the more relevant choice is between metros and urban expressways.

22. **Historic patterns in the evolution of urban roads and public transport systems.** In cities which rose to prominence in the pre-automobile age (London, Paris, New York), public transport systems developed a full hierarchy of modes, from on-street tramway and bus lines to a dense network of metro and regional rail lines, before roads did. Corresponding to this was a high-density pattern of urban development. Limited-access urban roads developed later and, in West European capitals, as late as 1960s, in smaller quantity and focused on the lower density fringe areas. All of these developments took place over long periods of time. Medium-size cities in Western Europe maintained their reliance on public transport by gradually extending and upgrading their street-based lines in both vehicle technology terms and the degree of segregation from traffic, coupled with a policy of subsidized fares. Eastern European capitals are only now going through the road building stage, having developed extensive and sophisticated public transport networks, whose dominance was predicated on low auto ownership and use. Los Angeles provides a counterpoint. Though initially growing around a grid of tramway lines, after 1950s the city developed around and together with an extensive and highly diversified road network, inseparable from a low-density land use pattern, near-universal auto ownership, absence of direct charging for road use, and abundant public finance earmarked for road building. Public transport remained to serve a "captive" market of the car-less, mainly the poor, young and old. For decades, the public transport systems were left at their lowest developmental stage, i.e. street-based bus lines operating in mixed traffic. Recently, as road building reached spatial, environmental and even fiscal limits, several US cities have invested into the MRT/IRT modes, against odds defined by low land-use densities and high auto ownership. This attempt to let the public transport system evolve to its higher-level forms is not being done because the new modes offer superior capacity, but for their quality of service. The latter is meant to achieve modal shifts away from autos, hence also open new channels for further transport demand growth and new, more sustainable land development patterns. A striking example of this has been provided by the recent construction of MRT lines in Los Angeles, with passenger densities of well under one million per line-km per annum.

23. **The current context of metro planning in developing countries.** Cities in less industrialized countries have been growing, at rates unprecedented in history: Bombay, for example, grew from 5 to 15 million in less than 25 years. Demographic and spatial growth of cities in these countries, particularly in South America and South-East Asia, has been accompanied by a highly polarized growth in income and wealth. All this has been happening in the presence of a mature,

product-diversified automotive technology. The new wealth of some feeds the growth in ownership and use of cars and motorcycles, whereas the persistent low incomes of others maintain their dependence on walking, non-motorized modes, and low-quality public transport. These conditions, particularly the small size or even absence of the so-called choice markets for public transport, tend to be inhospitable for its evolution along European lines. Unresolved price and subsidy issues have undermined even the street-based, conventional urban public transport enterprises in many Asian countries, leading to the expansion of the informal sector, with an overwhelming bias toward smaller vehicles and a plethora of lines. (China is exceptional in that bicycle mode has been and still is much more important than public transport in all but the largest cities). A weak fiscal base makes it difficult to develop roads and all other public infrastructure even in the presence of economic growth. In fact, low taxes are cited as a contributing factor to East Asian miracle growth. Land development and motorization have run ahead, and transport systems were left behind. Road networks tend to be scarce and functionally undifferentiated. Moreover, institutional capacity is not strong enough to develop and implement policies meant to achieve full utilization of the available road space through encroachment control, traffic management, congestion pricing and/or provision of exclusive-use lanes to public transport vehicles. Traffic is therefore chaotic and overwhelming, with public transport being particularly affected. In consequence, the consideration of MRT projects in such cities takes place in the presence of fierce competition between typically separate road and public transport bureaucracies and interest groups, the goal of which is to be the first to develop a limited-access network and thereby escape the congestion on ill-dimensioned and multiple-use streets. The flight from street congestion most often implies elevation, or -for MRT- tunneling, very costly propositions both. Budget constraints make it unlikely that roads and public transport systems could evolve simultaneously to the limited-access category, especially not in the same corridor. The scarcity of street space leads to a tendency of leap-frogging from low-level roads and public transport modes all the way to the top of their functional hierarchy, a very dear proposition. As revolution replaces evolution, the resulting system is unbalanced since the less expensive intermediate-level facilities, i.e. arterial roads and IRT modes, are skipped. The textbook ideas of incremental improvement, from bus-only lanes to busways to light-rail IRT to metros, give way to bitter choices between extremes.

Potential Impacts of New Metros

24. **Transport system impacts of new metros.** The impact of metros on street traffic has long been and remains a subject of controversy, much of it due to the fact that a before-and-after analysis of projects is much easier to do and understand than a with-and-without analysis. Introducing a metro in a corridor where public transport modes have operated in congested mixed traffic, or with a low degree of segregation, will first and foremost involve a transfer from these modes to the new service offered by the metro. The degree of that shift, and its impact on the street traffic will depend on the arrangements for the existing street operators, price elasticities and cross-elasticities of passengers on alternative modes, and the speed of reaction of the urban development agents to the change in accessibility patterns. The matter of the existing street operators is anything but naive, and can lead to substantial patronage under-runs (Pusan Metro comes to mind). Though transfer from walking and non-motorized modes may also occur, shifts from autos are far less likely in most developing countries. (It is only fair to say, however, that if any public transport mode could attract middle and upper middle class passengers in developing countries, metros and upper-level IRT modes are most likely to do it. These may be passengers shifting from autos, but also entirely new trips). Also, in many developing countries, new trips on street-based public transport modes may arise from the

inexorable population increase, as may new trips by private automobiles. Indeed, streets in cities like Bangkok will probably remain congested even when the new metro lines start operations. The pressure to expand roads will remain as well. Clearly, investing hundreds of millions of dollars in rapid transit and remaining stuck with street congestion and its environmental epiphenomena must not be accepted. Complementary actions are called for, primarily some form of congestion management. This should be done first for the sake of people remaining on-street transport, but also for the direct (new passengers) and indirect (image) impacts on the new metro line. In many cities, efficient pricing of congested road space is very much warranted but difficult to gain political acceptance, even if is limited to parking. By creating a high-quality option for passengers, the new metro system may soften political resistance to traffic restraint. With or without congestion pricing, physical and regulatory measures to restrain road use by moving or parked vehicles are essential to allow the full benefit of a new metro investment to be achieved throughout the transport system.

