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Metros in Developing Cities—Are They Viable?

Over the past decade, to build or not to build mass rapid transit (MRT) systems is a question that has spurred sharp debate.

Some analysts argue that while these large-scale, rail-based, mainly underground rapid transit systems are beneficial at various levels, they are phenomenally expensive: On average, the lines completed most recently run an astounding $50 million to $165 million for each kilometer.

Moreover, critics stress that such immense sums, plus the ongoing subsidies needed to operate the systems, absorb an unjustifiable amount of public funds. In Manila, for example, construction costs over five years took between 45 and 65 percent of all municipal revenues available for capital projects. Thus, critics argue that MRT expenditures are well beyond the means of most developing countries buffeted by heavy deficits and huge competing demands for resources.

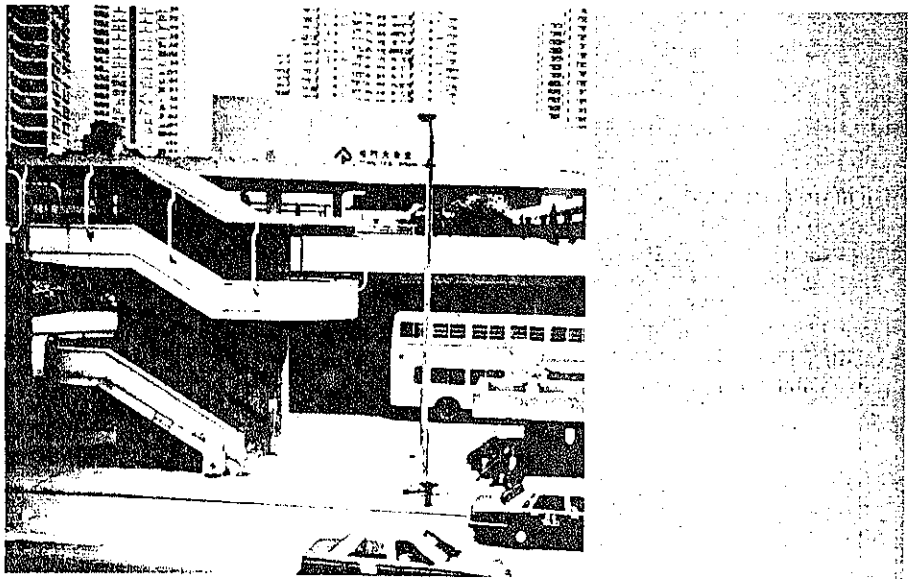
Others insist, however, that cost considerations alone are inadequate; rather, that factors such as convenience, the environment, safety, performance, and economic development must be weighed into the equation.

Until last year, planners and government officials wrestling with the issue—in both the developed and developing world—found relatively little information about the experience of systems built in recent years.

To fill the void, the British Overseas Development Administration, working through the Transport and Road Research Laboratory (TRRL), with the technical support of the World Bank, commissioned a study of 21 cities in the Third World where metros are either operating, under construction, or planned.

Nine cities had established MRTs—Hong Kong; Manila (Philippines); Mexico City (Mexico); Porto Alegre, Rio de Janeiro, and São Paulo (Brazil); Santiago (Chile); Pusan and Seoul (Republic of Korea). Four had incomplete but recently opened systems—Cairo (Egypt); Calcutta (India); Singapore; and Tunis (Tunisia). Two were under construction—Istanbul (Turkey) and Medellín (Colombia). And six were developing plans—Bogota (Colombia); Bombay and Delhi (India); Jakarta (Indonesia); Karachi (Pakistan); and Kuala Lumpur (Malaysia). Singapore and Hong Kong, which are no longer classified as developing cities, were included in the survey because they were in this category when the systems were planned.

The task given to the London-based consulting firm of Halcrow Fox and Associates was to gather details on



costs and revenues, on the quality of the plans, and on the performance of the various completed systems. The sponsors felt that if governments and donors were armed with this information, they could grapple more effectively with the decision of whether to approve a metro.

