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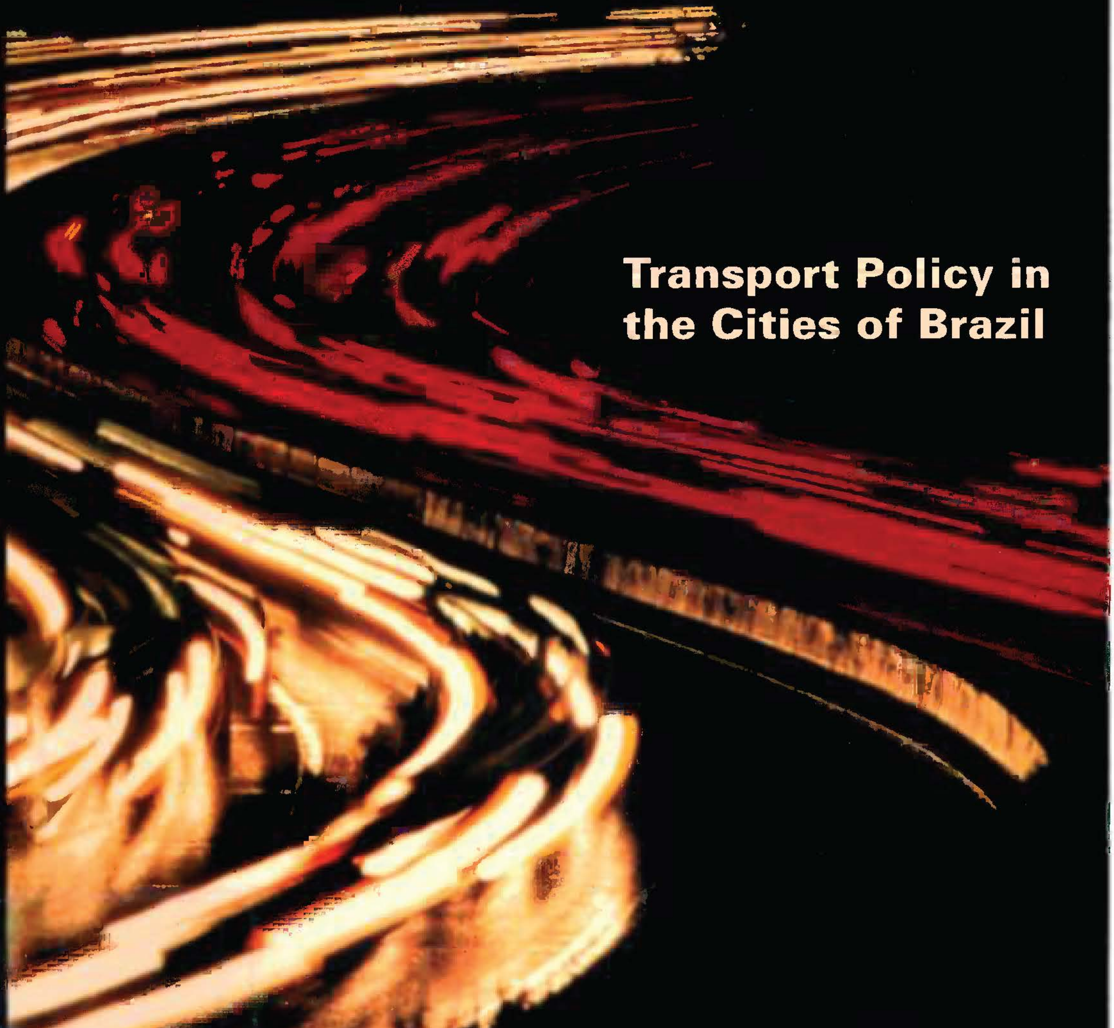

Transport Policy in the Cities of Brazil

Alan D. Poole
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Contents

Preface

What is the relation between urban transport and issues of environment, energy, and social equity? This question is best answered through a broad analysis of urban transport, including a systematic treatment of relevant institutional, financial, technological, and economic problems. Without addressing these problems, environmental, energy, and social objectives can never be achieved.

Brazil is a country whose study is fertile with implications for the urban transport policy of developing nations. Many of Brazil's problems are common throughout the developing world. It is also a continental country with an important political and economic mass and a diversity of design and policy problems. Its urban transport sector is relatively organized and has been the subject of many studies.

This book introduces the problems, possibilities, and choices facing urban transport in Brazil. Although far from complete, it reviews a broad range of subjects, seeking to stimulate a more integrated approach to relevant policy issues. Most of the ideas are familiar to urban and transport specialists, but the synthetic work that this book documents is scarce in developing countries. As such, it will be of interest to the professional community, both within Brazil and internationally.

It will also be of use to a wider audience. Urban transport policy is relevant to both energy and environmental concerns, for example. In the future, these concerns are likely to carry greater weight in urban transport policy. In the past, interventions to promote environmental or energy objectives have often been unsuccessful. Their usefulness has been limited by an inadequate understanding of the factors conditioning urban transport. This book will also interest all those concerned with social equity and welfare in the developing world.

Broad conclusions are reached regarding the diagnosis of the situation, guidelines for policy, and areas needing analysis. Some ideas and approaches of interest are presented. However, there is no pretence of suggesting an "agenda for action" or even for research. To achieve this, much more work, including more specific analysis, would be needed. Perhaps this book can help stimulate such work. The subject of urban transport deserves, and is likely to receive, more attention than it has in the past.

This book was commissioned and funded by the International Development Research Centre (IDRC) of Canada. The work was executed by ECOTROPIC, a Brazilian nonprofit nongovernmental organization (NGO) that is dedicated to the analysis of key environment and development issues in Brazil. We are grateful to IDRC, and particularly to David Brooks, Director of IDRC's Environmental Policy Program, and Bill Carman of IDRC Books for a consistently supportive attitude throughout the long preparation of this book.

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Chapter 1

Urban Transport in the South

The problem of urban transport in developing countries has become more prominent in recent years within the context of both transport planning in the world and general development issues in the South. Several factors explain this increasing urgency and importance.

First, there is the rapid growth in urban population. The proportion of people living in urban areas has increased dramatically. Growth has been higher in less urbanized regions but continues to be high in relatively more urbanized regions, such as Latin America. This growth is often accelerated in relation to the level of economic development and infrastructure and has resulted in a large population of urban poor.

Second, cities of all sizes have grown larger, and large cities have become both more numerous and responsible for a larger share of the urban population (Fig. 1). In 1970, 12 of the 22 cities in the world with populations over 4 million were in the developing world; in 1985, 27 out of 39; by the year 2000, at least 43 out of 57 (United Nations 1987). As cities get larger, transportation becomes more difficult and costly (Thomson 1983), with increasing demands on urban space.

Third, the use of automobiles is increasing rapidly in cities throughout the developing world. Increasing "motorization" is

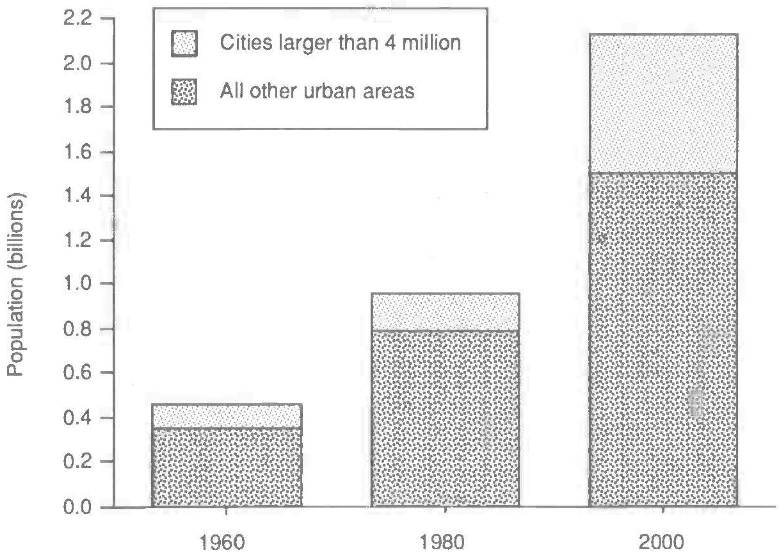

Fig. 1. Population of developing world in urban areas and cities of more than 4 million people (source: World Bank 1986a).

related to growing incomes and can be exceptionally rapid in countries with strong economic growth, as has occurred in parts of South and East Asia. However, it can also be high in times of economic crisis and stagnation, such as during the 1980s in most of Latin America. The vehicle fleet of São Paulo increased by 116 percent from 1980 to 1988. Over the same period, its index of motorization grew from 22 to 45 vehicles per 100 inhabitants (Vasconcelos 1988), a rate of increase as high as that experienced in the 1960s and 1970s. The use of private automobiles places especially heavy pressure on urban space and intensifies the problems resulting from a city's population growth.

Fourth, local social, economic, and environmental costs have grown, often dramatically. These costs adversely affect not only the quality of life, equity, and economy of the cities but also the country as a whole, given the major economic and political role of large cities (World Bank 1986a). The cost of maintaining the quality of transport tends to increase disproportionately with city size. In many countries, including Brazil, awareness of these costs has also grown considerably.

Finally, global environmental issues, particularly the greenhouse effect and carbon dioxide (CO_2) emissions, are refocusing interest on long-term energy developments. Transportation is a major consumer of fossil fuels, especially petroleum. Half of Latin America's oil and gas consumption is for transport (Poole 1984). The transport sector is recognized as the most difficult in which to achieve structural shifts — that is, changes beyond individual improvements in vehicle efficiency. However, such structural shifts may become necessary. What happens in the energy development of the South will clearly be critical to future global CO_2 emissions (although the developing world is responsible for only a small portion of the CO_2 buildup to date). Transport will inevitably play a major role in this development.

Yet another catalyst has been at work, reinforcing and reinforced by most of the preceding factors. Developing countries are beginning to voice their own opinions on urban transport. The South is producing more professionals and a body of information, analysis, and experience is forming. This phenomenon is quite recent and still in a phase of consolidation. The International Union of Public Transport (UITP) held its first plenary meeting in a developing country (Brazil) in 1983 and only after much pressure. The periodic Conference on the Development and Planning Urban Transport in Developing Countries (CODATU) has been a useful forum.

Traditionally, urban transport planning in developing countries has been an adoption of theories, techniques, technologies, and key parameters produced in industrialized countries. Often, not surprisingly, this has produced inferior results (for example, see Henry 1985). This situation is changing, but not quickly enough. Information on the experiences of developing-country cities is poor, and effective information flow is essential to provide a foundation for the decisions and actions needed to arrest and reverse the current chronic deterioration.

This book focuses on Brazil. It summarizes many of the major tendencies, problems, and policy issues. It identifies broad lines of action and some areas where investigation is needed. Brazil is important in itself, with a critical mass of population, market, technical capabilities, industrial diversification, and regional influence that puts it among the largest of the developing countries, along with India and China. It is also a pioneer in certain areas of urban transport policy. At the same time, this book situates Brazil within the broader context of Latin America and, generally, of the developing world.

The book also compares the large urban centres of the developing world with the major metropolitan areas of the industrialized world. In general, few Northern cities suffer anything like the intensity of problems faced in the developing world, where transport problems also threaten many of the developing world's intermediate metropolitan areas (500 thousand to 2 million inhabitants). However, research and development in urban transport policy are generally far more advanced in the industrialized world, and the results still dominate planning in developing countries and powerfully influence international financing. This financing, although relatively minor in terms of overall investment, has had disproportionate strategic weight. This is partly because of the transmission of basic policy guidelines, models, and know-how associated with the financing. It will be important for key actors to have a clearer idea of how conditions are different between the industrialized and developing worlds.

The importance recently attached to global problems such as the greenhouse effect will have a major impact on North–South relations, even if their diagnosis cannot be fully confirmed in the short term. The North bears the major responsibility for a problem that will impose new costs on an already difficult development process. Significant help will be needed and a major reevaluation of official development assistance (ODA) is in order. In the area of urban transport, developing-world experience could be relevant to industrialized countries. If CO_2 emissions really are a problem, then the industrialized world may be forced to take radical steps beyond the political limits of past urban transport planning, steps for which it may not be prepared. The dramatic challenges facing the developing world may produce innovations useful for the industrialized world.

The remainder of this chapter introduces the general situation, tendencies, and challenges facing urban transport in Brazil. Chapter 2 reviews in more detail the major factors conditioning urban transport policy. The relatively high costs resulting from the increased use of the private automobile are emphasized — be they scarce roadway space (congestion), pollution, or energy consumption. The serious problems of social equity and their relation to urban transport are also discussed. All this points to the strategic importance of strengthening collective transport. This effort will be constrained by scarce financial resources and will be significantly influenced by the policies of international development agencies.

Chapter 3 focuses on the question of collective transport, providing more detail on the diagnosis of the situation and indicating possible lines of improvement. Modal alternatives are reviewed, especially for high-volume transport corridors, which have a structural importance for the system. The relative roles of bus and rail systems are discussed. Particular attention is paid to the possibility of greater hierarchy in, and integration of, bus systems; in Brazil, pioneering work has been done on high-volume, segregated busways. The chapter then reviews crucial issues for the financing, planning, and operation of collective transport: regulation and ownership, tariff policy, subsidy mechanisms, and general institutional capability. Demand management is briefly considered as an alternative to enhancing the supply of collective transport. Both operational measures (such as spreading out typical workplace arrival and departure times) and measures to change the aspects of urban structure (physical layout and location of activities) influence the demand for transport services. Both are highly complex, both are important.

Chapter 4 presents our main conclusions. To summarize:

- The conditions of urban transport are deteriorating, especially those of collective transport. Unless this trend is reversed, prospects for the evolution of environment, equity, and energy use in large urban areas are not favourable. Equity issues are particularly urgent.
- The reversal of this trend critically depends on improving collective transport, complemented by measures to discipline private automobile use. Giving priority to collective transport is a serious test of political will.
- The improvement of collective transport depends on recuperating the capacity to invest. This cannot be achieved solely through fares, which are already high relative to many users' incomes. Subsidies will be required. A prime source should be other users of urban space who also benefit from the improvements. To avoid waste, adequate transfer mechanisms are important. Subsidies do not necessarily mean state ownership; however, continued private ownership implies more effective regulation.
- Even with the recuperation of the capacity to invest, financial resources will be scarce. Greater productivity of investments will be required, especially in high-volume corridors where most investment goes. Segregated busways are an underused alternative involving lower investment. Changes in bus-system management — such as ticket prepayment, tariff and physical integration, and improved vehicle maintenance — may also improve productivity.
- Transport planning must become more integrated. It is critical to the organization of urban space; therefore, it must incorporate broader urban concerns.
- The shape of the urban system will be influenced greatly by international financing and the flows of technology and planning paradigms. Urban transport must be taken out of the relative backwater where it has remained at most development agencies.