25. **Poverty impacts.** Spatial growth of very large cities generally increases trip distances, adversely affecting the poor especially when they reside at the shifting outer frontiers. When these distances exceed walking or non-motorized transport range, low-income passengers become captive to street-based public transport modes. These modes suffer disproportionately as street congestion increase, due to their larger vehicles and the need to stop for boarding/alighting purposes. By rescuing public transport vehicles from the street, metros can act as equalizers of accessibility between closer-in and outlying areas, and (more generally) between auto users and transit users. In this sense, rapid transit systems can improve the life and fortunes of low income populations, as has happened in Mexico City, Caracas, Sao Paulo and others. Unfortunately the opposite effect may also occur. The introduction of metros may involve the restructuring of street-based public transport service in order to re-orient it to serve as feeder/collector for the metro (a difficult thing to achieve), or to remove it as competitor. Mexico City Metro appears to have had this effect also. If fares on the metro system would be much in excess of what the old street-based lines charged, travel may become unaffordable for the poor. This could easily happen, given an increasing focus on cost recovery in public projects, for reasons ranging from local finance to macro-economic health, by lenders such as the World Bank. Given the Bank's priorities, it follows that the impact of a new metro on various low income communities must be a subject of explicit study and concern whenever a loan may involve large changes in transport system supply and/or pricing.

26. **Metros and urban development.** In that they have far more passenger carrying capacity per unit track width, in combined volume-speed terms, than any other urban transport mode, metros permit far higher development densities than other modes, as well as allow cities to expand spatially while staying within reasonable travel time envelopes. Moreover, because of the high accessibility offered by locations close to stations, they tend to encourage polynuclear-nuclear urban growth. Urban expressways also have an impact on development patterns, but are correlated more with spatial expansion at low-to-medium densities, even urban sprawl. Location impact of urban expressways is of importance to land uses generating both goods and people transport, whereas the impact of metros is focused on the latter.

27. Proponents of metros therefore claim that they generate more efficient development patterns, exemplified by a concurrence of vibrant downtowns and secondary centers around stations and terminals, increases in land values, and new economic activities attracted from outside the urban area. Opponents discount the claims for new activities and argue that differential impacts (as opposed to an aggregate urban area impact) on land values may occur but are essentially redistributive and should be left out of cost-benefit analyses to avoid double-counting. They cite study after study, mostly in

the US, which have rejected the hypothesis that metros can shape urban development, claiming that accessibility has ceased to be a scarce resource. (This of course would not hold in rapidly growing South and East Asian cities, where a basic level of accessibility is far from assured to a great number of residents). There are several different strands in the above arguments. Are there net benefits of new metros above and beyond the usually accounted for changes in travel time and vehicle operating costs? If there are, can they be brought into the standard project evaluation process, or at least can the benefits calculated on the basis of simple transport impacts be considered as a lower bound on "true" benefits? If there are no net benefits, can some use be made of the differential benefits? Finally, can metro projects be used to shape urban growth, whatever the benefits of any one growth pattern?

28. An emerging, empirically based consensus, is that benefits of urban infrastructure investments have exceeded considerably those estimated on the basis of micro-analysis of individual projects. An intuitive argument regarding major transport infrastructure is that cities can grow to be very large without either expressways or metros, but they function as non-organic groupings of small, weakly connected centers. Only those large cities which maintain good accessibility in spite of spatial growth, *inter alia* by constructing transport facilities with superior output in speed and volume terms, manage to capture agglomeration economies arising from efficient demand-supply linkages in commerce, manufacture, education, administration and culture. Unfortunately, there is little hope that these extra benefits could be forecast even at an aggregate level, much less at the level of individual projects and their alternatives. This conclusion holds even more for developing countries, given the difficulties experienced with forecasting even the simplest "user" impacts of alternative urban transport options therein. It is, however, quite valid to consider the benefits estimated using standard methods as lower-bound values.

29. A similar judgment can be made regarding differential land value increases. Whether or not they represent, in the aggregate, an exact transfer of transport user benefits to real property owners, urban land market distortions are so common in developing countries and the difficulties of measuring not to mention forecasting so formidable that an expansion of project evaluation framework in this direction is out of question. It is quite a different matter, though, to discuss differential land value benefits in the context of cost recovery for new projects. These benefits are as real as transport user benefits, and in fact they tend to be more identifiable given the limited number of land/building owners. Indeed, it is the large beneficiaries of potential location economies, rather than passenger associations, who tend to spearhead the pressure for building metros and expressways. That their support of these projects may not go as far as making voluntary capital contributions or getting into joint development ventures at stations reflects the expectation of getting these benefits anyway. The implication of this is that indirect beneficiaries should help to recover costs of new projects, most likely through real estate taxation. The difficulty, of course, is that this instrument is either rudimentary or even non-existent in many cities, and it is politically difficult to introduce or reform. This in turn suggests that the leverage of investing in a large-scale project such as a metro (or a major urban road) could be used to overcome the political resistance to taxation.

30. The question of using metros to shape urban development patterns does not have a single answer. Doing this has evidently been difficult if not impossible in the US cities. The counter-examples, however, are plentiful in Japanese cities and in Hong Kong, where the linkages between different levels of government, industry and commerce work in a different way, and where metro finance is commonly conceived in connection with land development. Still more different is the example offered by Curitiba (Brazil), which has adopted and strictly applied regulations linking the type and density of land use with the hierarchical level of the adjacent public transport and road

facilities. A converse of this approach would be to limit the land use densities in cities which cannot afford to construct high-performance transport facilities.