To determine what lessons could be learned, the research team visited all 21 cities to find answers to the following questions:

- What other schemes, besides metro projects, did governments pursue to resolve transport problems?
- By choosing metro systems, what did the 21 cities hope to accomplish?
- How thorough and appropriate were the plans that led to the go-ahead decisions?

Of the cities where metros were operating, other questions included:

- What was the quality of the construction?
- How well do the systems operate?
- What effect have metros had on physical, financial, and economic conditions?

Another aim was to create a quick and simple method to screen future projects in developing cities.

Finally, the researchers were asked to conclude under what circumstances metros can be justified and what role the various aid agencies can play in supporting the efforts.

The 21 cities: A profile

All the cities studied have populations of over 1 million, most have over 3 million, and the largest, São Paulo and Mexico City, have 16 and 19 million, respectively.

The researchers first looked at the cities' overall transport policies to learn what other measures had been taken to resolve transport problems. To one degree or another, all had adopted traffic management schemes such as junction components, traffic signal systems, and lane markings. Parking restrictions had been introduced, but these were poorly enforced. Where fees were charged for parking in central business districts (CBDs), they were often low. None of the cities except Singapore had seriously tried to limit the use of private cars in CBDs, although Hong Kong had levied high vehicle taxes to restrict ownership.

With regard to investments, 17 cities were building extensive road systems; five had introduced and were operating bus lanes, as had several others, but in the latter, they were not enforced; six had introduced light rail systems; and many had upgraded suburban railways.

Private bus lines were allowed to operate in 16 cities: In eight of these, the bus system relied entirely on private companies, while in the other eight, private and public operated alongside each other. Five cities had only public bus service, and 13 allowed some form of paratransit (for example, minibusses).

Expectations and realities

The study, which cost about $250,000 and was completed in just 15 months, found that the major reason for embarking on such a huge undertaking was to improve the quality of public transport. In all the cities, busses were severely overcrowded and slow, and the hope (especially in Latin America) was to produce systems that would provide more capacity and increase travel speeds.

The second goal, particularly for those in the Far East, was to relieve traffic congestion. Once this was accomplished, it was thought that accidents, pollution, and energy consumption would be reduced. The expectation was that many would stop driving their cars and, at the same time, bus riders would chose the new rapid transit system, thus reducing the number of busses on the road.

The researchers found that public transport was indeed improved, that nearly all the systems are well operated and provide good service. The report notes also that changes in both the quality and quantity of public transport were dramatic and that the greatest single benefit was the saving of time: A 12-kilometer bus trip that typically took 40 minutes was reduced to a 15-minute metro ride. Moreover, riders no longer endured overcrowding or the delays from traffic jams and exposure to noisy, polluted streets.

In addition, metros were moving huge volumes of passengers—up to 75,000 an hour, one way. This is triple the capacity of a busway (segregated bus lane), which can carry 25,000-30,000 riders. Transport specialists, however, are quick to point out that the price tag is more than triple, since surface busway systems cost just 20 percent of an underground mass transit system.

According to Richard Scurfield, an urban transport specialist with the World Bank, the second goal—to reduce congestion and pollution—was not achieved.

"In the short run, some motorists may switch to metros, but the space their cars once occupied quickly becomes filled by other motorists who decide to drive, when the original congestion is relieved.

"Moreover, the number of busses often remains the same, because many riders do not switch to the metro. First, the stops are farther apart and thus less convenient. Second, because metro fares are frequently higher than for the bus, they are usually unaffordable to the poor. In addition, although metros may reduce some of the busses' overcrowding, they still are heavily used," he explains.