Recent Trends in Brazil

The problem of urban transport is an unhappy reality for the inhabitants of the large cities of the developing world. "Getting around cities is a veritable daily epic" (Figueroa and Henry 1987). It is an epic that weighs heavily on the large majority of the population that uses collective transport, and most heavily on the majority of the urban poor who live on the fringes of the system.

Despite more per-capita motorized trips among private automobile owners, 60 to 80 percent of urban motorized trips are by collective transport in Latin America (Table 1). This situation is typical of poorer developing countries, but radically different from richer, industrialized nations. In the largest cities of poorer developing nations, average trip-time budgets for most income

Table 1. Population, motorized trips, modal share of collective transport, and average mobility in some major Latin American cities.

City	Year	Population (thousands)	Motorized trips per day (thousands)	Modal share of collective transport (%)	Average mobility (daily trips per capita)[a]
Asunción	1983	550	600	75.0	1.09
Bogotá	1984	4 169	5 000	83.1	1.20
Buenos Aires	1984	10 075	16 000	78.5	1.59
Caracas	1982	3 200	5 000	72.2	1.56
Curitiba	1984	1 035	1 080	73.9	1.04
Guatemala City	1982	1 500	1 800	80.0	1.20
Lima	1983	4 600	6 000	76.7	1.30
Mexico City	1984	17 000	19 500	80.3	1.15
Quito	1982	1 084	1 540	80.1	1.42
Recife	1981	2 153	1 605	74.0	0.75
Rio de Janeiro	1982	9 780	9 900	81.0	1.01
Salvador	1984	1 772	2 300	65.7	1.30
Santiago	1984	4 300	4 700	85.0	1.09
São Paulo	1984	13 000	16 000	61.0	1.23

Source: Figueroa and Henry (1987).
[a] Overall average, 1.21 daily trips per capita.

classes may be twice those in the industrialized world (Figueroa and Henry 1987), even with their lower mobility.

Brazil shares many aspects of the urban transport problem prevalent in Latin America and throughout the developing world. However, Brazil has its peculiarities. Three stand out:

- Relative to income, motorization in Brazil is high. This is because of the historical priority given to the automobile industry in industrial development.
- In Brazil, the privately owned bus systems, which are typical of most of Latin America and the developing world, are relatively consolidated. In fact, through holding companies, thousands of buses spread among different cities are owned by a single private group.
- "Intermediate" collective transport modes or "paratransit" play a relatively small role in Brazil. They use smaller vehicles than the conventional bus: *lotações* in Brazil and *jeepneys*, *dolmus*, and *matutus*, etc. elsewhere.

The consolidation of private-sector bus companies has concentrated ownership and suppressed smaller, nonconventional forms of collective transport. This is the result of sustained and deliberate government policy. However, the relation between the state and collective transport has not been stable or consensual, especially over the past decade of severe economic, social, and political challenges in Brazil.

The conditions of urban transport in Brazil have seriously deteriorated over the past decade. This is reflected in increasing trip times, increasing costs relative to income, and apparently decreasing mobility. In São Paulo, there has been an overall decline in mobility, especially among users of collective transport. This decline is related to factors of both supply and demand and appears to be widespread in the developing world, although this is difficult to document.

The reasons for deterioration are complex. Long-term macro trends such as urbanization and motorization have continued.

This has increased the pressure for supply despite slow growth in the formal economy — growth that is required to generate the tax income to finance any expansion in transport supply. At the same time, the prolonged financial crisis in the economic and public sectors has eroded investment rates in infrastructure generally. In financial terms, the crisis has been cumulative as debt service has grown relative to receipts, complicating any future recovery of investment. This general crisis has led to deteriorating service levels — from telephones and road maintenance to public health and education. In the short term, this could severely restrict any strong recovery of economic activity, a situation that is widespread in Latin America and probably elsewhere.

This and other aspects of financial deterioration are addressed in Chapters 2 and 3. It includes the fracturing of the financial–institutional model established in the mid-1970s during the Geisel presidency (1974–1979). Unfortunately, a new model has not emerged.

The reforms of the Geisel presidency were the first change in the heavy subordination of urban transport in Brazil to policies designed to support the rapid growth of the automobile industry. During this earlier period, public investment in collective transport was minimal; federal involvement was almost nonexistent. The institutional approach of the Geisel reforms emphasized, especially in their practical implementation, stronger centralized action and the substitution of liquid fossil fuels — general characteristics of government policy at that time. Since then, however, relations between the various levels of government (from federal to municipal) have been marked more by conflict than by cooperation. Also, relations between government and private suppliers of transport services have been difficult. These points and wider institutional problems are discussed more fully in Chapter 3.

One immediate consequence of the institutional limitations is that the inadequate resources available have been used less than optimally. A major share of the investment in urban transport has gone to projects of dubious priority or with limitations in design and implementation, such as several new rail systems (Belo Horizonte and Porto Alegre, for example). Meanwhile, advances in improving the productivity of existing investments, such as in traffic management and bus systems, have been limited (although often successful when undertaken). An important legacy is the poor articulation of policy and institutional weakness at the metropolitan level. Metropolitan institutions generally appear to be more closely linked to the federal government than to their component cities, and, in any case, have little authority or money.

Scenarios and their Implications for Brazil

The challenge today includes both reversing past trends in quality and accommodating future growth in demand. Little systematic work has been done on what this might mean at a national level. Several studies (for example, Bussinger et al. 1987; EBTU 1988b; Wright and Sant'anna 1989) point to major increases in demand to the end of the century as a result of continued urban and metropolitan growth (in cities of more than 100 thousand). They also predict increasing per-capita demand for transport services. The clear implication is that investment in collective transport and its associated infrastructure would have to be substantially higher than in the past (before the crisis) and much higher than it is today. Even at a high level of investment, recourse to desirable but capital-intensive options must be contained, and less capital-intensive possibilities must be developed on the many urban transport corridors that are approaching or already past saturation.

This implies major changes in priorities, institutions, and the planning process. The extent of change that may be required can be judged by the differences in emphasis between Bussinger (1987) and Wright and Sant'anna (1989) on the one hand and

EBTU (1988b) on the other. The study of the Brazilian Urban Transportation Agency (EBTU) represents the dominant and official federal view emphasizing investments in public urban rail. The other two studies, in different ways, make strong cases for upgrading the bus system, which is responsible for 90 percent of collective transport. Together with the argument for greater local (preferably metropolitan) control and planning, the argument for strengthening the bus system is very strong. Greater local control does not mean federal irrelevance. It means redefining priorities for federal activity and new institutional mechanisms. Such a redefinition is necessary in any case because increased decentralization is a key aspect of the new Brazilian constitution.

The most comprehensive analysis available of medium-term (10-year) trends and objectives, and their economic consequences, is that of Bussinger et al. (1987). That study is nevertheless quite simplified. It partially excludes the costs required to upgrade service levels for existing demand. The analysis focuses on increased demand for collective transport resulting from growing urbanization or "metropolitization" and higher mobility.

Urbanization, which has been going on at a high rate for decades, is projected to continue. The urban share of the total population, which stood at 68 percent in 1980, was estimated at 75 percent in 1990 and could reach 80 percent by the year 2000. The urban population is also becoming more concentrated. From 1980 to 2000, cities of more than 100 thousand inhabitants will increase their share of the total population from 41 to 55 percent (60 to 69 percent of the urban population); the so-called "metropolitan areas" (the 10 largest capitals) will increase their share from 29 to 37 percent. Consequently, the population of cities with more than 100 thousand inhabitants is expected to double between 1980 and 2000 (Table 2). Historically, the fastest growing cities are the medium-sized ones — those with 100 to 500 thousand inhabitants (Faria 1983). This trend is likely to continue. Cities of this size have received relatively little attention.

Table 2. Projected total and urban population growth in Brazil to the year 2000.

	1980	1990	2000
Total population (millions)	119	147	180
Urban population (millions)	81	110	144
Urbanization (%)	68	75	80
Cities over 100 000 (no.)	49	73	99
Urban population in cities over 100 000 (%)	60	66	69
Total population in cities over 100 000 (%)	41	50	55

Source: Bussinger et al. (1987).

Table 3. Projected mobility (*M*, daily trips per capita) and motorized transport demand (*D*, million passengers per day) in urban areas of Brazil to the year 2000.

	1980		1990		2000	
	D	*M*	*D*	*M*	*D*	*M*
Metropolitan capital cities	44.6	1.3	79.1	1.6	132.0	2.0
Other capital cities	7.7	1.5	14.5	1.7	24.2	2.1
Other cities over 100 000	16.0	1.8	31.1	2.1	52.3	2.6
Total	68.3	1.4	124.7	1.7	208.5	2.1
Total collective transport (71% of total)	48.5	—	88.5	—	148.0	—

Source: Bussinger et al. (1987).

Mobility is projected to increase from the current 1.4 motorized trips per inhabitant to 2.1 by 2000 (Table 3). There is some size overlap in this table, but, in general, the larger the city, the lower the mobility. The increase in mobility will have as great an impact as the increase in urban population on the number of motorized trips, which should roughly triple between 1980 and 2000. Of this total demand, 71 percent was supplied by public transport in 1980; it was assumed that this share would be maintained through the year 2000.

Both the mobility and modal-share projections are somewhat arbitrary. In fact, mobility has been declining in some cities. Although no nationwide estimate is available, it is unlikely that mobility has increased at anything like the rate projected for the 1980s by Bussinger et al. (1987). This means that if projected 2000 levels are to be met, there must be a rapid increase in the 1990s. At the same time, the modal-share assumption appears to run contrary to recent trends that show a growing use of private automobiles. In São Paulo, the share of automobiles in motorized trips grew from 38.7 percent in 1977 to 43.2 percent in 1987; this is partly due to a repressed demand for public transport (Table 4). A greater automobile share would imply less growth in the demand for collective transport. Consequently, this would reduce investment requirements for collective transport and increase general road investments.

These observations highlight the uncertainty in demand that faces transport planners. Nevertheless, the demand for transport, including collective transport, will grow rapidly over the next decade. It will grow because the mobility of the population is low, both by international standards and by the standard of its own perception. This is due to high fares (relative to income), poor-quality service (trip times, etc.), and poor access. Problems of urban structure contribute to the sense that there is a "repressed demand" for urban transport services. If the economy were to recover from its decade of stagnation, demand for urban transport services could increase rapidly and drastically.

Table 4. Trips (thousands) by principal mode in the São Paulo metropolitan area, 1967–1987.

Mode	1967	1977	1987
Private automobile	2 260 (31.4%)	6 127 (38.3%)	7 396 (43.1%)
Collective	4 823 (67.1%)	9 713 (60.7%)	9 731 (56.6%)
Metro	0 (0.0%)	542 (3.4%)	1 435 (8.3%)
Train	333 (4.6%)	512 (3.2%)	967 (5.6%)
Bus	4 490 (62.5%)	8 659 (54.1%)	7 330 (42.7%)
Other	104 (1.5%)	159 (1.0%)	50 (0.3%)
Total	7 187 (100.0%)	15 999 (100.0%)	17 177 (100.0%)

Source: Metrô (1989).

The scale of this growth will place severe financial limits on more capital-intensive alternatives. For example, what if the number of passenger trips per day increased by 35 million from the mid-1980s to 2000? This is slightly above the 31 million conservatively used by Wright and Sant'anna (1989) and significantly lower than the more than 60 million projected by Bussinger et al. (1987). With costs on the order of 1 thousand US dollars (USD) per passenger per day for high-capacity rail systems and 500 to 900 USD for medium-capacity rail without the usual cost overruns, only a small fraction of this increase can be accounted for by capital-intensive rail systems without a massive increase in financial resources. For the sake of comparison, one estimate of the evolution of federal investments in collective transport is shown in Figure 2. State, municipal, and private-sector investments would have to increase by 30 to 40 percent (Bussinger et al. 1987).

Major increases in investment in collective transport are clearly justified; however, they must compete with other priorities. In general, infrastructure is in a state of decay. Furthermore, most of the more capital-intensive options should be financed by the public sector, whose general financial situation is grave.

The repressed demand in Brazil for infrastructure investment requires significant state-sector intervention, either as a financial catalyst, an owner, or as a more effective regulator. The capacity of the state relative to the needs it faces is limited and needs to be increased rapidly. This will require considerable and widespread innovation in the planning and implementation of policy as well as increased financial resources. Even a substantial increase in private investment does not contradict this conclusion; the infrastructure "debt" is large and rapidly getting larger. Good institutional planning and administrative capability is almost as scarce as financing capability in the state sector and these two scarcities feed off of each other in a vicious circle. Recovery strategies will depend as much on management improvement in the broadest sense as on additional resources for investment. In urban transport, this means as much priority for

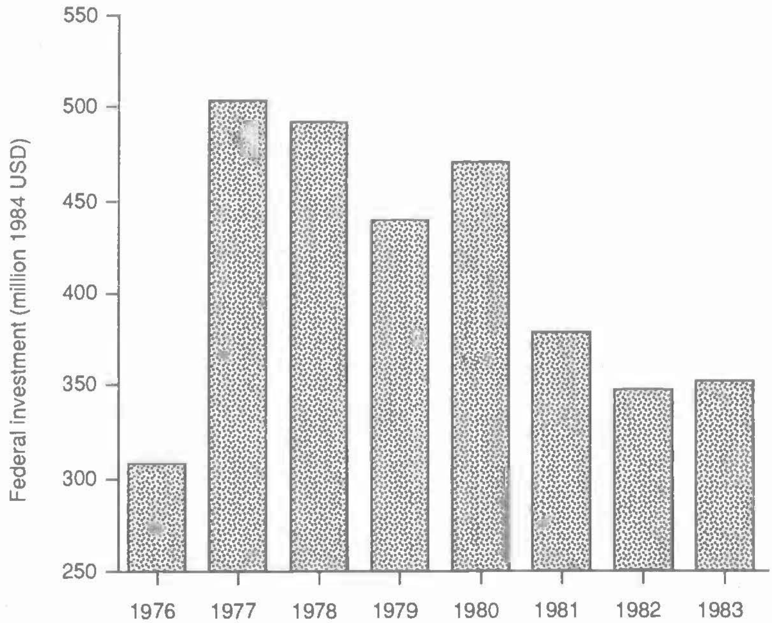

Fig. 2. Federal investment in Brazil's public transport, 1976–1983 (source: Bussinger et al. 1987).

improving regulation, enhancing maintenance, or addressing the tricky issue of integration of collective transport as for "big-ticket" infrastructure projects. The relative neglect of the crucial "software" side is highlighted in World Bank reviews of public transport projects in Brazil in which it has participated.