Evaluation Complexity

31. **Problem diagnosis and formulation of options.** Proposals to build new metros sometimes arise without a full understanding of either the nature of local problems, or the essential capabilities of the metro as an instrument meant to resolve these problems. There are several aspects to this:

- ◆ Lack of adequately wide-ranging data collection and analyses for in-depth knowledge of transport problems and their causes, arising from inadequate local planning institutions.
- ◆ Failure of planners and decision makers to recognize that in congested cities the degree of exclusivity of the travelway (not vehicle-technology) is the prime determinant of both performance and cost. It is common to have a choice among multi-attribute options erroneously perceived as a choice among vehicle types.
- ◆ Commercial pressure of manufacturers and builders committed to a particular technology, a counterpoint to similar coalitions with road building interests at heart.
- ◆ Norm-based planning, for example, relating the introduction of rapid transit lines to city size, lacking a broader analytical base, and particularly economic/financial aspects. This was common in the former Soviet Union and Eastern European countries.
- ◆ Neglect of some feasible options, notably those involving a take-over of existing road space to install full or intermediate rapid transit lines, or even those involving elevation rather than underground construction. This also leads to the above mentioned tendency to evaluate metros against poor alternatives, such as the continuation of street-based public transport operations.

32. **Construction complexity.** For metros built at grade, practical difficulties involve land assembly, whether this be changing the use of land from one mode to another (road to metro, or mainline railway to metro), or a relocation of households and businesses; both can involve administrative, legal and/or political complications, extending the construction period and adding to costs. Underground and aerial alignments may involve sizable construction risks, some due to incomplete knowledge of the geo-mechanical properties of the soil, others due to the presence of utilities, involving both administrative and engineering difficulties. At grade, aerial, or cut-and-cover methods of construction may immobilize entire urban corridors for years, creating severe traffic pressures, structural hazards to near-by buildings, and environmental hazards to the population. Many of these aspects are difficult to evaluate, a problem exacerbated by a widespread reluctance of the sponsoring governments to commit funds for requisite studies while the decisions about options are still wide open.

33. **Length of the planning horizon.** The planning period, from the initial studies to the start of construction, tends to be quite long for metros, 5 years being quite common. The construction periods vary widely, but even at the lower limit they tend to be about 5 years for a 10-km line, and often twice that. The useful life of metros is some 30-40 years for equipment and 50-75 years for tunnels and other structures. It follows that an exceptionally long planning horizon should be used in

comparing options. This, together with the rapidity of urban change in developing countries, has different and important implications and challenges for forecasting and evaluation of a metro than for its shorter lived alternatives. Moreover, decisions on what to forecast and what to control become necessary, perhaps essential. As noted above, cities, countries and cultures differ in their approach to treating demand for travel in cities: in some, for example, the US, the travel and land markets are taken as exogenous, while others, for example, Japan, take a view that both can be managed. In either case, given the length of the planning horizon, the planning approach of using single-value demand forecasts for project justification, however thoroughly done, is not appropriate for metros.

34. **Analytical limitations.** Evaluation of metros is especially affected by two general limitations of current analytical capability. First, there is a wide gap between transport simulation models which deal with fine-grained travel behavior in response to multiple-attribute transport options, and those which are based on robust, strategic relationships between land use, transport demand and modal split. The former are well-suited for current and short-term uses, particularly when travelers in the corridor under study have access to several modes and/or are sensitive to fares and other policy factors, while the latter may be preferred for exploring longer-term futures. Neither are very good for simulating long-term consequences of do-nothing alternatives. The trade-offs between these model types are in terms of temporal stability against accuracy, as well as costs of model calibration and running. The choice of a model to be used in a given study is not value-free, needs to be justified, and its probable consequences stated. It would be desirable to use different models for different parts of the planning process, but this may not always be possible in financially and technically constrained developing-country environments.

35. Second is the problem of structural effects. The real opportunity cost of a metro which enables denser land use in the center and at specific outer area nodes is the other social capital investment (and current costs) that would have been necessary to support a more dispersed activity pattern. Unfortunately, in the most common practice of transport planning, demand at the point of origin and destination is treated as an explicit function of land use, but the causal feed-back from individual network options to land use patterns is weak to say the least. At the level of planning work seen in most developing countries, it does not even exist. Perhaps one day the state-of-art of transport/land-use modeling will adequately handle the impact of proposed transport improvements on land use or on the overall level of trip making, but not just yet. This weakness is less important when project alternatives are similar, but becomes essential when comparing "unlike" cases, i.e. a do-nothing option against a \$1 billion metro. Better transport models use iterative procedures to simulate the redistribution of trips in response to congestion on constrained networks such as those postulated in do-nothing options, but this has little to do with different development patterns and their social costs and benefits. A multiple-scenario approach to land development is often used in studies, but this is more an attempt to deal with uncertainty of long-term forecasting and not with the problem of forecasting and valuing changes in development patterns caused by different transport investment options. The use of multiple scenarios is positive at least in that it introduces a dose of explicit contingency into the project evaluation process, and should be encouraged though it may make the results of analyses difficult to interpret. An entirely different approach would be a normative one, akin to the Japanese and Hong Kong experiences mentioned above, based on agreement and control of land use patterns rather than forecasting.

36. **Impact of the discount rate.** The cost/benefit time series of metro projects follow a very distinct pattern: they show very large net costs over long years of construction and the start-up period, followed by a very long stretch of years showing net benefits, often starting low and

increasing as the patronage builds up. This pattern is particularly stark when a metro proposal is measured against a do-nothing or low-cost option. In economic evaluation, a high discount rate militates against investments with this cost/benefit pattern because it allows a full impact of investment costs to be felt in the present value, whereas it reduces to a fraction benefits occurring 10-15 years later. The World Bank practice in project evaluation is to use a discount rate of about 10 percent, to represent the opportunity cost of capital, without actually going through the calculation of "shadow" interest rates in individual countries. Some economists argue that the rate should be adjusted upwards, to reflect the particularly high opportunity cost of tax-based public funds in poor countries. Others argue, however, that there is no empirical basis for the 10 percent rate: for decades, the price of capital in real terms has been about 4 percent *in real terms*, as has been the marginal return to equity investments. The adoption of a high discount rate is also seen by critics as a poor substitute for rigor in cost benefit analysis. The standard 10 percent rate may have erected a high barrier against long-gestation and long-lived projects, in effect working against the idea of sustainable development. Given the very large impact of discount rate where the project alternatives have drastically different expenditure patterns and economic lives, exactly the case when metros are compared against do-nothing and lower-cost options, the existence of diverging views among specialists casts a shadow on the use of a single discount rate. The practitioners should not take it upon themselves to decide whether one or another school of economic thought is right. It appears more sound to consider the value of discount rate as uncertain rather than fixed, repeating project analysis with several rates falling in the 4 to 10 percent range. A sensible procedure may be to calculate a switching value of the discount rate, at which a metro and a closest alternative are equivalent, and present the result as an essential input to decision makers. This approach reinforces the above taken position that neither single-valued forecasts or single-valued evaluation outcomes are appropriate when it comes to deciding on large, long-lived investments.