Thus, according to the report, congestion is still severe in Cairo, Calcutta, Seoul, Tunis, Santiago, and Rio de Janeiro. In Hong Kong, while the metro did indeed absorb many bus riders, those who still used busses lobbied heavily and successfully to keep the lines operating. There was also no evidence that the number of cars in the city center was reduced. In São Paulo, congestion was initially reduced but is currently heavy. Only in Pusan did the

metro absorb one third of bus passengers, and congestion is thus no longer a problem.

The TRRL report notes also that truck traffic has been virtually unaffected. Further, it observes that when comparing cities with and without metros (such as Bangkok, Jakarta, Delhi, or Lima), traffic conditions are about the same.

According to Jeffrey Gutman, chief of the World Bank's division for transport planning, policy, and research, providing public transport options at low fares, whether metros or busses, is "not enough to lure people away from their cars as motorization continues to grow."

He insists that in addition to good public transport alternatives, governments will have to attack urban congestion through a combination of measures that includes the proper pricing of automobiles in the city center—levying substantial charges on those who choose to drive into the CBD. To this end, he notes, "Increasingly, once-reluctant national and local governments are looking at road pricing as a viable instrument. Singapore has done this effectively. And while other governments have not taken this particular step, more and more are introducing parking charges and urban tolls."

Mr. Gutman adds that the availability of technology that can electronically levy fees on vehicles may broaden the options.

What would have happened if no MRTs had been built? The authors argue that when roads reach the saturation point and congestion is a daily occurrence, "traffic will cease to grow ... conditions reach the threshold of the intolerable, and people will avoid the road by any means possible." In addition, city centers may stop developing; further, if authorities wish these areas to continue growing, they may need the metro systems. Other analysts, however, argue that city center growth depends on a number of variables, and cannot be attributed solely to the existence (or lack) of a metro.

OVERRUNS IN CAPITAL AND OPERATING COSTS FOR METROS IN U.S. CITIES

Heavy Rail Transit Projects

	Washington	Atlanta	Baltimore	Miami
Years to Which Data Apply				
Forecast data	1977	1978	1980	1985
Actual data	1986	1987	1987	1988
Annual Rail Operating Expense (millions of 1988 dollars)				
Forecast	66.3	13.2	not forecast	26.5
Actual	199.9	40.3	21.7	37.5
% difference	202	205	—	42
Rail Project Capital Cost (millions of 1988 dollars)				
Forecast	4,352	1,723	804	1,092
Actual	7,968	2,720	1,289	1,516
% difference	83	58	60	39

Source: U.S. Department of Transportation, 1989.

Costs grossly underestimated

Perhaps the most glaring discrepancy between plans and results is in the area of costs, since both capital and operating costs in almost all the systems far exceeded the amounts predicted—a phenomenon in both developing and developed cities alike (see chart, above).

When making this observation, the authors note they do not imply that metros ought to make a profit—because maximizing profits is not usually government policy. But they add that "most governments were led to believe that their metros would be financially viable, which they certainly are not."

Construction costs in three fourths of the cities were far above the amount projected. In Seoul, for example, cost overruns on two lines were about 35 percent in real terms. In Manila and Santiago, overruns were between 60-100 percent; in Cairo and Medellín, they were over 100 percent; while in Calcutta and Rio de Janeiro, the figures soared to over 500 percent. Only the Hong Kong, Singapore, and Porto Alegre mass rapid transit systems were completed within budget.

Flaws in the plans

Why were estimates so mistaken? According to the report, important changes in the metro system were made in over half the cities—which translated into vastly higher costs. In Manila, for example, authorities decided to elevate a line that was originally to be built at ground level. In Istanbul, 3.2 kilometers of a line were placed underground (for environmental reasons), instead of at grade. In Medellín, a line originally planned to

bypass the city center was rerouted to go through it.

Moreover, projects took an average two years longer to complete than projected, which affected the total price tag.