A key element in both investment and operational planning is the space dedicated to major corridors of traffic, both for passenger and freight or service vehicles. The importance of high-intensity corridors is that their space is valuable and the cost of expanding their marginal capacity is high. They also play an important role in determining trip times and frequency of service. The necessary public-sector investment to increase flow on the densest corridors is at least an order of magnitude larger than the total investment (which can be mostly private) required to improve capacity and quality of transport on low-density routes.

Even in Hong Kong or the London Docklands project, private-sector investment does not exceed 15 percent of the total.

The denser the corridor, the higher its marginal cost of expansion. Thus, a few strategic corridors, with a relatively small part of total transport demand, will require a disproportionate share of investment. Overall investment in collective transport will be dominated by these corridors. However, financial constraints severely limit the extent to which realistically costed, capital-intensive alternatives can be used. Determining trade-offs on major corridors between improved bus systems (lower capital cost) and rail systems (higher capital cost) will be a challenge for urban investment planning.

The role and characteristics of corridors are poorly defined and quantified at both regional and national levels. For example, the study of Bussinger et al. (1987) assumes that 10 percent of the growth in demand for collective transport might be supplied by capital-intensive, high-capacity systems; 30 percent might be supplied by intermediate-intensity systems, with characteristics similar to light rail (500 to 800 USD per passenger per day). Although this breakdown may be correct, there is little published evidence. The National Mass Transportation Plan (EBTU 1988b) suggests a lower figure for intermediate-intensity systems. A reasonable profile of major corridors has not been organized, although the basic information does exist. Without such profiles it is impossible to estimate the investment that is required in the country or in the regions.

Beyond individual metropolitan areas, information and analyses necessary to evaluate tendencies and strategic planning are shaky. This would not be surprising were it not for the fact that planning has been dominated by centralized federal entities for more than a decade. Financial series tend to be out of date, environmental information is sporadic, and categorization of metropolitan areas is inadequate. Planning at all levels could be improved by consolidating relevant information from different cities and agencies.

Urban transport is a problem of increasing importance on the political agenda of Brazil. The institutional and financial challenges facing the existing model of organization are great. They imply widespread changes ranging from new financial resources, to structural change in metropolitan institutions, to new priorities in planning. These changes will likely occur in an increasingly decentralized environment of national decision-making. Federal and state agencies will continue to have important if redefined roles. Urban transport has elements of both local and national concern.

Chapter 2

Problems Facing Policymakers

Many major issues currently face policymakers and planners in urban transport. They are diverse and include the following:

- *Congestion*, which is increasing dramatically in many large cities and intensifying other problems;
- *Pollution*, which is now more severe in many of the developing world's large cities than it is anywhere in the industrialized world;
- *Energy*, a major long-term structural priority that is tied to concerns over greenhouse gas emissions;
- *Equity*, the serious lack of which is aggravated by the evolution of urban transport and its impact on poorer classes;
- *Financial constraints*, which have grown more severe as investment needs increase; and
- *The role of international agencies*, which has been reinforced by current economic conditions.

This chapter describes these issues, with emphasis on the Brazilian context.

Our discussion demonstrates the great impact of the private automobile on the use of urban space, the environment, and energy. Any serious strategy to improve urban transport as a whole must discipline the use of the private automobile and give a high priority to collective transport. The problems of social and economic equity also point to collective transport as a solution. At the same time, however, financial problems severely limit any improvements in transport. Key investments are likely to be strongly influenced by international financing and its conditions.

Congestion, the Automobile, and the Value of Space

One of the most visible expressions of the urban transport problem is roadway congestion. This congestion brings major costs, both economic and environmental. Trip speed by all users (both public and private) declines, travel time increases, and mobility is reduced. Congestion is created by an excessive demand for scarce road space. It tends to worsen in cities experiencing rapid population growth and rising incomes, and tends to become more of a problem as cities become larger (Thomson 1983).

The underlying dynamics of this problem show why it is difficult to satisfy road-space demand. As cities and incomes grow, various factors come together to ensure that road-space demand, if unconstrained, grows much more rapidly than population; the urban area devoted to road space would have to increase dramatically to keep pace with this demand. A simplified example, based on generic World Bank calculations and discussions, illustrates the dimensions of the problem (Zahavi 1976; Linn 1983).

As the urban area enlarges — a result of increasing total population and decreasing population density — average trip lengths increase (Fig. 3). Some evidence suggests that in Latin America cities are generally becoming less dense (Zahavi 1976). For trip time to remain constant with increasing trip length, velocity must increase. This means additional road space (Fig. 3), an effect intensified by the increased need for motorized transport. By the time city population has doubled three times (an

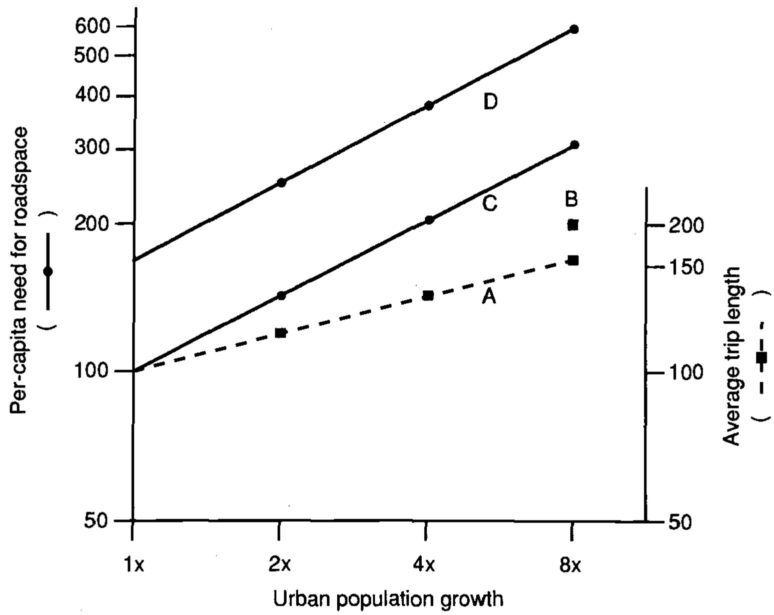

Fig. 3. The effects of urban population growth, density changes, and increasing automobile motorization on trip length (distance with original population = 100) and per-capita need for road space (need with original population = 100): A, no change in urban density; B, 40% decrease in urban density; C, 40% decrease in density over full time period and no change in automobile motorization; D, same as C except automobile motorization is double the original level (source: Zahavi 1976, in Linn 1983).

eightfold increase) and population density has been reduced by 40 percent, per-capita demand for road space has increased by more than 250 percent. If we add to this the influence of increasing automobile use, the impact is dramatic. A doubling of automobile ownership per thousand inhabitants leads to a 500 percent increase in the per-capita demand for road space. It is unclear whether the model used in this example allows for either the increased number of trips associated with automobile use or the increased demand for parking space.

Increased road space per capita implies an increasing share of urban land devoted to road space. In our example, the share of land devoted to road space increased by more than 250 percent (including the effect of increased automobile motorization). If 10 percent of urban land was initially required (typical of older cities), after three doublings of the population, 35 percent would be needed (in fact, higher percentages are found in some US cities, considering all transport modes). At the city margin, the percentage would be even higher.

The "three doublings of the population" is an immense increase that has required four or five decades in most Brazilian metropolitan areas. Automobile motorization can double in a much shorter time. If we assume a single doubling in both motorization and population over the same time, and interpolate the results of the example, the share of all urban land required for road space must more than double. This implies that while the population is doubling, the new road space constructed must be three and a half times the initial road space.

Although highly simplified and generic, these examples describe an explosive combination: demand for urban space and growth in automobile use. In the end, the urban fabric must be extensively reordered. The cost and difficulty of this means that the potential demand is chronically constrained by supply, and congestion worsens. In the industrialized world, the city of Los Angeles has left automobile demand unchecked with a massive effort to create road space; yet, congestion worsens inexorably. This approach is now widely recognized as a dead end, at least for the world's largest cities (*Economist* 1989b; Weisman 1989).

The scarcity and growing value of urban road space means that more attention must be given to the "space consumption" — and its cost — of different modes, with particular attention to the private automobile. Analysis shows that the automobile is a lavish consumer of space relative to other modes; probably more than most people imagine. That is why the impact on road-space demand is so sensitive to automobile use, as detailed in our examples.

Table 5 gives an estimate of the space consumption per passenger of different transport modes for a 5-kilometre trip. Two important characteristics of Table 5 are the inclusion of parking where relevant and the effect of different parking times associated with different trip purposes. The importance of parking is most evident — especially when the automobile is used to commute to work — when parking time tends to be greater. Sutton (1988) argues that the cost of increasing parking capacity is equivalent to that of generating transport capacity. Whether this cost equivalence is strictly true or not, the high consumption of space for automobile trips compared with collective transport modes is obvious: there is a 10- to 100-fold difference. As congestion is related to space and parking is a major component of space use, it also suggests a promising source for recovering the economic cost of the automobile's use of space. This is an area that has not been overlooked, but deserves renewed emphasis.

Table 5. Space consumption per user (square metre hour) for a 5-kilometre trip on an infrastructure used at its optimum capacity.

	Parking	Traffic	Total
Pedestrian	0	2	2
Motorcycle			
Work (duration, 9 hours)	13.5	7.5	21
Leisure (duration, 3 hours)	4.5	7.5	12
Shopping (duration, 1.5 hours)	2.3	7.5	10
Private car (1.25 passengers per vehicle)			
Work (duration, 9 hours)	72	18	90
Leisure (duration, 3 hours)	24	18	42
Shopping (duration, 1.5 hours)	12	18	30
Bus (50 passengers per hour)			
Without exclusive right-of-way	0	3	3
With exclusive right-of-way			
60 buses per lane per hour	0	6	6
Brazilian experience[a]	0	0.5–1	0.5–1
Metro (30 000 passengers per direction per hour)	0	0–1	0–1

Source: Adapted from Sutton (1988).

[a] Assumes an average of 10 thousand passengers per hour per lane with a trip speed of 20 kilometres per hour.

The automobile in an urban environment, especially in large cities, is a good example of the "tragedy of the commons." To start, the automobile is uniquely responsive to individual needs. Trips by car are usually much briefer than trips by public transport. This becomes increasingly important as incomes increase: as incomes increase, so does the value of nonwork time. As congestion increases, the difference between individual and collective transport widens even though automobile performance worsens. This increases the incentive for the user to invest in and use individual transport, an outcome that worsens the commons problem.

Many planners take a fatalistic view of congestion: because of suppressed demand, it will remain; and what can realistically be done by the state is limited and growing more limited. This mind-set has prevailed in political terms in most cities of Brazil and Latin America as a whole. In the countries of Latin America, as in the developing world in general, there are many pressing problems that continue to intensify. Why should we try to solve an "insoluble" problem that is often seen as mostly affecting a minority group, many of whom are relatively privileged?

If the political will exists, however, there are several possible broad lines of action. These lines of action should be seen as complementary measures to achieve a change in the overall system:

- Make the user of individual transport pay more of the public cost caused by his or her trip; in some cases, physically limit car access. If the trip cost cannot be recovered during travel, special attention should be given to parking. Revenues could be used to support a variety of improvements to the urban transport system, from off-street parking to collective transport.

- Improve collective transport and general pedestrian access to space. In addition to investment, this often implies restricted automobile use (for example, segregated bus lanes).

- Improve general traffic management and invest in key road space, incorporating collective transport considerations. (Opportunities to enlarge road corridors in the central area of a city are likely to be limited.)
- Manage demand. In the short and medium terms, this mostly involves "flattening" demand peaks (for example, staggered rush hours); in the long term, land-use planning is required.
- Pay close attention to conflicts between the transport of goods and passengers.

The objective is to improve the quality of transport for all major classes of users, including users of individual transport. Although several measures involve restricting the use of road space by automobiles, in practice, congestion for individual car users can also be reduced (World Bank 1986a; OECD 1988). This is due in part to the much greater productive value of collective transport. Its use of space is much more efficient than that of the automobile. The fact that users of individual transport are also beneficiaries is of great importance for policies to finance change — especially in collective transport — and, consequently for pricing policies in general. This key consequence, incidentally, is not recognized by the World Bank (1986a).

Charging Users

Charging accurately for the cost of public road space, especially in congested areas, is an ideal for the urban transport economist. To be able to do so would help mightily to solve several problems, including that of the "commons." Unfortunately, it is very difficult to design a practical system.

The ideal system would record, for each key class of user, the space–time occupation cost as it varies by place and by time of day. The more congested the place at a certain time, the higher the space–time cost. In principle, it would be like an electricity meter with variable tariff categories. Such a system exists nowhere in the world. Something close, however, was almost implemented in Hong Kong. The scheme exploited recent advances in the electronics revolution and appears to have been technically feasible; but political objections buried it, at least for the time being (World Bank 1986a; Darbéra 1987; OECD 1988). Yet, such systems should emerge, and almost certainly in the industrialized world first. Interest is clearly growing in these countries and specific tests are being proposed in some small cities such as Cambridge, UK. Commercially tested systems charging users a space–time cost should exist by the end of the century. However, even then, they are likely to be too expensive for the large cities of the developing world.

Nevertheless, the basic idea is worth pursuing in developing countries, even if the sophisticated ideal remains remote. Although it is difficult to charge a moving car for its space occupation, it is easy to charge a parked car, and parking is an important part of the space equation, especially for work trips (Table 5). Work trips contribute disproportionately to the peak demand — the time of maximum congestion. Rush hour everywhere is determined by work schedules; other kinds of trips tend to adapt. In developing countries, work-related trips represent an even larger proportion of total trips. The rush-hour peak is higher relative to average flow than it is in industrialized countries, making the supply problem even more difficult.

Charging for the use of parking space is a well-established practice. Unfortunately, there seems to be no systematic review of this measure. Its effectiveness may be difficult to estimate because it is generally not considered in isolation (OECD 1988). Norms and regulations for parking are a complement to charging for parking space. Where norms are tough on the use of publicly owned space, entrepreneurial opportunities emerge to provide parking.

Another approach is to charge users for the right to enter a congested area with an automobile, as is done in Singapore. This approach involves policing. There are entry restrictions on motorists who have not paid the daily or monthly permit rate or who carry fewer than a certain number of passengers (four in

Singapore) (Gray 1988; OECD 1988). As in Singapore, this approach can be combined with specific parking charges as well as measures to restrict parking and automobile circulation (to improve conditions not only for public transport but also for pedestrians).