37. **Distribution of costs and benefits.** Aggregate methods of project evaluation are most useful when the distribution of costs and benefits over the affected population is balanced. Metros, however, are examples of projects with a potentially lopsided distribution of costs and benefits, including narrowly defined project impacts as well as externalities. Indeed, activities of interest groups in metro planning contexts are endemic, on local, national and international stages. The previously discussed potential for real property taxation is but one example of using distributive impacts of metros constructively. On a wider stage, the sheer scale of investment required by metros and distributive characteristics of metros increase the political content of the planning and decision making processes. The more a society is open, the more intensely political becomes the debate. For such major investments, therefore, the analytical techniques and in fact the entire project planning cycle must be designed to reflect the requirements of the political decision making. In some cases, this may be limited to mandatory impact studies, such as those addressing poverty, relocation or environmental quality. In other cases, it will include diverse forms of public participation, all the way to popular referenda.

38. **Implications.** The foregoing issues combined lead to the following implications for the project preparation process:

- ◆ Thorough diagnostic studies should precede any proposal involving metros.
- ◆ Incremental development of mass rapid transit corridors should be considered to the maximum degree possible.

- ◆ As evaluation proceeds from multiple and diverse options to one or two front-running options exhibiting marginal differences, more detailed evaluation methods, models and data should be used.
- ◆ Multiple development/demand scenarios should be explored.
- ◆ Results should be developed for discount rates in the plausible range of 4 to 10 percent.
- ◆ Multiple criteria analyses should be employed, with poverty and environmental concerns leading but by no means exhausting the list.
- ◆ Multiple scenarios and multiple criteria imply the necessity for sensitivity analyses, pointing away from the concept of option evaluation being a straightforward technical exercise leading to an unequivocal answer.
- ◆ Forecasts should identify policy variables which need control to ensure project success.
- ◆ As a special case of the preceding point, possibilities for joint planning of land use structures and mass rapid transit links should be explored.
- ◆ Project planning process should cohere with the locally-specific arrangements for public participation and political decision making.

Institutional Issues

39. **Project ownership.** The issues relevant to the implementation of a metro as a development project touch on all urban transport modes, both public and private, as well as development planning and municipal finance arrangements. Only a metropolitan level agency could exercise jurisdiction over that whole gamut of issues, and be the effective project "owner". The implication is that a project with such wide ramifications as a metro can only be conceived as a development project if there exists a local partner with requisite political and legal power. A key difficulty with large-scale mass transport projects in developing countries has been that there may be a strong coalition of interests behind a metro proposal, but no local institution that meets the above conditions. This is in sharp contrast with the situation commonly found when planning large-scale urban road projects, even in developing countries. The road sector exhibits well-developed institutions at state, regional and local level, with solid vertical integration and continuity of project planning activities.

40. **Municipal finance.** The capital requirements of large, indivisible, metro projects are likely to dwarf the capital budgets of most city governments in the short term, and loan servicing and repayment requirements continue to severely burden the current budgets thereafter. Few cities have managed to siphon off into municipal coffers enough of the growth in private wealth (which also fuels the increasing motorization) to meet the requisite financial burden. Even if there is a well-functioning system of non-earmarked intergovernmental transfers, national or regional government will usually have to become a partner in large public transport projects, typically through one-time capital grants or loans [World Bank, 1995]. (This is again in sharp contrast with arrangements for financing major roads, which often have a national designation, and make use of a vertically integrated planning and financing system). At the municipal level, assembling equity funds from other branches or levels of government is difficult, because of strong competition for funds between

cities or between sectors in the same urban area. Attracting earmarked capital grants from other levels of government thus becomes the major objective, overshadowing the project design process and often leading to poor investment choices. Such complicated financial relations among several governmental partners makes it difficult for a prospective external lender to appraise the creditworthiness of the nominal project owner. Given the heavy burden of large-scale metro investments on capital budgets of even the largest and best-off developing countries, their implications for other desired expenditures should be analyzed in a city-level public expenditure review, supplemented with macro-economic checks. Once these studies are done, the role of the World Bank as a confidence-giving partner may be essential when private co-financiers are present, even if the Bank's financial participation is minor or zero.

41. **Fares and subsidies.** With few exceptions, metro operating enterprises do not earn sufficient revenue to meet their full operating costs and many do not even cover their direct operating costs (staff, energy, parts and other materials, and external services). This is often a consequence of the imposition by government of low fares. The key arguments advanced for low metro fares include: (1) affordability to low-income groups; (2) compensation for undercharging private vehicles for the use of roads; and (3) spreading the cost of decreasing-cost urban transport industries beyond travelers to non-user beneficiaries, such as property owners or employers. What is an appropriate policy is best determined in each specific situation. Two general principles concerning subsidized fares can be stated however. First, an explicit subsidy policy should be developed related to perceived local problems and objectives. Second, whatever the level of subsidy derived from non-commercial objectives, it should be affordable to, and directly paid by, the sponsoring government.

Risk and Uncertainty.