Mr. Scurfield explains that postponements are often due to unexpected problems such as the need to reroute utility lines. "Until excavations begin, it's impossible to know with certainty what lies under the street in a crowded city center. And unless a substantial contingency is made for this in cost estimates, the figures will be badly off." As the report notes, unexpected service diversions proved very costly in Tunis, Cairo, Istanbul, and Calcutta.

Construction can also be delayed by disputes among some of the various principals (as occurred in Tunis and Rio de Janeiro); by problems in acquiring land (as happened in Tunis, Cairo, Istanbul, and Calcutta); by difficulties with import licenses (as in Medellín); by a shortage of materials (as in Manila); or by inadequate finances (as in São Paulo, Calcutta, and Rio de Janeiro). Only Hong Kong, Seoul, and Singapore completed their systems on schedule.

Delays, the report explains, "add to costs through accumulated interest, cancellation charges, underemployed labor and plant, and extra costs of management, supervision, and security."

The report also stresses that original cost estimates were overly optimistic and assumed that construction would proceed without delays. Further, although the estimates were raised by 15 percent—to account for inflation and contingencies—this was hardly enough to cover the overruns.

Additional problems included unexpected devaluations, which occurred in several countries and raised the real cost of borrowing.

Further, unforseen problems added to the price tag—as happened in Cairo, where soil conditions required expensive construction. In the same manner, Calcutta was forced to adopt a more costly method of construction because the conventional method led to intolerable disruption of traffic.

Finally, the authors insist that whether mishaps are due to chance or poor management, they inevitably occur and inflate costs: For example, excavations in Calcutta were flooded and in Istanbul, some caved in. In Manila, the principal contractor went bankrupt.

When is mass transit feasible?

According to transport specialist Roger Allport, certain conditions must be met:

1. Existing demand must be high, at least 15,000 riders an hour during peak hours on a major corridor.
2. Cities must have a population of at least 5 million. Exceptions are cities such as Pusan or Singapore, which have developed in a linear manner and population is dense along a proposed metro corridor.
3. Cities must have high enough income levels (an average above US$1,800 per capita) to attract enough riders who will pay the metro fares. Also, since the major benefit will be a savings of time, income must be sufficiently high that riders will value the savings and choose the metro over the bus.
4. Because most of the benefits depend on economic growth, plans that project sustained development must be realistic. Too often, assumptions are overly optimistic and appear more like wishful thinking.
5. Metro lines must flow from the periphery to the city center, down a major corridor, in order to attract all the riders who have some activity in the center, as well as to provide for its continued development (if that is perceived positive by authorities).
6. Fares must be set at levels that riders can afford and should be graduated (increasing with distance).
7. Systems should be managed by new companies that are autonomous and therefore capable of creating new modes of operation and management

They conclude that the errors that led to the overruns occurred mainly in the planning process: Either proper studies were not made because authorities wanted to begin quickly or the analyses were completed long before construction began; and, as they were followed by long periods of debate and procrastination, when work finally started, many of the variables had changed. But, as updated studies would have meant still more delays, these were rejected.

Operating costs (such as for management and maintenance) were equally underestimated and revenues overestimated. At the time the metros were designed, planners justified enormous outlays on the grounds that new MRT systems would attract mass ridership and generate enough revenues to recover both capital and operating expenses. But the riders projected simply did not materialize.

According to Roger Allport, one of the authors of the report, the disappointing levels of ridership in eight cities were due to the routes chosen for the metros. In Porto Alegre and Santiago, designers tried to find lower-cost alternatives, where the metro could either be elevated or built at ground level, which would eliminate the extremely costly task of building tunnels under a densely developed city center. As a result, lines were located a half mile away from the center. Thus, while it is true that designers succeeded in reducing costs, they also reduced the number of people who use the system.

In Rio de Janeiro, ridership estimates were based on calculations about future development: The idea was that metro construction would stimulate private sector development or government housing construction. But, according to Mr. Allport, the development never occurred.

"This is a high risk strategy, and can prove disastrous," he says, adding that "a metro can only succeed if one can be absolutely sure of huge numbers of riders."