In Singapore, as a result of such measures, vehicle entry fell 40 percent in 1975 and is about half of what it would otherwise be today. Despite this considerable success, Singapore's policy to restrict and charge for entry to the central business district has not been emulated elsewhere (Derbéra 1987). Such a drastic measure is politically difficult to implement and requires serious ongoing enforcement. In Singapore, a strong authoritarian government was helped by widespread acceptance in the business community and relatively low car ownership at the time of implementation (OECD 1988). In many cities, it would be difficult to define a central high-congestion area with restricted access. In São Paulo, for example, the area would have to be very large.

Another approach is to tax fuel (especially for automobiles). Although widely practiced, this approach has less impact on the use of individual vehicles in cities than the preceding measures. A fuel tax is indiscriminate: everyone pays the same rate. Therefore, the politically acceptable level of such a tax is limited. Even a relatively high sales tax by current international standards (0.30 USD per litre of gasoline) would contribute less to the cost of a trip to a congested area with a private car than the payment of a modest two-dollar parking fee. Another problem, quite serious in a country like Brazil, is that such a tax would immediately be incorporated into the Consumer Price Index, giving a short-term inflationary signal to the economy.

Despite these limitations, fuel taxes remain as a viable complementary strategy. They are consistent with the idea of "carbon taxes" addressing the greenhouse effect. They can also generate a considerable amount of money to improve transport supply, especially collective transport, if explicit transfer mechanisms are established. The resulting transfers may be more important in changing the profile of transport demand than the direct "price elasticity" effects of more expensive gasoline.

Finally, whatever measures are undertaken, it is important that the policy and management of urban transport in large cities recognize that road space is both scarce and expensive, and that its use must be controlled (Servant 1990).

The Urban Environment

There is a general sense in Brazil, as in many developing countries, that the quality of life is deteriorating in most large cities. This strong, if subjective, sense among city dwellers is related to many factors. Some are only remotely related to urban transport, such as the increase in violent crime that has beset many cities in Latin America and Africa; however, some factors are closely related to urban transport. Among these are increases in congestion, air pollution, sound pollution, and fragmentation of the urban space, which results in an increasing dependency on transport, creating a vicious circle.

Air Pollution

The problem of air pollution has increased significantly in many cities of the developing world. The intensity of deterioration and the characteristics of the pollution vary with the nature of the air basin, the growth and mix of polluting activities, and the mix of energy sources. In Brazil, urban transport is generally the most important source of air pollution; in some smaller metropolitan areas, however, industrial sources may dominate (for example, in Vitória and Cubatão).

In many cities, atmospheric and topographic conditions aggravate the problem. High insolation levels aid in transforming primary pollutants into even more harmful secondary products. Two important examples of this are the transformation of nitrous oxides (NO_x) and hydrocarbons (HCs) to photochemical oxidants such as ozone and peroxyacetyl nitrate (PAN), and the conversion of nitrogen and sulfur oxides (SO_x) to acids. Many cities are subject to frequent thermal inversions during certain seasons of the year (Delhi, São Paulo, and Tunis, for example). Dense canyons of buildings along congested traffic corridors are common and tend to concentrate primary pollutants of local importance (such as carbon monoxide (CO) and lead).

In general, urban densities are higher in the developing than in the industrialized world. As well, fuels are often of lower quality, maintenance and motor regulation tend to be inferior, and the stock of vehicles is older. Not only do older vehicles tend to have higher pollutant emissions to start with, but also the emissions of some pollutants (like CO and unburnt HCs) increase with vehicle age (OECD 1988). Consequently, their ambient levels can be very high, although accurate measurement is a common problem. There are many examples in the literature where annual averages equal or exceed the 8-hour averages recommended by the World Health Organization (WHO) (Joumard 1989). In general, there are more cities in the developing world with serious air-pollution problems than there are in the industrialized world (excluding Eastern Europe).

The contribution of urban transport to air pollution is variable. Unfortunately, the available literature is rather sparse and fragmentary, especially regarding the relation between air pollution and transport policy. However, in Mexico City transport is estimated to be responsible for 99 percent of CO emissions, 89 percent of HCs, 64 percent of NO_x, and 25 percent of anthrogenic particulate emissions (Table 6). Within all transport (including cargo), the contribution of private automobiles is disproportionately large: 55 percent of CO, 69 percent of HCs, and 53 percent of NO_x. Considering only passenger transport, 80 percent of HCs and 76 percent of NO_x were contributed by private automobiles, which, in turn, account for only about 20 percent of total motorized passenger transport or 27 percent of nonelectrified transport. Buses, which supply 41 percent of total passenger transport (59 percent of nonelectrified transport), were responsible for only 1 percent of transport CO and HC

Table 6. Emissions (percentage of total) of carbon monoxide (CO), hydrocarbons (HCs), nitrous oxides (NO_x), sulfur dioxide (SO_2), and particulates in Mexico City.

Source	CO	HCs	NO_x	SO_2	Particulates
Private vehicles	54	61	34	—	—
Taxi and secondary transport	13	14	8	—	—
Bus	1	1	3	—	1
Goods vehicles	31	13	19	2	8
Subtotal, transport	99	89	64	2	9
Industry	1	11	36	98	30
Natural sources	—	—	—	—	61
Total (thousand tonnes)	3 549	335	270	445	428

Source: Joumard (1989).

emissions and 4 percent of NO_x (7 percent if only passenger transport is considered). Overall, the published information for Mexico City indicates that private automobiles have a far greater impact per passenger trip on air pollution than do buses, let alone electrified rail transport. The effect of the private automobile is at least 50 times greater.

For Greater São Paulo, a metropolitan area equivalent to Mexico City, the data are less emphatic. But the broad conclusions remain regarding the importance of transport as an overall pollution source and the smaller impact of collective transport (CETESB 1989). Unfortunately, the breakdown of pollution sources (Table 7) is not directly comparable to that of Mexico City. The division of transport sources in São Paulo is by fuel type and emission "escape route" (for example, tail-pipe exhaust versus evaporation); for Mexico City, the breakdown is by transport sector.

There are significant differences between the contribution of transport as a whole and that of individual transport modes to the air pollution of these two megacities. In general, compared with Mexico City, the impact of the private automobile in São Paulo (roughly, from Table 7, gasoline, alcohol, evaporative emissions, and a good part of the particles from tire wear) is lower

Table 7. Emissions (percentage of total) of carbon monoxide (CO), hydrocarbons (HCs), nitrous oxides (NO_x), sulfur dioxide (SO_2), and particulates in Greater São Paulo, 1988.

	CO	HCs	NO_x	SO_2	Particulates
Gasoline vehicles[a]	60	29	13	4	6
Alcohol vehicles[a]	12	5	4	—	—
Diesel vehicles[a]	16	13	71	69	15
Motorcycles[a]	2	2	—	—	—
Taxis[a]	4	2	1	—	—
Evaporative emissions	—	18	—	—	—
Lube oil emissions	—	4	—	—	—
Tires	—	—	—	—	10
Gasoline handling	—	4	—	—	—
Industry	3	18	10	27	51
Open-air burning	3	5	1	—	18

Source: CETESB (1989).
[a] Tail-pipe emissions.

in relation to those activities linked to diesel fuel (buses and freight). Carbon monoxide appears to be an exception, but may be explained by the larger share of transport trips attributed to private automobiles in São Paulo (see Table 4). In the extreme case of SO_x emissions, collective transport by bus may have a greater impact per trip than transport by car. In Table 7, the contribution of transport to total particulates is less important than the contribution of industry. However, the contribution of transport to the more dangerous "inhalable particulates" is much more significant (Table 8). Comparable estimates were not available for Mexico.

In the estimates of air-pollution sources in Mexico City and São Paulo, there are some dramatic differences that are difficult to explain only in terms of differences in categories, transport mode, climate, or fuel quality. This is particularly the case for NO_x and sulfur dioxide (SO_2) emissions. In the case of NO_x, the data from Mexico suggest a far more important impact of gasoline and private automobiles; in São Paulo, 80 percent of NO_x is estimated to come from diesel vehicles. With SO_x, the difference

Table 8. Concentration and source emissions of inhalable particulates at four sites in Greater São Paulo, 1988.

	Park D. Pedro (city centre)	Ibirapuera (central residential area)	São Caetano (industrial suburb)	Osasco (industrial and dormitory suburb)
Concentration of inhalable particulates ($\mu g/m^3$)	82	45	87	64
Vehicle emissions (primary, %)	50	35	40	41
Dust from street	22	23	30	25
Secondary sulfates (%)	10	20	12	12
Secondary carbon (%)	10	13	7	17
Fuel oil (%)	4	4	4	2
Other (%)	2	3	6	2

Note: Much street dust and most secondary sulfates and carbon can also be attributed to transport.
Source: CETESB (1989).

is even more drastic. The Mexican data suggest that transport is an insignificant source of SO_x; in São Paulo, it is the dominant source, led by diesel vehicles. It would be interesting to systematically compare air-pollution diagnoses for these two cities in more detail. Indeed, there is a need for systematic and detailed comparisons of many metropolitan air basins. Such diagnoses should consider the impact of urban air pollutants on human health. This may be significant in some cities. In São Paulo, for example, in 1983, acute respiratory illness was the fourth-largest cause of death in general and the second-largest cause of infant mortality.

A strategy to limit and decrease air pollution from urban transport can have diverse elements:

1. *Decrease the emissions intrinsically associated with vehicle design* — This is the most important line of action being

pursued throughout the world. The primary objective has been to achieve reduced emissions in new vehicles; the chosen policy instrument has been minimum norms per vehicle-kilometre under standardized driving conditions.

Exhaust emission standards for new vehicles in various industrialized countries are shown in Table 9. In Brazil, standards for light vehicles, and a schedule to improve them, were adopted in PROCONVE, a 1986 protocol with the automobile industry (Table 10). Because of the substantial lag with respect to standards in the industrialized world, the cost of the tail-pipe catalyst systems now being introduced to meet the 1992 target is not as high as it could have been. New standards for NO_x, CO, and HC from diesel vehicles, based on the 1989 norms of the European Economic Community (EEC), are coming into effect in 1993. Earlier norms established for smoke emissions are widely disrespected; and there are no norms at all for SO_x. In both these important cases, maintenance and fuel-quality issues are crucial (Moreira and Poole 1991).

2. *Improve vehicle maintenance and fuel quality* — Inadequate maintenance is a widely recognized problem in developing countries, with implications for both pollutant emission and

Table 9. Exhaust emission standards (grams per kilometre) of new gasoline-fueled automobiles in OECD countries.

Country	Model year	CO	HCs	NO_x
Australia	1986	9.3	0.90	1.90
Canada	1987	2.1	0.25	0.62
European Community (1985 agreement)	1988–1991	6–11	1.6–4	0.8–1.5
Japan	1978	2.7	0.39	0.48
Sweden	1989	2.1	0.25	0.62
United States (weight < 2 720 kg)	1983	2.1	0.25	0.62

Note: Emission standards cannot be precisely compared between all countries because of differences in test procedures, vehicle durability, and size specifications. CO, carbon monoxide; HCs, hydrocarbons; NO_x, nitrous oxides.

Source: OECD (1988).

Table 10. Pollution emission standards (grams per kilometre) for automobiles produced in Brazil, and the year by which all new car production must meet that standard, as established by PROCONVE in 1986.

Year	CO	HCs	NO_x
1990	24	2.1	2.0
1992	12	1.2	1.4
1997	2	0.3	0.6

Note: CO, carbon monoxide; HCs, hydrocarbons; NO_x, nitrous oxides.

Source: CETESB (1989).

energy consumption, not to mention vehicle availability and useful life. In Brazilian diesel fleets, simple, routine maintenance can significantly reduce particulate emissions. Unfortunately, much deregulation of diesel motors, to increase power output, is deliberate. The introduction of tail-pipe catalyst systems in light vehicles (gasoline and alcohol) will add a new dimension to maintenance concerns: the useful life of the catalyst system (nominally 80 thousand kilometres) is less than that of the vehicle. There is a natural tendency for emissions to increase with vehicle age, and this is worsened if old catalyst systems are not replaced. More and more, norms must be enforced for all operating vehicles, not just new ones. Unfortunately, the police have shown little disposition for this function, tending even to ignore more conventional traffic violations.

Emissions are also greatly affected by fuel quality. A prime example in Brazil is the sulfur content in diesel fuel (see Table 7). Impurities in gasoline may significantly shorten the life of tail-pipe catalyst systems. To upgrade fuel quality, investments must be made in refining. Such investments would represent a change in the historic priorities of the state oil monopoly — Petrobras — which have emphasized output.

3. *Substitute inherently cleaner forms of energy* — Substituting the dominant fuels of road transport — diesel and gasoline

Table 11. Estimated pollutant emissions (grams per kilometre) in new cars (gasoline and alcohol) produced in Brazil, 1980–1985.

Fuel	CO	HCs	NO_x
Gasoline	33	3	1.4
Alcohol	18	2–3.5[a]	1.0

Note: CO, carbon monoxide; HCs, hydrocarbons; NO_x, nitrous oxides.

Source: Murgel (1986).

[a] Murgel (1986) expressed some doubt about the accuracy of these measurements. Some alcohol components of unburned hydrocarbons appeared to be less reactive than major components from gasoline, resulting in a lower level of irritating secondary pollutants.

— with less polluting forms of energy is an option that has been widely discussed but, until now, used relatively little worldwide. The main candidates for substitution are alcohols, natural gas, and electricity. The possibilities of substitution are strongly conditioned by the characteristics of the energy supply system.

Brazil has been the world leader in replacing gasoline with ethanol. The principal objectives of this program were petroleum-import substitution and support to the politically powerful sugar industry. However, along the way, the air has benefited. These benefits, echoed by many environmentalists, especially in the United States, are real. Table 11 shows emissions for gasoline and alcohol vehicles in the early 1980s, with a clear advantage to alcohol. However, similar results could probably have been achieved by advancing the date of applying PROCONVE norms (Table 10). Furthermore, there is a serious crisis in Brazil's alcohol program. Because of its high cost in a political context where subsidies are less feasible, shortages of ethanol have occurred. These shortages have caused changes in the ratio of the gasoline–alcohol blend. Given the difference in fuel–air requirements between gasoline and ethanol, millions of light vehicles are emitting increased amounts of CO and HCs because appropriate adjustments have not been made to allow the engine to burn the fuel mixture efficiently. Mercifully, these increases did not occur in the season when air-pollution problems are at their worst. But they do emphasize the need for stable specifications on fuels entering the market.