42. Within the narrowly defined project sphere, we distinguish four different categories of risk which need to be considered in assessing new metros. *Evaluation risk* consists of choosing the wrong instrument, i.e. deciding to build a metro when another option would have been better in terms of social cost-benefit analyses. This might occur because local problems have been diagnosed poorly, the investment ill-matched with the problem, alternatives were too narrow, or the evaluation itself was sub-standard. *Closure risk* concerns the failure to actually go through with a selected project because the financing deal could not close, or the public approval failed to materialize. *Construction risk* refers to either construction costs or duration turning out higher than expected. *Operational risk* concerns the failure of an implemented project to perform in the way anticipated in terms of operating costs, patronage and revenues. If the World Bank is to participate in a project, then there is also *development risk*, referring to policy and institutional objectives well beyond the narrow scope of the investment itself.

43. *Evaluation risk* refers to the process and outcomes of economic benefit-cost analyses of mutually-exclusive project options, and is of relevance only to public sector decision makers, as well as institutions such as the World Bank who work with public-sector clients. Private sector investors do not carry out economic evaluation of investments. Metros belong among those projects where the governments have played the major role. The governments' input is important at various stages of the project, for example, financial participation in capital costs, work permits, land assembly, relocation of residences and businesses, relocation of utilities, permits for associated land-use developments, re-organization of the public transport system to cohere with the new metro, and the provision of nearly ubiquitous operating subsidies. It follows that the governments will continue to be major partners in metro-type projects, even if the role of the private sector is on the increase. Since economic

evaluation of projects is mandatory with many governments, and lenders such as the World Bank, it will remain as a major formal input into decision making. The paradox is that it is the private sector which is known for risk analysis of its investments, whereas the public sector appears to seek greater certainty in decisions. In democratic societies where project evaluation has its origins, the urge for certainty was probably generated by a necessity to reach political consensus, undergo open public scrutiny, and even get public approval through voting, all difficult to achieve when admitting contingency. This tendency may not be a serious shortcoming for many project evaluation contexts, but in those involving metro proposals, it is quite counterproductive. Given the above cited features of metros, it is essential to seek integrity in technical and economic studies, but it is illusory to seek certainty, and downright wrong to claim it. The challenge is therefore to acknowledge and respond to risks at the economic evaluation stage. This should be done through an appropriate study design, some elements of which were already suggested and will be detailed below, as well as changing the form in which the conclusions are stated. The "project justification" mode, characterized by a statement that "option X has an acceptable economic rate-of-return", should be replaced by one where the evaluation study informs the decision makers about the relative standing of the most attractive options, under a variety of assumptions about the future.

44. *Closure risks* affect both public and private sectors. The favored project may not be prepared to a sufficient degree of detail or emphasis for either private or public decision makers to commit the funds. Discrepancies between the forecast and the real may be large, with surprises derailing a decision to proceed occurring as late as evaluation of tenders for major works, not an uncommon occurrence. For the public sector, particularly in many developing countries, implementation can be inhibited by insufficient financing, or a lack of credit-worth. A decision to proceed without assured finance is highly risky and can turn even the most promising project into an uneconomic venture. It took Warsaw about 11 years to complete a 12-km metro line, all of it underground, and Calcutta is said to have taken 20 years for a 16.5 km line. For the private sector, metro projects are, by virtue of their size and strategic importance, particularly susceptible to political risks. These include government restrictions on the remittance of interest payments, foreign exchange risks, and policy interventions to control fares or impose social service obligations which will affect their commercial and operating performance.

45. Historic experience with *construction and operational risks* in metro projects in developing countries has not been good. Of the 13 metros in developing countries included in the TRL study, 7 had cost overruns between 20 percent and 100 percent, while 2 had cost overruns between 100 percent and 500 percent [Fouracre et al, 1990]; 8 out of 13 had time overruns of 20 to 200 percent. While there is much confusion as to what prior cost estimate should be used to compare against the final accounts, there is little doubt that overruns relative to cost forecast at the time of contract signature have taken place. A variety of technical, financial, institutional and political factors lie behind these, some of which could be easy to control and some less so. Conversely, traffic and revenue tended to be overestimated: Two out of 9 had overestimated traffic by 20 percent and 50 percent, and 5 out of 9 overestimated the traffic by 50 to 90 percent. These bitter experiences have led some analysts, particularly in the US, to conclude not that these metro projects were poorly prepared and/or poorly executed, but that even their very acceptance relative to other options had been wrong. For better or worse, bad forecasting has not been an exclusive feature of metro projects but of many undertakings involving large and complex works, as aptly illustrated by recent experiences with toll roads in Mexico and France, for example. The consequences, however, may be more serious politically for metros than for roads. A bankrupt toll road may be turned into a no-

charge road, which at least may be considered as covering its operating costs. When, however, costs had been underestimated or traffic overestimated for a metro, operating account shortfalls remain to torment the operator and its sponsoring government for years to come, even in a place as well off as the metropolitan Washington, DC.

46. Insofar as perceived risks prejudice the implementation of good projects it is essential to identify them and seek ways to reduce them. The Bank, acting on behalf of client governments, has a traditional focus on the economic evaluation stage, and should address the associated risks by solid diagnostic work and better design of project appraisal. In contrast the private sector focuses more on implementation and operation risks. Having identified the risks, the private sector typically seeks to manage them in a flexible way by using competition in the factor markets, buying insurance, adjusting product prices, seeking guarantees, seeking control over critical decisions, and/or passing risks to someone else. These approaches are complementary. Partnership between government, the private sector and the World Bank may thus improve projects by enabling each member to carry that risk category which it is best suited to control. Changes in the project preparation process to suit the requirements of each partner are called for, however, and will be proposed below. Political aspects of all risk categories should be carefully identified and addressed in contract or design. Private sector participation to reduce costs and attenuate construction and commercial risk may best be encouraged by the exclusion -both by contract design and where necessary by guarantee- of political risk. Construction and commercial risk can best be reduced by the introduction of commercial competition in all major elements of the project. Granting long-term concessions to the private sector may be the most appropriate instrument to achieve this. The question is when to do that.