Based on the researchers' findings, the gulf between the number of passengers forecast and the number actually carried in almost all cities is immense.

	Forecast	Actual (in millions)
Cairo	566	150
Calcutta	470	19*
Hong Kong	683	532
Porto Alegre	72	36
Pusan	350	79
Santiago	330	139
Seoul	1,750	854

**Only half the line was open.*

Gerhard Menckhoff

Another factor accounting for diminished revenues is that governments set metro fares at a level low enough to allow a substantial amount of the public to ride.

Slobodan Mitric, a transport engineer at the World Bank, notes that governments traditionally set low fares for metros and public transport in general, often not adjusting them to reflect increased costs. While the stated reason is to allow lower-income people to use the transport, it is also the case that fare increases have fanned tensions and even street riots, so governments have acquiesced.

Mr. Mitric says that "as often happens when goods or services are open to everyone, benefits intended for the poor end up 'leaking' to people who should not be subsidized at all. And, not enough has been done to identify target populations and devise ways to limit the leakage."

He also stresses that, on the cost side, those involved in planning typically underestimate direct operating costs—staff salaries, fuel, spare parts, and various taxes—at the feasibility study stage. Further, staffing ratios presented in the plans are largely based on what is technically necessary, which results in relatively low ratios—while the actual numbers turn out to be much higher.

Moreover, operating costs have been greater than anticipated, due, at least in part, to the segregated nature of the systems.

"Metros operate in separate tunnels, stations, and elevated tracks, and the cost of maintaining these areas must be absorbed completely by the metros, alone. In contrast, public transport operators whose vehicles share streets with other traffic, are not responsible for road maintenance," he says.

Reduced revenues and higher-than-expected capital and operating costs translate into operating deficits. And, Mr. Mitric observes, "the long-run problem of financing these deficits remains in the background at the planning stage but emerges to haunt authorities and operators, afterwards."

He warns that because the gap between revenues and costs persists indefinitely, governments must face the question of how to finance that gap.

He notes that, until recently, financial forecasts over the life of metro projects (or for reasonably long periods) were not included in feasibility studies and most urban governments did not have budgeting systems that could make full use of these projections, even where they were provided. "In developed countries, shortfalls are also ubiquitous, but authorities find alternate means to finance them. However, this is more difficult to achieve in developing countries," he says.

Hong Kong's success

According to Mr. Allport, only Hong Kong's metro can be considered financially successful (although it still received $1 billion in equity contributions from the government). One of the reasons he offers for its unique position concerns the city's layout and dense population. "The main statistic that separates Hong Kong from the others is that an average of 50,000 people live within walking distance from each of the stations, which are about 1 kilometer apart," he explains.

Another reason is that authorities engaged in a good deal of planning, weighed the options, and made a rational decision that the public would benefit from a metro. While this process seems unremarkable, it differed from the norm, where cities often decided to build metros because of pressure from manufacturers, he observes.

Further, once the Hong Kong government decided to proceed, it committed sufficient resources to insure the work would be completed. The commitment also guaranteed that construction was given top priority—at every turn.

Elsewhere, the story was not so positive. In several cities, governments changed and funding was halted. As a result, work stopped—as occurred on

one of Rio de Janeiro's lines—and morale plummeted.

"To this day, the funding tap in Rio is still turned off and on, which affects maintenance and, subsequently, daily operations, since many of the metro cars that should be in service are broken," says Mr. Allport.

Another aspect of Hong Kong's success is the fact that the government owned the land in the center city. In addition to the enormous subsidy this implies, the government was able to allocate whatever was needed to the Mass Transit Railway Corporation, the autonomous agency created to manage the metro. "Having the capacity to acquire land without delays is a critical factor, and the inability to do this caused serious setbacks in several of the cities studied," he says.