Some countries have introduced compressed natural gas as a transport fuel. Although it is the cleanest hydrocarbon fuel, the distribution system limits its use. Despite limited gas reserves, Brazil is embarking on a major program to introduce natural gas in urban bus and taxi fleets. The program is widely supported by municipal authorities, but its costs and benefits relative to other investments are questionable.

Electricity is used as a transport fuel around the world, but only on a small scale. Its use is overwhelmingly in collective transport systems (rail and trolleybus). A very limited market for electric automobiles may someday be stimulated by environmental legislation such as that in southern California. But the environmental benefits of electrification depend on the environmental characteristics of the generation system; air pollution is easier to control in power plants than in vehicles. The main problem is the substantial investment that electrification implies.

4. *Strengthen the role of collective transport* — As previously shown, the overall impact on air pollution of collective transport is substantially less than that of individual vehicles. In developing countries such as Brazil, the objective is probably not so much to increase the share of collective transport, which is already high, as it is to restrict its decline as incomes grow. Much of this book is about how to strengthen collective transport.

5. *Reduce congestion* — Traffic congestion substantially increases the emissions of some pollutants (Fig. 4). It also increases energy consumption. As previously discussed, the problem of congestion can be addressed through a range of measures: charging vehicle users more for their use of space;

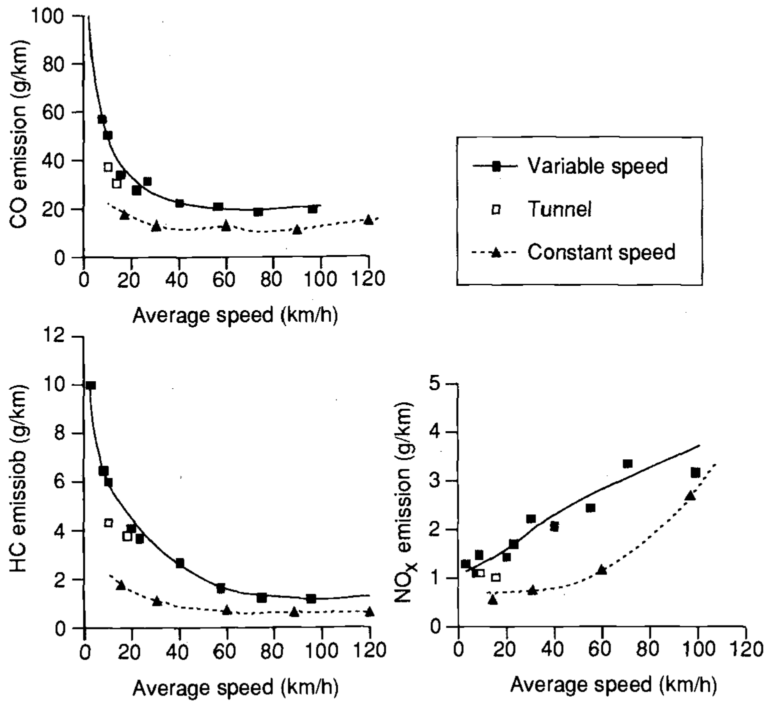

Fig. 4. Emissions of carbon monoxide (CO), hydrocarbons (HCs), and nitrous oxides (NO_X) as a function of average speed and stability of speed (source: Joumard 1989).

restricting automobile access in some areas; improving collective transport; improving traffic engineering; modulating rush-hour peaks; and, in the long term, land-use planning. These measures are complementary and can have objectives other than to reduce congestion. For example, restricting vehicle access to some high-density areas may reduce not only congestion but also local air and sound pollution.

Beyond these strategies, there is a fundamental issue in the urbanization of developing countries that must be addressed. Air-pollution problems, like many other problems affecting the environment and social welfare, tend to intensify exponentially as cities grow in size and wealth. The example of traffic congestion was illustrated earlier. Simple and low-cost solutions are overwhelmed by the dimensions and intensities of demand across wide areas when cities become very large. To control problems at a tolerable level, disproportionate per-capita investments must be made.

The early formation of gigantic cities is almost a constant in the urbanization of the developing world (Table 12). The phenomenon is clear in Latin America, where the percentage of the population in metropolitan areas with more than 2 million inhabitants is typically higher than in North America and continental Europe. The creation of these giant cities within poor countries exaggerates the pressures on government resources for public welfare and infrastructure. There are also increased cost pressures for the economy in general. For example, the megalopolis may need far more restrictive emission standards than the country at large. Some costs with minimum benefits for the rest of the country may be incurred, especially if these emission standards are enforced throughout the country (as in Brazil).

Historically, remunerative economic activity has been concentrated in the megalopolises, which are irresistible demographic magnets. This has been reinforced by a lack of systematic evaluation of the "diseconomies of scale" of large cities in environmental and other terms to counterbalance their evident economies of scale in more traditional terms of industry and commerce. It is absolutely vital that this trend be reversed.

How important is air pollution on the political agenda of developing countries? Today, even though urban pollution is probably more severe in the developing world than in most industrialized countries, its priority among environmental problems is unclear, not to mention the host of other problems faced by developing countries. There are many environmental priorities, ranging from deforestation and soil erosion to urban water quality. Impacts on the economy and social equity must be considered. At the same time, the importance of air-pollution issues is enhanced by their close linkage to the energy problem.

Table 12. Urbanization and large metropolises in selected countries.

Country	Total population, 1986 (millions)	Per-capita income (1986 USD)	% of total population: (A) in urban areas (1985)	% of total population: (B) in metropolitan areas of more than 2 million (1985)	A/B (%)
Developing world					
Argentina	31	2 390	85	35	41
Brazil	141	2 020	75	26	35
Colombia	30	1 240	69	15	22
India	781	290	25	6	24
Indonesia	171	450	27	7	26
Mexico	82	1 830	71	28	39
Nigeria	107	370	33	4	12
Peru	20	1 470	69	28	41
Thailand	54	850	21	11	52
Turkey	53	1 210	47	11	23
Venezuela	18	3 230	83	20	24
Industrialized world					
Australia	16	11 400	86	43	50
Canada	26	15 160	76	23	30
France	56	12 790	74	16	22
Greece	10	4 020	61	27	44
Italy	57	10 350	68	26	38
Japan	122	15 760	77	27	35
Spain	39	6 010	77	20	26
United Kingdom	57	10 420	92	28	30
United States	244	18 530	74	23	31

Source: United Nations (1987), World Bank (1988).

Evaluating relative priority, whether in Brazil or elsewhere, however, is complex and goes beyond the scope of this book. Also, literature on this question is scarce (for São Paulo, see Thomas 1981).

The level of various emissions — CO, HCs, particulates (in diesels) — is directly associated with inefficient combustion, an energy problem. Conversely, more energy-efficient vehicles have helped contribute to lower emissions. Some specific trade-offs exist. Nitrogen oxide emissions are a key example that challenges technological ingenuity: they increase with the temperature of combustion (higher temperature increases efficiency). By and large, however, there is a synergism between policies to reduce air pollution and energy consumption in urban transport. This synergism has been strengthened by the growing preoccupation with the greenhouse effect and emissions of gases such as CO_2 (which, until recently, was regarded as innocuous). As such, energy consumption becomes even more of an environmental problem than it already was. It is the transport sector that has proven to be the most difficult in the push to reduce the demand for petroleum, the great preoccupation of energy planning from 1973 to 1985. It is also among the most difficult economic sectors in the drive to reduce greenhouse gas emissions, besides being the largest anthropogenic source in the world. In Brazil, it is the second-largest source — the destruction of forests being the well-known primary source.

To the extent that the greenhouse problem is politically accepted as real and urgent on both national and global agendas, transport in general and urban transport in particular will be seen to require more drastic actions. Creativity will be needed for the actions to be economically and politically viable. Innovations will be needed on a broad front, but mostly in strengthening collective transport, adapting urban structure, and charging automobile users the full cost of the externalities of their activity. All three of these issues have been relative backwaters of interest, especially among the environmental and energy planning communities, which would be key actors in sparking such a new policy posture. Although these areas are strongly interrelated, this book will concentrate on strengthening collective transport.

Noise Pollution

Noise is a more subtle environmental problem. In studies of the urban environment, it is generally given low priority. The average person, however, may feel quite differently. The majority of complaints relating to the environment in countries of the Organisation for Economic Co-operation and Development (OECD) concern noise (OECD 1988). Residential property values are clearly sensitive to noise levels and, in all countries, transport is by far the major source. Road traffic is the chief offender, followed by air traffic.

Noise levels are measured in decibels (see Fig. 5). On this scale, an increase of 10 points is equivalent to a doubling of the

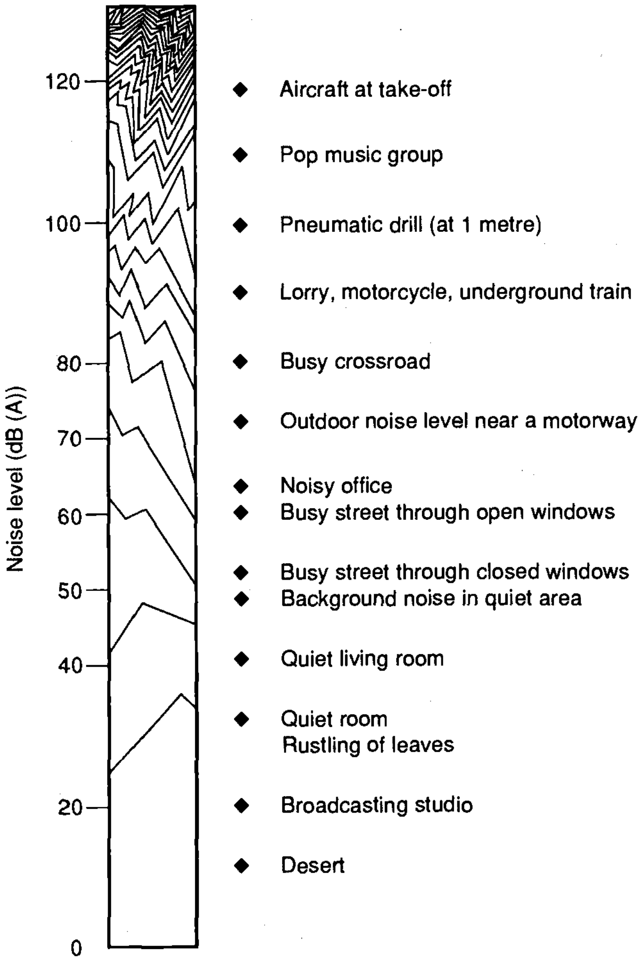

Fig. 5. Examples of noise levels (Leq (A) scale) (source: OECD 1988).

sound level. In this book, we generally express decibel levels in terms of the Leq (A) scale ("equivalent sound level" A — weighted), adapted by OECD, which measures sound level in terms of its impact over a typical 24-hour period.

The health effects of noise are difficult to pinpoint. Induced deafness is the most acute and easiest to quantify. It can result from prolonged exposure to noise levels above 80 decibels and is primarily a hazard of certain kinds of work (rock groups, bottling plants, etc.). Lower, more chronic noise levels are now recognized as serious stress factors. "Stress" is an ill-defined (especially in its epidemiology) but important syndrome whose primary and direct impacts are on the cardiovascular and digestive systems. Research is demonstrating, among other things, that people do not adjust to noise as well as was once thought, especially certain kinds of noise. Also, noise during sleep is an insidious problem, in part because the person cannot perceive the deterioration in sleep quality.

The epidemiology of noise is complicated because people are exposed to a wide range of noise sources. Each individual's "dose" will depend on the time he or she spends in distinct environments, which makes it extremely complicated to estimate. Most studies on noise pollution are restricted to a particular environment, which tends to underestimate the problem for substantial at-risk populations.

The most careful study of population exposure has been made in Japan (and it is only preliminary). It found that 36 percent of "workers" (of both sexes) and 33 percent of "housewives" were exposed to noise levels of at least 70 decibels, which is a striking finding (OECD 1988). It means one-third of Japan's total population, and probably more than half of its urban population, puts up with noise levels that are the equivalent of continuously standing outside near an expressway (see Fig. 5).

Road traffic is clearly a major component in the exposure of most at-risk individuals. Table 13 lists outdoor noise exposures for most OECD countries. In Japan, 31 percent of the population is exposed to an average, continuous, "background" outdoor

Table 13. Exposure of national populations (percent, cumulative) to road transport noise in some industrialized countries, early 1980s.

Country	>55 dB	>60 dB	>65 dB	>70 dB	>75 dB
Austria[a]	50	35	16	7	<1
Belgium[a]	69	39	12	1	—
Denmark[b]	38	24	12	4	1
France[a]	44	25	13	4	<1
Greece[b]	50	30	20	10	2
Japan[a,c]	80	58	31	10	1
Netherlands[a]	40	18	6	<1	—
Norway[b]	18	10	5	2	—
Spain[a]	74	50	23	7	1
Sweden[b]	38	24	11	4	1
Switzerland[a]	54	28	11	4	1
United Kingdom[a,d]	50	25	11	4	<1
United States[b]	37	18	7	2	<1

Source: OECD (1988).
[a] Daytime noise, 0600 to 2200.
[b] Over full 24 hours.
[c] OECD estimates.
[d] Road traffic noise averaged 6 to 24 dB according to a 1973 survey of England only.

noise level of 65 decibels. This suggests, extrapolating crudely, that roughly half of the overall problem in Japan may be due to exposure to road traffic noise.

Table 13 also shows high levels of noise in Greece and Spain (exposure to more than 65 decibels), countries with characteristics closer to Brazil than to the OECD average. This suggests that exposure to road noise is relatively high in the urban areas of developing countries. In Brazil, only a few short-term studies have been done. All reinforce this view.

The natural human response to a high level of outdoor noise is to shut the windows (above 60 decibels according to French studies cited by OECD). In a tropical environment, this can be particularly perverse in terms of either comfort or the energy required to compensate for the lack of ventilation. Air-conditioning becomes a necessity; this triggers a whole new set of environmental and financial problems in electricity supply. Air-conditioning is already a major source of commercial and residential electricity demand in the more tropical regions of the developing world. To give an idea of the potential weight of this phenomenon in energy and economic terms, in humid tropical Manaus, the household consumption of electricity is perhaps the highest of any metropolitan area in Brazil, despite a household income that is well below the national urban average (Poole et al. 1990).