47. When concessions are signed at the completion of works, or for already existing systems, an opportunity has been lost to bring the private sector's experience in project planning and management, including risk management, to bear early on in the project cycle. *Per contra*, when long-term concession agreements are negotiated following the feasibility stage, the private partners have all the incentives to help improve the project. There are precedents for trying to involve the potential private sector partners in even earlier stages of the planning process, as a means of reducing both evaluation and closure risks. This can be done by inviting private participation well before the convergence on one favored project option, to make a diagnosis of problems and propose a strategy, and may involve open modal or technological advocacy. A recent experience in Bogota indicates the relevance of this approach to urban transport planning for cities where local institutions do not have sufficient capacity to carry out the requisite studies themselves, perhaps not even to initiate, manage and interpret studies carried out by outside consultants. The city invited bids from interested parties to submit proposals for a mass transport project covering specified corridors. The received bids, based on bidders' assessment of problems, encompassed a variety of travelway and vehicle technologies. Expert consultants were commissioned by the city to evaluate bids. The process continued to the stage of contract signing for a project involving a build-and-operate an exclusive busway, but faltered when the investors judged the implementation risks too high against the received guarantees. The key risk had to do with the acceptance of the new scheme by the existing operators and speaks also to the problem of the political and legal power behind the proposal.

48. Indeed, a major problem experienced in some recent projects involving concessions is that private partners were seeking guarantees that the local governments were not willing or capable to make. This speaks well for the timeliness of the World Bank's recent efforts to use guarantees as instruments in development projects. Bank presence in large projects also tends to increase the credibility of the local partner vis-à-vis potential investors thus reducing the scope for guarantees and

improving their credit standing. Given that the magnitude of metro investments dwarfs past Bank loans for urban transport improvements, the most promising avenue for Bank involvement with metro projects may be less through classic lending operations and more through tripartite partnerships with governments and private concessionaires. Governments would contribute equity and functions that come with jurisdiction; the private partners would bring in major capital, the technological and operational know-how, market-based decision making, and an explicit risk management approach. The Bank's financial contribution, minor in comparison to that of other partners, would be supplemented by extending guarantees, assisting with planning and procurement, and adding a development dimension.

Implications for Project Cycle

49. **Preparation studies.** The combination of size, complexity and strategic significance of metro projects poses some difficult problems for an institutionalized project cycle like that followed by the World Bank. Normally, evaluation of public transport investments is done through a feasibility study, designed and monitored by Bank staff, but typically carried out by consultants under contract to the sponsoring government. The evaluation consists of two parts: (1) an economic comparison of mutually exclusive project options, and (2) a financial analysis of the operating enterprise. The study feeds into a formal "project appraisal" when its outputs are checked and taken over by a Bank project team, and used to write an appraisal report, a basis for presenting the project to the Board. Following Board approval, the consultants are commissioned to develop detailed engineering designs, costs estimates, and tender documents. The only opportunity to re-study the decision itself may arise if the lowest evaluated bid price for the agreed investment exceeds the engineer's estimate by a substantial amount. This would normally trigger a second tender, following a design and procurement review, but not a re-evaluation of options. The problem with this approach, when applied to metro projects, is that a study of multiple options is necessarily much less detailed than a study of a single option. The more options one has, a desirable feature at this stage, less detailed they tend to be. This applies to both construction cost and demand/revenue aspects of options. The Board decision is therefore made on the basis of a study less detailed than may be prudent for large projects, thus compounding evaluation risks with closure risks. Moreover, if private partners were to be involved as co-financiers, it would not be multiple options but the preferred option which would be the overwhelming focus of their interest, at a level of detail much exceeding that typically available in multiple-option analyses. The approach of reducing the planning study to a comparison of a metro option against a do-nothing option, by no means a rare event in site-specific studies, does nothing to reduce the evaluation risk. To resolve this problem, it is recommended to separate the wider-ranging studies of transport problems and multiple investment options, both at a strategic level, from a detailed feasibility study of a single, provisionally accepted option. Moreover, the decision whether or not to invest, by the Board and the external partners, should be moved to follow the latter study. The composition of the various studies, feeding the decision process, might be as follows.

- (i) **Urban transport strategy study.** This study is meant to provide the overall framework and orientation for actions in the urban transport sector for the city in question. It should be distinguished from the so-called "comprehensive transport-land use" studies, which are typically built around a detailed, large-scale modeling effort leading to a long-range structure plan. (The latter may in fact identify and test a rapid transit structure plan needed to "nest" individual MRT projects). The strategy development could be incorporated into the terms of reference for a comprehensive study, but it is best done separately to avoid being drowned out by the model building

effort. Ideally, it should be done following the comprehensive study, to profit from the collected data set. The strategy study should include: a diagnostic section on urban society, economy and its transport system; identification of transport problems, causes and issues; hypotheses ("vision") regarding urban futures; and propositions focusing on the key action areas for urban transport in any city. The standard building blocks of a narrowly defined urban transport strategy will as a rule concern the following: (a) pricing, management and investments for the road/traffic sector; (b) pricing, organization and investments for the public transport sector; (c) institutional responsibilities and mechanisms, inclusive of local/national relations; and (d) financial resource mobilization and allocation of the local government. Whether other action areas will be included in the strategy, for example those touching on land use development, special markets (for example, communities defined by income and/or by location), special suppliers (for example, the private sector), and special objectives (for example, air or water quality, safety) will vary from one city to another, and should be identified within the diagnostic phase.