Mr. Allport notes also that the Mass Transit Railway Corporation, along with private developers, constructed large residential and commercial complexes above the metro stations, and the rents the corporation currently collects contribute substantially to revenues.

But the most important result of this development had to do with attracting potential riders. "Locating 25,000 people on top of a metro station gives you a captive market," he explains.

Integration: Is it attainable?

Integration of transport systems takes various forms, and the degree to which some of the measures are achieved can be essential to a metro's health.

Full integration implies, first, that feeder bus lines should be provided to enable riders who do not live within walking distance to gain access to the metro. Second, a single fare should be established that allows passengers to transfer from one mode of transport to another without having to pay twice. Third, bus routes paralleling the metro should be curtailed. In addition, metro station exits should be located close to major bus stops, taxi services, and car parks.

Despite the advantages to be gained from such linkages, the report notes, full integration is rarely attained. In fact, of all the cities studied, only São Paulo fully integrated the busses and metros using the same corridor, with the result that half of all metro passengers transfer to or from busses.

In the course of interviews, the researchers learned that governments were indeed aware of the importance of introducing feeder bus service and that it was planned in all the cities studied. To date, most have attained such service, developed either spontaneously by bus operators or the government. However, several have still not achieved this: Only one feeder line was set up in Calcutta, a few were begun in Rio de Janeiro and Pusan, and none was introduced in Cairo.

The report observes that integration with bus lines can be attained if bus operators respond to reduced demand and remove routes that are no longer competitive or needed. Most often, however, integration is only obtained when governments take the initiative, and such actions can be unpopular.

To this end, authorities planned to remove busses along the metro corridors in 13 cities—in fact, the number of riders projected for the metro was calculated on the assumption that the new MRT would be the only transport system on a given corridor. But this has been accomplished in only two cities. When authorities tried to eliminate bus routes elsewhere, the public resented the disruption to its normal travel patterns, particularly in cases where metro fares were higher than the bus. In some instances, the attempt provoked social unrest—which ultimately led to the reinstatement of the bus lines.

Integration of fares was promoted in eight cities, but has been introduced in only four—Porto Alegre, Rio de Janeiro, Santiago, and São Paulo. In a fifth, Mexico City, fares are so low that, even without an integrated scheme, two fares pose little problem for riders. In Calcutta and Cairo, however, metro fares are higher than those of busses and trams and, as a result, the metro is used largely by the middle class.

A problem that arises with integrating fares is that the system essentially works best with only a few large bus operators in the scheme, because revenue sharing between the metro and busses is difficult to achieve when many principals are involved. Thus, a number of small operators may be eased out during the process of consolidation, thereby reducing the competitiveness of the services.

Lessons from attempts thus far to integrate systems and fares are:

- If the combined fare is higher than a single bus fare, low-income riders will continue to use the bus.
- Revenues must be shared between the metro and bus operators. However, bus operators, who have considerable influence (since they are essential in any integrated scheme), may demand a

(continued on page 10)

Additional readings

Towards a more realistic assessment of urban mass transit systems," J.S. Gutman and R.G. Scurfield, *Rail mass transit*, Thomas Telford, London, U.K., 1989.

"Rail mass transit in developing cities—the Transport and Road Research Laboratory Study," J.M. Thomson, R.J. Allport, and R.R. Fouracre, *Rail mass transit*, Thomas Telford, London, U.K., 1989.

Urban Transit Systems: Guidelines for Examining Options, Alan Armstrong-Wright, World Bank Technical Paper Number 52, Urban Transport Series, Washington, D.C., 1986.

Urban Transport: A World Bank Policy Study, Washington, D.C., 1986.

World Bank documents can be obtained through the World Bank publications department, 1818 H St., NW, Washington, D.C., 20433, USA.

(Continued from page 6)

disproportionately large part of the fare. This, in turn, reduces metro revenues.

Who benefits and how much?