There are several means of reducing exposure to motorway noise:

- Reduce vehicle sounds by establishing and enforcing norms. Reductions are technically possible and may correlate well with increased energy efficiency. Analyses in Denmark, France, and Switzerland suggest that achievable vehicle standards can greatly reduce the number of people exposed to a 65-decibel multisource noise level (the principal at-risk population). In developing countries, buses and motorcycles should be the first targets. One simple measure attempted in Brazil was to remove the horns from buses.

- Increase sound absorption between source and population by using acoustic barriers. Such barriers range from sound insulation to "urban gardens," but tend to be expensive relative to the benefits provided.

- Implement other measures along transport corridors. These include zoning to reduce residential exposure, creation of a buffer space on new corridors, and changes to the transport system on existing corridors. For example, trolleybuses and light-rail trains are considerably less noisy than diesel buses or an equivalent number of automobiles.

Noise exposure is projected to increase in OECD countries unless explicit steps are taken. A larger increase can be expected in the cities of developing countries.

Combatting noise polution is usually given low priority. This is partly because so little is known about the impact of noise among the many sources of stress in large cities. However, the problem of noise is immediately relevant to collective transport planning for dense corridors, along with other factors influencing the choice of transport mode. In the densely populated areas of Brazil, people along hundreds of kilometres of roadways must endure the noise of a hundred or more buses per hour.

Fragmentation of Urban Space

The urban transport system is a key element in the spatial structure of cities. It plays a central structuring role in urban space, tending to induce major changes in land-use patterns (expressed in terms of densities, urban morphology, and social, economic, and psychological content). Consequently, urban transport planning and urban design are inseparable. Most importantly, to understand urban transport problems, we must identify the constraints to mobility and accessibility (and, by extension, to urban transport policies) posed by the spatial structure of cities. The intraurban patterns of Brazilian cities present specific features that intensify urban transport problems. There is a lack of adequate planning and control on the part of government institutions in real estate development, land-use patterns, and the spatial allocation of urban-development investments. In the context of the rapid urban growth and skyrocketing land values in Brazilian cities, the potential for high profits in the real estate market is great. This market becomes, therefore, an uncontrolled arena in which the agents evolve strategies that lead to the increased fragmentation of urban space.

This is the basis of a critique developed by the Working Group on Urbanism and Traffic of the National Public Transportation Association of Brazil (ANTP 1989). The critique considers the forces, such as property speculation, that lead to rapid urban growth, mould the urban space, and result in the "chaotic metropolization" that characterizes the urbanization of Brazil. Metropolitan communities become fragmented into distinct and evermore disarticulated centres: home, services, work, leisure.

Between these centres are "dead spaces": environmentally degraded areas that are the loci of speculative operations and are associated with land appreciation resulting from public investments in infrastructure. A major feature of Brazilian cities is their structural heterogeneity: the coexistence of a large ring divested of infrastructure and services, including transport, that surrounds the relatively privileged central area. Hence the importance of public investment to speculation.

In this context, the role played by government institutions is central. Before 1979, the Brazilian legal framework regulating plot subdivision and land development was archaic and ineffective. It essentially amounted to a "laissez-faire" posture. There were virtually no provisions requiring the construction of public infrastructure or the allocation of areas devoted to community facilities. Law 6766, passed by the Brazilian government in 1979, corrected some of these problems. Even with this legislation, however, much remains to be done. Most important of all is the fiscal area. Sanctions against land stocking in interstitial areas are needed to prevent urban sprawl and the transport problems that it generates.

The critique of ANTP (1989) argues that urban transport has been, and remains, a key instrument in this urban reality of ever-increasing fragmentation, distances, obstacles, and diminishing mobility. This leads to a paradox: mobility declines as cities grow larger and invest more in transport. In Brazil's 10 largest urban centres, mobility is 1.3 trips per person per day; in other capital cities, it is 1.5; in intermediate cities, 1.8 (ANTP 1989). Meanwhile, the cost of urban transport grows, as does trip time, pollution, the number of accidents, congestion, and invasion of urban space by transport functions. There is a profound and growing social alienation, and there will simply not be the financial resources necessary to supply the transport service that the current model implies.

The key proposal of ANTP (1989) is to reduce drastically the need for transport — that is, work, services, and home should be closer together. This resembles the proposal in the energy sector to increase the efficiency of energy use rather than simply expanding supply. However, it is likely to be much more difficult to implement. Indeed, if the diagnosis of ANTP is correct, then the outlook for Brazil's large cities is truly grim. It is extremely unlikely that an already low mobility can be drastically reduced in a short time by reorganizing the economic fabric of various cities.

An integrated view of human activities in the context of urban space is critical. For example, valorization of collective transport involves valorization of the pedestrian (Wright and Sant'anna 1989). This means not only protecting pedestrians from cars but also improving their access to services. Practically every collective transport trip involves two pedestrian subtrips. What happens during these subtrips ("Can I stop at a grocery store on the way home?") may have an important impact on the user's overall judgment of the quality of the journey. Nonmotorized transport as a whole needs attention. A key contribution of the ANTP report is that it emphasizes the consumer, the demand side. Much transport planning is too supply driven.

Energy

There is a strong interaction between transport and energy. Transport is a key part of the energy equation, especially for liquid fuels, which represent the most difficult long-term part of this equation on the supply side. In Brazil in 1990, 67 percent of the final energy demand for petroleum derivatives and alcohol (excluding the energy sector's own demand) went to transport, up from 58 percent in 1980 (MME 1993).

At the same time, energy is an important part of the transport equation. It represents an important share of direct and indirect costs (vehicles and infrastructure) and is frequently a major source of tax revenue for infrastructure investment. Together with basic industrial materials (like metals, bulk petrochemicals, paper, and cement), transport is the most energy-intensive economic activity relative to its value added. However, transport is a more important variable for energy than vice versa, at least until a much higher level of fuel costs is reached.

Despite this powerful interaction, analysis of the interface between transport and energy policy remains poorly developed, especially in developing countries. The residential and industrial energy-consuming sectors are far better understood.

What little policy work has been done has concentrated on increasing the intrinsic efficiency of the vehicle or substituting petroleum derivatives (especially in Brazil, with its alcohol program). Although both of these issues are important — especially improved vehicle efficiency — they do not reflect the whole question. Total demand, modal mix, and vehicle operating conditions — what one might call "structural factors" — are also important for both energy and transport policy. They are complex, and perhaps that is why they have been avoided. But their understanding is important, not only for policy issues but also, more generally, to create a more market-oriented energy policy and a transport policy that is more explicitly conservationist. The world faces major and durable increases in the cost of liquid fuels in the indeterminate but not too distant future and possibly major constraints in energy and CO_2 emissions. In such a world, cities like Curitiba and Toronto are heading one way while Brasília, Detroit, Los Angeles, and others are headed the other. Can we afford to ignore these differences?

Today, the potential impact of changes in the structural factors conditioning urban transport cannot be estimated with accuracy. There is little basis for estimating even what fraction of total transport energy is consumed under urban conditions. In the case of Brazil, data from Petrobras show that 50 percent of gasoline and alcohol and 30 percent of diesel fuel are sold in the capital cities (state and national), which include most but not all metropolitan areas. Even though virtually all of this fuel went for transport, not all was actually consumed within metropolitan areas. Thus, roughly 35 to 40 percent of total transport energy is consumed in metropolitan areas; 25 to 30 percent goes to urban passenger transport. Including smaller cities (below 200 thousand inhabitants) would increase these figures.

In addressing structural change in urban transport, we must start with the role of the private automobile. As with environmental impact and the use of urban space, there is an order of magnitude difference in energy consumption when comparing collective transport and private automobile transport. An automobile fleet with an average fuel efficiency in urban driving conditions 50 percent higher than today (which will likely require more than a decade to achieve) typically provides 15 passenger-kilometres per litre of fuel; a reasonably optimized bus system, more than 100. The greater congestion provoked by automobiles results in reduced energy efficiency for most users. The indirect dynamics of the automobile also lead to a greater dispersion of the urban fabric. Motorized trips become longer and more frequent to the extent that cities seek to adapt to the uninhibited logic of the car.

As incomes and motorization increase in the developing world, the logic of the car will inevitably persist. Official urban transport plans in Brazil frequently project that the modal share of the car will decrease or remain constant. This is surely unrealistic and certainly has no historical footing (see Table 4). But to what extent can urban policy intervene in this dynamic? To what extent is intervention worthwhile?

Using the experiences of industrialized countries to predict the future in the developing world casts little light on the question. Surprisingly little is known, at a comparative international level, about such experience. This is the key message of a recent OECD report (Webster et al. 1986). In general, this report describes the inevitable advance of an urban transport system and city structure that revolve around the private automobile. However, it notes interesting exceptions. In North America, Canadians use more collective transport than expected (Table 14; *Economist* 1990). In Spain, people use their cars less than expected. Webster and co-workers admit that they don't know why this is; in fact, their work shows just how fragmented and

Table 14. Public transport ridership in some industrialized countries.

Country	Ridership, 1980 (journeys per individual per year)[a]	Ridership trend, 1970–1980 (% per year)
Australia	31	–1.3
Belgium[b]	85	+1.7
Canada	74	+3.8
Finland	108	+1.3
Ireland	72	–1.5
Italy	85	+4.3
Netherlands	80	+0.8
New Zealand	30	–1.4
Norway	81	+0.3
Spain	51	–0.8
Switzerland	106	+0.4
United Kingdom	114	–3.3
United States	28	+0.8

Source: Webster et al. (1986).

[a] These data are not fully reliable as, in some cases, ridership statistics do not include passengers carried on smaller operating networks.

[b] Statistics for Belgium refer to urban networks only. But it is estimated that these account for 45 percent of total public transport use, and the trip rate has been adjusted accordingly.

poor the analysis and information are in the industrialized world on the subtle factors that could decisively influence urban transport. The dynamics of urban transport development in the industrialized world should receive more scrutiny.

Another analysis (Vuchic 1981) suggests that European cities that took collective transport more seriously (the criterion was greater investment in "light-rail transit") have a significantly higher ridership in collective transport. This study refers principally to cities of 100 to 600 thousand inhabitants, a size range that is almost ignored in analyses of developing countries. A study performed in Brazil points to the same conclusion (Table 15). Curitiba's fuel consumption per automobile is lower than that of any other city of a comparable size. The contrast with Brasília and Salvador is particularly striking. These two cities are characterized by urban sprawl and poor public transport. In

Table 15. Fuel consumption per automobile in selected metropolitan areas of Brazil, 1980.

City	Population (thousands)	Automobiles per thousand inhabitants	Fuel consumption per automobile[a]
Belém	934	58	1 784 (1.21)
Belo Horizonte	1 782	126	1 925 (1.31)
Brasília	1 177	146	2 729 (1.85)
Curitiba	1 034	200	1 472 (1.00)
Fortaleza	1 039	54	2 846 (1.93)
Porto Alegre	1 126	157	1 688 (1.15)
Recife	1 205	111	1 820 (1.24)
Salvador	1 506	74	3 020 (2.05)
Weighted average		114	2 072 (1.41)

Source: Lerner (1989).

[a] Values in parentheses give fuel consumption per automobile relative to Curitiba (1.00).

contrast, Curitiba has the best collective transport system in Brazil and an effective land-use policy that incorporates transport concerns. This suggests that urban policy has had an appreciable impact on the intensity of automobile use, although other factors would have to be analyzed before arriving at a definitive conclusion.

An important area of interaction between energy and transport is pricing policy. A good example from Brazil, common to many countries, is the low price of diesel fuel relative to gasoline. Diesel's low price is justified in official policy by its use in "essential" sectors, such as collective transport, to which cost-inflation indices are sensitive. This has stimulated demand and increased the problems of supply (World Bank 1990). Fuel quality has suffered, with environmental consequences, as previously described. Now, a major objective in energy policy is to limit the growth of diesel consumption. However, a coherent strategy has yet to emerge.

More and more, politicians are recognizing the economic rationale behind incorporating externalities into consumer prices, in part through taxes. In theory, pollution taxes are more economically efficient than most forms of tax, and they are high on the agenda for fiscal policy reform in some OECD countries. Carbon taxes are only one example. Energy and transport are key sectors in the application of such pricing philosophy. At the same time, there is increasing acceptance that the user of urban collective transport should not be expected to pay the full cost of providing the service. Fuel "externality taxes" and other charges, such as parking fees, are obvious and legitimate sources of money. A systematic treatment of externalities would be useful for policies of fuel pricing as well as the pricing and financing of urban transport.

Energy policy for urban transport is closely linked to environmental problems. Some of these relations, such as fuel quality and the impact of congestion, were discussed earlier; others, relevant to the form of energy used in bus systems, will be discussed in Chapter 3. In general, environmental and energy-efficiency objectives often reinforce each other. This synergism will be important in determining the viability of measures to change existing trends, as will the convergence with objectives to reduce both congestion and existing socioeconomic inequities.

In Brazil, a planning posture that effectively incorporates such multiple objectives would imply important changes in the energy policy of transport. Traditionally, such policy has been dominated by goals to substitute petroleum derivatives (first gasoline and now diesel) with other energy forms: alcohol, electricity, and natural gas. Even energy efficiency and pollutant emission have been treated as secondary, unlike in most industrialized countries. The sort of structural changes raised here have barely merited an afterthought. As in transport planning, a supply-oriented philosophy has prevailed, as has an excessively narrow and "sectoral" view of the problems (Moreira and Poole 1991). This posture is, however, slowly changing.

Equity

The social dimension of urban transport has received very little study. Following the tradition of the industrialized world, urban transport studies in developing countries have tended to focus on technical analysis. In Latin America, this type of analysis generally produces incomplete and undesirable results, given the existing socioeconomic conditions and disequilibria in the cities.

Urban transport is clearly a major factor determining access to employment and income. Maintaining or increasing this access is particularly important in countries where the distribution of income is perverse and cities are marked by real-estate speculation. A prerequisite for access is urban mobility, and mobility is strongly conditioned by the characteristics of urbanization, the labour market, and the supply of transport services. This web of interrelations explains the considerable weight of urban transport in issues of social and economic equity in the developing world.

The urban poor and people who live in the suburban periphery — where public services and infrastructure are most precarious — are the most sensitive to the conditions of transport, especially collective transport. They are captive users. Broadly, they tend to be the same group. In Brazil, the urban and social structures are such that the worst conditions of work and income generally go together with housing that is distant and of poor quality.

Peripheral urban growth has predominated in the large cities of Brazil since the 1940s. The best example is São Paulo. In some cities, the predominant form of low-income settlement has been high-density *favelas* or slums in the more central urbanized areas (such as in Rio de Janeiro). But comparative studies on this issue are practically nonexistent, limiting how far we can go in explaining its origins. Nevertheless, there has been rapid growth in both peripheral settlements and central *favelas* in the large cities of Brazil, especially in the 1970s. For example, in the 1980s, population growth in São Paulo was higher in the central and intermediate zones than in the periphery.