- (ii) **Public transport options study.** The focus of an options study is a given, high-priority urban corridor, where earlier studies have identified a significant current or future transport problem and need for additional capacity. The options study has five distinct activities: (1) carrying out of a detailed survey and diagnosis of the status quo of land-use and transport activities in the corridor, from which a case is built that a major investment may be warranted to upgrade the public transport system in the corridor; (2) making a travel demand forecast; (3) defining a set of promising and mutually exclusive investment options in increasing increments of cost, starting with a minimal-cost upgrading of the existing infrastructure and extending towards higher-cost options, such as diverse rapid transit modes; (4) developing preliminary engineering designs and costs for each option, as well as the corresponding demand forecasts; and (5) carrying out of a multi-criteria evaluation of options. Though costing, demand forecasting and evaluation of options commonly receive most attention, the diagnosis of existing conditions and the generation of options are absolutely essential. The pathology of street traffic congestion and short-term trends can be easily misinterpreted and lead to less than adequate proposals. The inclusion or exclusion of certain options is guided by a combination of technical, economic and political criteria, some of which tend to be left in obscurity. The call for a multi-criteria evaluation means that an approach which aggregates impacts, such as standard economic evaluation, will be supplemented by partial analyses. This would accommodate diffuse impacts of projects such as metros and the existence of multiple objectives not easily collapsed into a single criterion. Partial analyses are meant to highlight the risks and trade-offs of diverse choices, be it in the cost/output terms, or in terms of impacts on diverse interest communities. At this stage of the planning process, the ability to test robust options against multiple future scenarios is more important than accuracy. It is therefore recommended that the economic evaluation be based on transport/land use hypotheses derived from a strategic-level demand model, which can handle a number of urban development and transport policy scenarios quickly and cheaply. The output of this study is not a demonstration that a given option is better than an inferior one (typically the do-nothing option). The output should be in the form of a brief for the decision makers, tracing the implications of

choosing amongst several promising options. In line with the above discussion of risks at this stage, it is essential to state the degree of confidence behind the brief, especially of the accuracy of the construction cost estimates if the top options are capital-intensive. There will be situations when one option would clearly outperform other options under a variety of possible scenarios and objectives. In other situations, several good options could be bunched at the top of the list, the choice depending on how close they contribute to achieving priority objectives of the decision makers. Following this study, the sponsoring government would decide what option, if any, holds most promise and whether to commit funds necessary for the next level of analysis.

- (iii) **Feasibility study.** Following the provisional adoption of a preferred option, the feasibility study would go to a considerably deeper detail as concerns the design and impacts of this option only. Variations in route location and/or design features which would not compromise the essence of what was provisionally selected would of course be included. The study would be designed to serve as input to a process in which government, private partners, commercial banks, and development banks decide their interest in the investment and negotiate the extent and terms of their participation. It follows that this study should be couched mainly in financial, not economic, terms. Its key objective would be to identify risks in each of the major cost and revenue categories of the proposed project. The study should cover the financial implications of the project itself, including construction costs, demand forecasts, pricing policy, and operating cost/revenue forecasts, under a variety of financing alternatives. It should also cover the finances of the local government, expanded into a local public expenditure review, to establish credit standing and/or indicate desirable changes in resource generation and allocation policies. Though the financial analyses of even the longest-lived investments tend to include life-long forecasts, their prime focus is on the costs and revenues of the construction period and the early period of operations which are pivotal to the success of the whole undertaking. At this stage, accuracy for the start-up period being preferred to stability of demand estimates, the use of policy-sensitive (disaggregated) demand models is warranted. The use of disaggregated demand modeling may also provide opportunity to expand on the poverty impact analysis done in the preceding study. On the cost side, the level of engineering design should be approached with flexibility, depending on site-specific conditions such as the degree and difficulty of underground construction. Under the best conditions, it may suffice to design at the level of preliminary engineering, aiming for accuracy and hence an overall contingency factor of 15 percent. In difficult situations, it will be necessary to go to the bid-level, detailed engineering and costing in order to satisfy the risk identification and allocation requirements of the financial negotiations. The surprises are, of course, still possible, and imply great care in designing the tendering process to achieve competition.

50. **Linking the investment project with other aspects of the strategy.** Although Bank investments have to be justified in terms of narrowly defined project costs and benefits, the essence of development projects is that they have important non-investment objectives. These focus on the adoption by the partner government of institutions and policies that point towards sustainable economic growth and poverty reduction. Investments in works and equipment can leverage policy

decisions by the partner government. Metro projects offer unparalleled potential in this respect. Their within-sector and cross-sectoral links both call for and permit a strategic approach involving both investments and policies. Foreign currency content of metro investments is high, making possible large loan size with unusually high leverage, increasing the probability of overcoming local resistance to substantial change and hence of a successful policy component.

51. The most critical problem facing urban transport policy in large cities of Asia and South America is that of reconciling the growth of motorization, itself a manifestation of economic growth, with the reduction of income inequality and the maintenance of a livable urban environment. Undercharging the use of road infrastructure is at the heart of this problem. Except for charges for parking and for use of purpose-built toll roads, urban roads are widely seen as a free public good. Proposals for network-wide charges have so far failed to gain widespread political or public acceptance. Recent research suggests that the political acceptance of road use charges will take place only if there is some compensation involved and that revenues generated from road use charges should not go into a general tax fund, but should be earmarked for road and/or public transport improvements. Still, there is a need for a catalytic event to bring this about. The introduction of a new metro line may be such an event, not least because it provides new capacity for "tolled off" road users. World Bank loans may leverage the adoption of a congestion reduction program through participation in a metro venture. This has been attempted, albeit in a weak form, in the Bank's project in Pusan, and should be actively and more ambitiously emulated elsewhere.

52. Investments in metros might turn out to provide sufficient leverage to address and make headway on some wider policy issues. Apart from its effect on traffic congestion, road use pricing has an important fiscal dimension. City-specific pricing for roads may be difficult to introduce if the country already has a high fuel tax. An attempt to reform the former will inevitably involve the latter, and may possibly escalate to looking at the general problem of state-city financial relations. Another area of interest which also involves fiscal sources touches urban land use. The popular approach of using development rights and joint development agreements focuses on a few large private-sector partners and a priori contributions against risk-laden, future gains tied to a specific metro project. It has proved to be of limited potential even under such propitious circumstances as in Hong Kong. The alternative, or a complement, would be to expand both the number of contributors and the time scale of contributions by introducing or reforming local real estate taxation.