Based on interviews and results from an evaluation model the consultants developed, the key advantage to riders is time saved. After this, the two most important gains are relieving discomfort (from the overcrowded busses) and generating additional trips by those who were previously not travelling.

The greatest benefit accrues to those who formerly rode the busses regularly: Riders who switched enjoyed a faster and more comfortable mode of transport; moreover, those who continued to ride the busses also gained, because overcrowding in most cases was dramatically reduced.

Contrary to expectations, however, motorists and motorcyclists gained little. In addition, small bus operators occasionally lost a sizeable portion of their riders. Governments also stand to lose, say the consultants, from the ongoing subsidies they have to provide the metro.

For these reasons, Mr. Scurfield suggests that before cities embark on metro projects, they should study and price the cheaper alternatives, such as bus lanes, segregated busways, improvements to the road network, light rail systems, and extensions to suburban rail lines. He stresses that surface construction for a light rail system is just 20 percent of the cost of an underground system; and the other options, such as busways and bus lanes, are even cheaper.

Mr. Scurfield warns that cities seriously considering metros should be aware that, even if capital costs are absorbed by central governments, operating costs for rapid transit systems can easily absorb 10 percent of municipal budgets.

Further, he notes that "because metros tend to benefit middle-income groups—since the poorest generally don't ride them—governments must decide if they really want to subsidize this part of the population."

Incremental development

Mr. Scurfield states that cities wishing to improve public-transport should consider incremental developments to their systems. "First, they could put in busways. Then, when the area reaches a certain density, these could be replaced with light rail systems, particularly in the suburbs. Eventually, if the numbers warrant, an underground system could be introduced." He cites Brussels and Dusseldorf, which initially had non-segregated tram lines that shared the road with other motorized vehicles. Later, these cities added light rail in the suburbs and underground trains in the city centers.

The role of donor agencies

As developing cities continue to expand and search for more efficient modes of transport, donor agencies will increasingly be asked to support the construction of metros. Until now, large multilateral institutions have rejected these projects on the grounds that the initial investment needed is so large and the ongoing subsidy is so great (as the metro will never be self-financing), that metros cannot be justified under any conditions.

However, some analysts argue that certain projects proposed in the past few years may have merit and should be considered on a case-by-case basis.

The report also notes that donors may be asked to fund extensions to existing systems, which might be "easier to justify and certainly less risky."

But, according to Gregory Ingram, principal advisor, policy and research at the World Bank, metro investments must be considered in the macro framework of developing country economies.

"The Bank sends teams to review public sector expenditures and to reduce public sector deficits. And the TRRL survey shows that all the metros studied in the developing countries have operating deficits. Thus it would seem that those which face severe shortages of investment finance, have debt problems, and are undergoing structural adjustment, have better uses for their funds than to build metros," he states. He continues that "the first consideration the Bank makes in analyzing projects, including metros, is economic criteria."

Mr. Scurfield notes that transportation plans and land use plans should be seen as a whole. At the most fundamental level, he adds, "governments must look at whether they can afford these systems when compared to other priorities such as drainage, sewerage works, schools, and the like."

Some researchers observe that new funding arrangements could be designed so as to attract private sector investment.

Along these lines, Peter Midgley, an urban transport specialist in the World Bank's Asia department, points to the case of Japan, where in many major cities, private companies invested in the construction and operation of MRTs as well as in the development of land along the corridor (usually for housing) and at the stations (for hotels and shopping centers).

"Private corporations stood to benefit from the land development and the ridership this development would generate. It made financial sense and provided a needed public service," he explains.

Mr. Midgley adds that Japanese systems were built 30-60 years ago and the lead time for the overall developmental benefits of these systems to materialize was at least 30 years. Thus, we need to take a longer-term view of the results and better understand the mechanisms involved in their success. He stresses it is this avenue that should be explored, to see if the concept of substantial private sector involvement could be applied in developing cities, especially in the more dynamic economies of Asia. UE