This information does not invalidate our arguments on the interrelations between transport, housing, and employment. Today, large masses of people live in peripheral zones; for 40 years, these areas have been the key source of low-income housing, irrespective of recent changes in relative growth. In some cities, such as São Paulo, the move away from peripheral growth may be less pronounced than first perceived. The peripheral zones of the central municipality may be reaching saturation because of land-use constraints; but there are always other outlying municipalities. Some of these now serve as an "extended periphery" for the central urban area.

Such a segregated sociogeographic structure is illustrated by the distribution of automobile motorization. In Greater São Paulo, for example, the 1980 census showed that motorization in the high-income zones of the city exceeded 300 vehicles per thousand inhabitants, higher than the 1980 levels in London, New York, and Tokyo (World Bank 1986a). In the periphery of São Paulo, the motorization level was below 50 per thousand.

Some data illustrate how the great majority of the low-income population is dependent on collective transport. Unfortunately, however, there are no nationwide statistics relating income, motorization, and use of collective transport. A 1977 survey in Greater São Paulo (Metrô 1980) showed that 72 percent of the population with a household income below five minimum salaries (which describes 77 percent of the total population) used collective transport for trips from home to work; 13 percent walked and 15 percent used one of the other modes (private automobile, motorcycle, taxi, paratransit, etc.). At the same time, the use of private automobiles by the total population, including high-income classes, increased to 39.3 percent of motorized trips. Average trip time also varies with level of income. The lower the income, the longer the trip time (all trips; Table 16). Longer trip times imply lower accessibility.

Table 16. Proportion (percent) of trips on collective transport by duration and income class for Greater São Paulo, 1987.

Average trip time (min)	<210 USD/month	210–420 USD/month	421–840 USD/month	>840 USD/month
0–15	1.3	3.0	3.5	4.8
16–30	11.5	14.8	17.7	23.0
31–45	18.2	18.4	20.7	23.7
46–60	17.6	16.3	17.1	17.2
61–75	14.3	13.0	12.7	11.4
76–90	10.9	10.0	9.1	7.3
91–105	8.1	7.6	6.5	4.7
106–120	5.9	5.8	4.7	3.1
121–135	4.3	4.4	3.4	2.0
136–150	3.2	3.4	2.4	1.4
>150	4.6	3.2	2.3	1.2
Total no. of trips (thousands)	1 507	1 489	3 115	3 620

Source: Metrô (1989).

The conventional bus is the predominant mode of collective transport in Brazilian cities; it is almost always the only mode available. Even in Rio de Janeiro and São Paulo, the only cities in Brazil with metro and suburban rail systems, buses account for more than 75 percent of collective transport. Bus service tends to be unreliable. A 1988 survey showed that, in 7 of the 12 state capitals, more than 40 percent of users judged bus service to be either bad or very bad.

Also, as previously discussed, the predominant urban structure is characterized by a spatial concentration of employment and a dispersion of habitation in vast suburban and "sub-urban" peripheries. This has increasingly dissociated places of residence, work, and services, especially for low-income groups. There are some exceptions. The poor live in extremely high-density settlements in the slums of central areas. At the same time, real estate speculation has produced enormous empty areas in the interstices of the urbanized area. In Porto Alegre, for example, unoccupied areas accounted for 42 percent of the officially defined urban area in 1987. The urban space is profoundly hierarchical and segregated in terms of land values, infrastructure, and housing conditions. Government programs for low-income housing have had little effect.

Difficulties in the housing market are compounded by problems of finding a place in the labour market, especially in times of economic crisis such as the past decade. In this situation, few workers are able to optimize the geographic relation of employment and residence. They are forced to make extended trips. The great majority are "captive" users of collective transport whose mobility is low. The "metropolitization" of urban areas tends to aggravate these problems: the larger the city, the lower the average mobility (see Table 13).

The characteristics of restricted mobility, as experienced by the low-income classes, changed somewhat from the 1970s, a time of economic growth, to the chronic crisis of the 1980s. In the 1970s, there was some increase in mobility (in terms of motorized trips per capita). However, this was only achieved through higher expenditures (see Table 34), longer trip times (a 30 percent increase in average trip time from 1969 to 1975), and a deterioration in the quality of collective transport (more overcrowding and longer waiting times). In the 1980s, the restricted mobility (motorized trips per capita) already achieved began to fall. There was a major increase in trips taken on foot, and the average duration of motorized trips remained high. In São Paulo, 44 percent of collective transport trips lasted more than an hour.

Surveys in São Paulo allow us to quantify these changes. In 1967, the rate of mobility was 1.01 motorized trips per capita per day. In 1977, this had increased to 1.53. By 1987, the rate had fallen back to 1.07, close to the 1967 level. From 1977 to 1987, the population of the metropolitan area had increased by 58 percent; over the same period, motorized trips increased by only 8 percent (from 16 to 17.1 million trips per day; Table 17). Virtually all this increase was due to increased automobile use. Trips by collective transport remained constant at 9.7 million. At the same time, trips on foot increased from 5.2 million per day

Table 17. Evolution of daily trips and mobility in Greater São Paulo, 1967–1987.

Year	Motorized trips: Collective (thousands)	Motorized trips: Individual (thousands)	Motorized trips: Mobility (per capita)	Pedestrian trips (thousands)	Total (thousands)
1967	4 387	2 776	1.01	NA[a]	7 163
1977	9 713	6 927	1.53	5 234	21 874
1987	9 731	7 397	1.07	9 516	26 644

Source: Metrô (1989).
[a] Information not available.

in 1977 to 9.5 million in 1987, or from 24.8 percent of total trips to 35.7 percent. Also, regarding the decline in motorized trips per capita, the percentage of the population that is economically active has been increasing, a tendency that would normally increase mobility, other factors being equal.

One interpretation of the large increase in pedestrian trips is that it is a natural result of a greater "regionalization" of the economy and public services of the metropolitan area. It is argued that this has modified trip patterns and diminished the need for longer trips. This rather comfortable interpretation does not appear to entirely explain the phenomenon or to exclude other explanations. To begin with, the reduction in mobility has not been distributed evenly throughout the population; it is concentrated in the low-income classes (Table 18). The increases in trip time have also been concentrated among users of collective transport. The proportion of collective transport trips of over 1 hour increased by 10 percent between 1977 and 1987 (Table 19). Meanwhile, the average trip time for private automobiles remained constant at 24 minutes (Table 20). Complementary information to interpret these trends is lacking. The constant automobile trip time may be due to two factors: the "regionalization" of the metropolitan area and users' strategies to reduce long-distance trips to avoid traffic congestion. The great increase in pedestrian trips may also be associated with the rise of the informal economy and, more generally, with falling incomes. The informal economy tends to have low salaries and precarious

Table 18. Individual mobility by income class for Greater São Paulo, 1977 and 1987.

Income class (USD/month)	1977	1987
0	0.75	0.44
0–125	0.94	0.52
125–210	1.33	0.68
210–420	1.68	0.92
420–840	2.20	1.31
>840	2.50	1.86

Source: Metrô (1989).

Table 19. Duration of trips by individual and collective modes in Greater São Paulo, 1977 and 1987.

	1977		1987	
Max. duration of trip (min)	Collective (%)	Individual (%)	Collective (%)	Individual (%)
5	0.03	1.91	0.01	0.27
10	0.88	12.96	0.76	9.74
15	3.77	29.18	3.33	26.67
20	8.95	45.16	7.70	43.81
25	15.86	58.55	13.35	58.08
30	23.73	68.96	19.73	69.05
40	39.82	82.54	32.96	83.11
50	54.03	89.85	45.29	90.57
60	65.45	93.78	55.96	94.56
75	77.72	96.62	68.74	97.45
90	85.61	97.83	78.21	98.70
120	93.81	98.64	90.29	99.54
150	97.19	98.83	96.90	99.76

Note: Percentages are cumulative.
Source: Metrô (1989).

work conditions. There may also be some "regionalization" of employment.

The large amount of time spent each day in commuting to and from work, especially by the residents of the suburban periphery, consumes both free time and a large chunk of the family budget. Long commuting times often deprive these people

Table 20. Average trip time (minutes) by mode in Greater São Paulo, 1977 and 1987.

Mode	1977	1987
Automobile	24	24
Bicycle	20	22
Bus	52	57
Metro	34	33
Metro/train	58	71
Micro bus	NA	39
Motorcycle	NA	22
Pedestrian	NA	15
School bus	NA	32
Taxi	26	25
Train	85	85
Trolleybus	NA	45
Truck	NA	43

Note: Times include walking to station, waiting, and transfers. NA, not available.

Source: Metrô (1989).

of the opportunity to earn supplementary income or enrich their individual or family lives. Analysts refer to the "poverty of time" resulting from the poor transport conditions in the periphery.

The urban transport system, especially collective transport, is marked by an intense concentration of trips during peak hours (see Fig. 9). This is especially true for the long-distance bus lines that serve the suburban periphery. It creates a system-management problem: the idle capacity between peaks. In general, operating companies reduce costs by drastically reducing the supply (and frequency) of service during off-peak periods, increasing the instability of an already unstable system. Informal paratransit modes (called *lotações*) and unlicenced buses are often used in the periphery because of the deficiencies in regular transport service.

Clearly, although the collective system as a whole is deficient, the deficiencies are concentrated in the suburban periphery — home to most of the captive users. In one suburb of São Paulo, with 900 thousand inhabitants, 45 percent of total trip time is spent gaining access to the system — walking and waiting. These users spent an average of 3 hours and 15 minutes each day getting to and from work (Pacheco 1985).

One of the most perverse effects of the precariousness of collective transport, especially in the periphery, is the negative selectivity it exercises on the possibilities of the population within the labour market. This selectivity has a powerful effect on employment and salary opportunities. Access to the labour market is differentiated by the tolerable limits of time and cost, which segment the market into submarkets, even within households by sex, age, and qualification.

The relative qualifications and contribution of an individual's salary to the household budget have an enormous impact on that person's use of transport. In São Paulo, those with the highest income in a household seek to enter the metropolitan labour market, making longer trips and, at the same time, trying to reduce trip time, even if it increases expenses. For less-qualified individuals, income levels force them to use the lowest cost and generally lowest quality option. As a result, they are subjected to relatively long trip times. In turn, this limits these workers to the local labour market. Salaries in this market are generally lower. This vicious circle particularly affects women and youths, making the process of increasing the qualification levels of these large and growing contingents of the labour force more difficult. In this case, shorter distances do not necessarily mean shorter times. Given the shaky state of local transport subsystems and the need to limit expenses, trip times are similar for those who work close to their residence and for those who travel to the centres of employment — they are equally long (Pacheco 1985).

In Brazil's medium-sized cities, pedestrian trips typically account for a larger part of total transport. This is due to both the shorter distances and the reduced network of collective transport. Table 21 shows the modal share of pedestrian trips in 10 medium-sized cities of Brazil; only pedestrian trips over 500 metres are considered. These data suggest the challenge that many of these cities will face over the coming years. As a class,

Table 21. Level of motorization and motor distribution (modal share) of urban trips in medium-sized cities of Brazil, 1978.

City	Automobiles per 100 inhabitants	Automobile (%)	Bus (%)	Pedestrian[a] (%)	Other[b] (%)
Bauru	13	32	23	43	2
Campina Grande	6	21	31	44	4
Campinas	17	35	36	27	2
Caruaru	4	14	9	74	3
Caxias do Sul	14	30	26	42	4
Cuiabá	7	25	21	49	5
Manaus	6	29	28	23	20
Natal	8	30	36	30	4
Pelotas	10	21	36	34	9
Ribeirão Preto	15	27	28	35	10

[a] Trips of less than 500 metres are not included.
[b] Includes taxis, motorcycles, and other motorized transport.

medium-sized cities are the fastest growing in Brazil. The scarcity of financial, institutional, and human resources in these cities, combined with their intense growth, makes it likely that transport conditions will deteriorate.

Our analysis demonstrates the contribution that collective transport could make toward improving equity in Brazilian cities. Segregated cities, a polarized society, large populations with low mobility — all make the conditions of accessibility to the labour market and services an essential factor in avoiding a further increase in social inequality. Public policy to strengthen collective transport can contribute to improved equity if it is anchored by objectives such as

- Promoting accessibility;
- Maintaining tariffs at a level compatible with the paying capacity of the majority of the population;
- Giving priority to improved service in the suburban periphery;

- Consolidating collective transport into a true system, with the effective integration of the diverse transport modes; and
- Articulating metropolitan, multimunicipality policies in recognition of the geography of large cities.

The realization of such objectives requires confronting a range of problems: institutional, technical, economic, financial, and political (discussed in Chapter 3).

Financial Constraints

Urban transport policy typically requires large amounts of capital investment. Hence, it plays an important macroeconomic role in developing countries. Investments in the construction or improvement of road or rail systems in traffic engineering, and in facilities such as bus terminals require a large share of government income. These investments can only be effectively made if adequate financing mechanisms are established.

In the 1970s, there was an influx of petrodollars, and money was borrowed from the international financial markets. In developing countries, including Brazil, such foreign borrowing cut across many sectors. State enterprises in the transport, steel, and energy sectors contracted a great volume of loans not only for capital investment but also to restore international reserves.

Brazil's transport policy is a good example of one in which external sources have played an important role, especially in key components of national programs. From 1978 to 1987, Brazil's Urban Transport Program was largely financed by loans contracted with the World Bank and various commercial banks. It involved six large projects with a total cost of 1.3 billion USD. Significantly, the share of external borrowing in EBTU's total income rose from 4.4 percent in 1979 to 89 percent in 1985. The corresponding share for the Federal Railway Corporation (RFFSA) and the Brazilian Urban Rail Corporation (CBTU) rose from 4 percent in 1979, to 44 percent in 1983, to 72 percent in 1984 (Fagnani and Cadaval 1988, p. 45).

Loans were used chiefly to finance suburban rail systems. The sudden dominance of external sources resulted not from an increase in the absolute value of foreign borrowing but, in fact, from a declining amount of available internal sources. Externally funded investment peaked in 1984. Since then, total investment has declined systematically. For Brazil, therefore, it could be argued that the central financial constraints to transport policy can be found in the factors affecting the internal financing mechanisms.