SYNTHESIS OF RECOMMENDATIONS

53. Previous Bank urban transport policy may be characterized as indicating that metros may be necessary in exceptional cases and would be considered for financing when they are "likely to produce high rates of return" [World Bank, 1986]. In truth, neither the state-of-art of economic evaluation of metro projects nor its quality as practiced by consultants working in developing countries are strong enough to justify treating the assessed economic rate of return as both necessary and sufficient condition for project acceptance. It is simply too narrow, doing injustice to the complexity of the subject of cities in developing countries and their strategic decisions in the transport dimension. What is recommended instead is a wider appraisal process and a recognition of the contingent nature of outputs. The guidelines set out below stay as much as possible within the standard Bank framework for working on development projects, making adjustments necessary to reflect the size and risk of investments in metros, the magnitude of externalities, and the fuzziness of the boundary between the variables and constraints characteristic of urban transport systems in developing countries.

54. The major recommendations for consideration of metro projects are as follows.

(i) Examine the potential of metros and other public transport options in the context of local problems.

Too many studies involving metros take the approach of a solution looking for a problem, with little work done on problem diagnosis. This should be rejected:

- ◆ *no project proposal should be discussed unless the basic collection and evaluation of the relevant data has been done;*
- ◆ *the key input/output features of metros should be compared to those exhibited by the competing options, with specific reference to local problems and objectives;*
- ◆ *the degree of segregation and the location of the travelway should be treated as the pivotal factor in both cost and performance assessment; and*
- ◆ *within each travelway category, different vehicle types should be compared with explicit reference to service regimes.*

(ii) Plan metro projects as components of a wide-scope urban transport strategy

Metro proposals should be evaluated as components of a comprehensive urban transport and land use strategy, using the leverage of the investment to achieve the adoption of some crucial elements of the strategic package. Specifically:

- ◆ *projects must be integral elements of the overall strategy, particularly as concerns the coherence of investment, organization and pricing policies for individual and public transport modes;*
- ◆ *transport policy reforms which are prime candidates for leveraging include the introduction of congestion pricing of urban roads, parking pricing, and non-price congestion management;*
- ◆ *metro investments should also be used to leverage the introduction of real estate taxation, or other locally-based resource mobilization schemes, seen as parts of the cost recovery campaign; and*
- ◆ *development projects cutting across several modes or even sectors will have multiple objectives, hence will have to be evaluated using a multi-criteria framework.*

(iii) Evaluate alternatives with a clear acknowledgment of the risks involved

The wide experience of cost overruns and patronage/revenue under-runs relative to values cited in the decision making process, as well as irreversibility of investment decisions, the size of the cost burden, and their long useful life, place metros in the category of risky projects. It follows that:

- ◆ *cost-benefit studies should be used as tools for exploration and learning in the context of studying multiple options and futures;*

- ◆ *economic justification of metros based on single-valued long-term forecasts of costs and benefits is inappropriate;*
- ◆ *evaluation should be staged, with a more detailed technical and financial study of the option provisionally selected for final decision making focusing on the period of construction and early years of operation; the financial package should not only refer to initial capital requirements, but also to those regarding loan repayment and operations;*
- ◆ *factors that have to be controlled, a corridor land development program before all, should be identified within the project analysis; and.*
- ◆ *integration of the proposed project into the existing transport system is essential; in developing countries, given oft-observed political power of on-street operators, achieving integration goes well beyond the technical design of feeder lines and transfer terminals.*

(iv) Seek partnership with the private sector as a means of risk management

A recent trend is for the private sector to become co-investor in the provision of public infrastructure in the framework of long-term concessions. This implies giving increased attention to:

- ◆ *the division of function, and risk, between public and private sectors;*
- ◆ *financial evaluation as the main analytic aid in the project implementation process; and*
- ◆ *possibilities for the Bank to offset political risks through guarantees.*

(v) Ensure that the local community has a financial stake in the project

The bias towards capital spending often induced by the nature of fiscal relations between national and local governments, including the existence of ear-marked capital grants programs in some countries, should be reduced by ensuring:

- ◆ *technical integrity of preparation studies for metro proposals; and*
- ◆ *significant local stake in such projects in the form of equity participation and the responsibility for downstream repayment of debts.*

(vi) Explore the effect of metro-related expenditures on the entirety of public expenditures for the urban area

Investments in metros tend to be among the largest ever made in any given city with financial impacts not only at the city level, but also at the macro level. This implies that:

- ◆ *the scope of the financial analyses should be extended beyond the narrow confines of the project itself in the direction of public expenditure reviews; and*
- ◆ *necessary additional resource mobilization measures should be identified as part of the appraisal.*

(vii) Develop a fare policy in conjunction with an explicit subsidy policy

Large urban public transport undertakings often experience financial problems far in excess of those forecast in the project preparation process because fares are used as a tool in social policy or second best traffic management policy. This implies the need for

- ◆ *an explicit subsidy policy based on site-specific data;*
- ◆ *consideration of alternative subsidy mechanisms, including direct subsidy targeting the poor, taking the transport operator out of the social assistance loop; and*
- ◆ *incorporation of the subsidy policy within the public expenditure review.*

(viii) Examine impact of the proposed on the low income population

Low income populations may be affected by the construction of a metro line in a number of ways. This implies the need for examination of likely impacts, including:

- ◆ *direct effect on access to jobs and other opportunities, including the time and money costs of travel for low income communities;*
- ◆ *indirect effects on the existing public transport system, and*
- ◆ *resettlement.*

(ix) Ensure equal treatment of public transport and roads in pricing and investment rules

Application of the above principles only to capital-intensive public transport projects could bias urban transport futures towards road construction. It is therefore recommended that:

- ◆ *the wide-ranging consideration, such as proposed herein for metro proposals, be also applied to strategic road investments, irrespective which level of government is responsible; and*
- ◆ *the pricing policy for public transport is coherent with that for the use of roads.*

(x) Appraise the local partner as part of the project appraisal

The wide scope of the above propositions for metro projects and the associated strategy poses institutional requirements much higher than having an effective implementation agency. It is recommended that:

- ◆ *local "ownership" of the project has to take the form of a strong political alliance, preferably with broad public participation;*
- ◆ *the local partner must be an institution or institutional grouping whose jurisdiction and resource powers cover all major elements of the proposed strategy.*

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