Foreign borrowing in general has several shortcomings, most notably from the macroeconomic perspective where, in the context of floating interest rates, the loan conditions are directly dependent upon the US prime rate. The recent history of the developing-world indebtedness shows that the unilateral decision of the United States to systematically raise the prime rate in the late 1970s and early 1980s had a catastrophic impact on their economies. World Bank loans, in turn, present specific problems (discussed in the following section on international agencies).

In addition, the negotiation of foreign loans often involves government, suppliers of goods and services, and various forms of supplier credits. As a result, "technological packages" are imposed upon borrowing countries. The loan that funded the suburban rail project in Recife is a case in point. Credit was made available along with a package of foreign goods. This package included, among other things, spare parts (including a supply of ordinary, locally available lamps) for the carriages for 20 years. On top of this, the design of the trains proved to be inadequate for the local climate. In sum, supplier and Eximbank credits for transport projects in Brazil have a record of inefficiency. They are not a viable alternative without further considerations.

The international financial markets stopped lending to developing countries (with a few exceptions) after the 1982 Mexico crisis. Current loans are made with the World Bank as cofinancer. This means that the World Bank and internal sources are now the principal sources of financing. However, with the current profound structural fiscal crisis affecting most Latin American economies, internal sources are very unreliable.

In Brazil, for example, interest on the internal debt, according to the 1990 budget, absorbed two-thirds of federal government revenue. Moreover, servicing the public-sector deficit — measured as public-sector borrowing — requires 6 percent of the gross domestic product (GDP). Currently, the primary deficit (the deficit minus the financial costs involved in servicing it) is virtually zero. In other words, the deficit has become a structural and purely financial phenomenon.

Brazil's urban transport sector has both contributed to and been affected by the fiscal crisis. The case of CBTU provides a clear example. For the seven suburban rail systems operating in metropolitan regions, operational revenues have accounted for only 19 percent of operating costs (excluding depreciation and return on assets), ranging from 1 percent in Porto Alegre to 38 percent in São Paulo. This has produced annual deficits of over 100 million USD. Thus, CBTU must seek support from the National Treasury to cover operational deficits and its investment program.

The fiscal crisis is currently affecting all levels of government in Brazil. Both municipalities and states depend on taxes related to production, sales, and income. Because of this, their revenue structures are sensitive to changes in macroeconomic conditions. The economic problems of the 1980s have, as a result, severely restricted their ability to implement transport policy. The effect of mounting inflation has been devastating. The short-term commitments of the major state capitals — where urban transport problems are more severe — rose rapidly to absorb over a quarter of their revenues in the mid-1980s (Andrade 1987; Afonso and Resende 1989).

The effects of the fiscal crisis on federal transport policy are easily identified. The effects of inflation on the accumulated debt of EBTU are evident in the ratio of debt service to investments. From a negligible 0.6 in 1980, this ratio climbed to 15.6 in 1982, to 71.0 in 1985, to an unimagined level of 538.0 in 1987.

At the municipality and state levels, the crisis is particularly felt in the lack of local counterpart funds. In turn, this leads to substantial delays or canceling of World Bank or federal projects. World Bank projects chiefly involve reimbursing outlays by municipalities and states, and, in Brazil, time overruns have varied from 25 to 100 percent, mostly as a result of the lack of counterpart funds.

A critical bottleneck is the renewal of the bus fleet. From 1979 onward, this has been accomplished by internal financing, namely through the FINAME program (a financing scheme for the purchase of machine tools and industrial equipment) of the National Bank for Social and Economic Development (BNDES). In 1987, the existing fleet consisted of 70 thousand buses. To maintain the 1987 level of bus production, the average working life of a vehicle would have had to increase from 7 years to 8.1 years in 1990. Therefore, even to maintain fleet lifetime, additional investments must be made.

In the case of BNDES, this would mean that significant subsidies would be necessary within the FINAME program. It is virtually impossible to transfer this cost to users: the income of the urban poor continues to decline; sectoral policies, such as anti-inflation measures, keep tariffs artificially low; and the political costs of transition of regime and democratization remain high.

The Role of International Agencies

In the developing world, international agencies play a crucial role in transport policy. Developing countries typically lack the human resources and expertise to identify and design technically consistent solutions to their urban transport problems. Although there are instances of creativity and innovation, the problem is serious. Developing nations also lack the institutional capability to implement public policy, not only in the transport sector but also in many areas of urban development. More importantly, they suffer from a structural scarcity of funds to finance investment in urban transport; such investment typically absorbs a large share of local, state, and federal expenditures allocated to urban development. All of these problems have been recognized by international experts and institutions, albeit with different approaches and assumptions. Similarly, the policy recommendations and concrete actions of international agencies to help tackle these problems have differed significantly.

In Latin America, bilateral aid and support from international institutions such as the Inter-American Development Bank (IDB), the Organization of American States (OAS), the United Nations (UN), and the World Bank group have helped to overcome some of these problems. The role of the World Bank merits in-depth analysis, not only because of its sheer magnitude and qualitative aspects but also, and more importantly, because of its current comprehensive and decisive involvement in the formation and financing of transport policy in the developing world. The World Bank is expected to increase the scope of its action in development policy, with important and wide-ranging policy implications in the areas of transport, urban development, environment, and energy (Feinberg 1986).

The World Bank

In the evolution of the World Bank, involvement in urban transport is a relatively recent event (Cohen 1983). It began during the McNamara years (1968–1981), particularly since 1972. Lending for urban development in general became an important aspect of the Bank's operations, in sharp contrast with its previous emphasis on economic infrastructure. In 1968, 57 percent of total lending went to infrastructure (power, transportation, and telecommunications) (Payer 1982; Ayres 1984); in 1981, infrastructure accounted for only 39 percent.

Lending to Brazil paralleled this trend. Before 1971, energy and infrastructure absorbed over 70 percent of total lending. The share of urban projects, which represented a new concern with distributive issues, climbed from 0 to 18 percent between 1982 and 1989. Together with the programs devoted to alleviate rural poverty ("rural development") and improve public health, they came to represent almost half of total lending.

These figures emphasize the qualitative changes in the role played by the World Bank. Three distinct stages can be identified. First, from an institution primarily concerned with infrastructural projects, the Bank evolved into an agency for both infrastructure and social development (Ayres 1984). Second, in a parallel development, the Bank's shift from the advanced capitalist societies to the developing world was further pursued and consolidated. Third, the debt crisis of the 1980s led the Bank to redefine its strategies and policies toward the structural adjustment of indebted developing-world economies.

The Bank also expanded its scope to include new areas of investment, thereby enhancing both the visibility and magnitude of its operations. Between 1968 and 1981, total lending went from 950 million to 12 billion USD, a more than 12-fold increase. This represents a real growth of 500 percent in total lending. The number of projects approved also increased substantially, from 62 to 266.

The debt crisis of the 1980s ushered much of the developing world into recession. In reaction, the Bank further strengthened its international standing. The crisis closed international financial markets to the developing world; it resulted in an unprecedented structural fiscal crisis that has severely restricted the capacity of developing nations to mobilize internally generated resources (with the exception of some countries in South and East Asia). As a result, the World Bank has become a crucial source of financing for transport projects, and by extension, for development projects in general. This has important implications for the urban transport sector. On the one hand, the Bank's leverage to impose its particular approach to urban transport has increased; on the other hand, at a more general level, the Bank has become an even more important institutional actor in the policy-making process.

The urban transport strategy pursued by the World Bank during the late 1970s and early 1980s was first set out in the influential *Urban Transport Sector Policy Paper* (World Bank 1975). In line with the "conservative reformism" of the McNamara years, this document criticized the Bank's emphasis on projects that frequently involved heavy capital and recurrent expenditures and that appeared to be unrelated to the immediate needs of low-income, urban populations. Such projects included the construction of subway systems and beltway roads. The document stressed that the Bank must place the physical elements of urban transport projects in the context of policy measures, institutional development, and management solutions (World Bank 1975, p. 13). It also stressed that primary emphasis be placed on low-cost urban transport — providing greater access to job opportunities — and on facilities for commercial traffic, cyclists, and pedestrians (p. 14). The urban transport sector also incorporated the requirements of replicability, affordability, and cost recovery that all Bank projects must meet.

This strategy became very influential within academic, professional, and policy-making circles worldwide, and the Bank came to play a prime role in setting the agenda of the transport sector in many developing countries. The role played by the World Bank has had more to do with its influence in decision-making circles than with the magnitude of its projects. In fact, in many countries (including Brazil), World Bank financing represents only a small portion of total investment in urban transport (although this conclusion cannot be quantified on the basis of recent reliable empirical data).

The Bank's strategy has proven difficult to achieve in many cities: city expansion frequently requires the construction of transport infrastructure; vested interests exist in construction and real estate speculation; and politicians resist supporting projects with low political visibility. In a review of urban projects up to 1982, Cohen (1983) shows that 56 percent of investment in urban transport went to improving infrastructure (road and rail), not the primary thrust of the 1975 policy paper. In contrast, traffic management received little investment. However, this may be due to the relatively low cost of traffic-management projects, not their importance. Of all project components, 38 percent was devoted to traffic management and technical assistance (Table 22), tackling issues of policy and existing resources.

Brazil received 84.6 percent of the Bank's total lending to the urban transport sector in Latin America from 1977 to 1985. This suggests that Brazil was an "experimental camp" for the Bank strategy. Brazil also received the largest World Bank loan for an urban transport project worldwide (the Porto Alegre Suburban Rail Project).

Table 22. World Bank's urban transport lending, 1972–1981 (selected data).

Amount of loans (million USD)	
Urban transport projects	546.9 (11)[a]
Urban projects with transport components	139.5 (11)
Urban transport investment as % of total project costs	
Road construction, improvement, maintenance	32
Rail systems	24
Bus acquisition, facilities, priorities	22
Traffic management	9
Training and technical assistance	6
Other (sector lending)	6
Pedestrian facilities	1
Urban transport components as % of total project components	
Road construction, improvement, maintenance	27
Rail systems	3
Bus acquisition, facilities, priorities	25
Traffic management	16
Training and technical assistance	22
Other (sector lending)	2
Pedestrian facilities	6

Source: Cohen (1983).

[a] Number of loans in parentheses.

Table 23 summarizes Bank projects in the urban transport sector of Brazil. The First Urban Transport Project had three main objectives:

- To finance investments that would improve urban transport services with emphasis on providing public transport, especially to the poor;
- To promote and support the development and implementation of appropriate urban transport policies; and
- To strengthen municipal, state, and federal capacity to prepare, appraise, and execute adequate urban transport projects.

The project had a broad scope. It included traffic engineering in central urban areas and at critical points, introducing exclusive bus lanes and segregated busways, widening critical links, constructing missing links in the road network, reorganizing or constructing bus terminals, paving bus routes in low-income

Table 23. World Bank projects in the urban transport sector of Brazil.

Date[a]	Description	Amount (million USD)
1976, 1978	First Urban Transport Project: A multicomponent project involving Belo Horizonte, Curitiba, Porto Alegre, Recife, and Salvador	88.9
1978, 1980	Second Urban Transport Project: Suburban electric rail with associated car parks and bus feeder services, and interchange facilities in Porto Alegre	159.0
1979, 1981	Third Urban Transport Project: Institutional development at the federal level, improvement in medium-sized cities (AGLURB), and a program for paving bus routes (PROPAV)	90.0
1986, 1989	Fourth Urban Transport Project: Corridor, maintenance, and institutional development programs in nine metropolitan areas	200.0

Source: World Bank (1979, 1986b, 1987a,b).

areas, and institutional development and technical assistance. The project included five metropolitan regions — Belo Horizonte, Curitiba, Porto Alegre, Recife, and Salvador — involving nine different agencies under the general coordination of EBTU.

The Second Urban Transport Project aimed to

- Improve the distribution of land use around a major Porto Alegre corridor with the fastest growing population;
- Reduce petroleum fuel consumption in the same corridor; and
- Reduce traffic congestion in both the corridor and the metropolitan centre of the city.

These objectives were to be achieved by providing a conventional suburban electric railway, with associated bus feeder services and interchange facilities. The project was executed with a 159 million USD loan (of which 26 million was canceled).

The Third Urban Transport Project consisted of three subprojects:

- Institutional subprojects were intended to improve the quality and efficiency of EBTU through changes in structure, procedures, and staff allocation.
- The AGLURB subproject was intended to improve transport infrastructure and operations in 14 medium-sized cities and conurbations. It consisted of establishing and operating a management unit in each city and included various low-cost improvements to existing infrastructure with emphasis on public transport, planning and operation of urban transport, and services at the local level.
- The PROPAV subproject served to pave about 850 kilometres of bus routes in low-income areas in medium-sized cities, state capitals, and metropolitan regions.

The Fourth Urban Transport Project emphasizes institutional development, improved and wider cost recovery, and system maintenance. Consistent with the Bank's recent advocacy of neoliberal economics, there is clear emphasis on eliminating subsidies and achieving efficiency through market mechanisms.

The World Bank's involvement in Brazil's urban transport sector has been intensive. It played a key role in consolidating EBTU as a widely respected and relatively autonomous agency in the federal system. It also supported the innovative policies promoting the extensive use of segregated bus lanes in Brazil. According to a confidential project audit (World Bank 1986b),

> The [first] project was successful in implementing some of the most imaginative and radical bus priority measures carried out anywhere in the world. These experiences have relevance for Bank-financed projects worldwide.

However, as recently indicated in the National Mass Transportation Plan (EBTU 1988b), Brazil's urban transport policy has shifted away from segregated bus lanes to light rail — a move that is based on ambiguous financial and technical assumptions. The Bank's support for this policy shift sharply contradicts its extremely favourable evaluation of previous policies involving segregated bus lanes.

Bank-financed projects also have many more general problems. First, Bank loans have conditions of effectiveness, commitment fees on undisbursed tranches, and lending procedures (for example, loans are made through a pool of currencies, the exchange-rate risk being supported by the borrower). Together, these conditions have made many Bank loans very costly in real terms. Weighed against loans from commercial banks, World Bank loans may have a comparative advantage. But this does not mean that they are costless.

Second, the Bank's criteria in project appraisal clearly favour market solutions and private enterprise in lieu of public regulation and control. This approach ignores many of the problems affecting Third World economies. In the South, market solutions frequently intensify the already severe distortions in social equity or may simply be impossible to implement.

Third, and most important, the Bank's approach in general is too rigid and demanding in view of the realities of developing countries. This results in a high level of inefficiency in project implementation, recognized in World Bank internal reviews. For example, the *Annual Review of Project Performance Results* for 1987 (World Bank 1988, p. 70) concluded that

> Virtually all reports identified proposed institutional changes and project arrangements that were doomed to failure because they were incompatible with country political, economic and administrative policies. Inflation was underestimated in almost all countries. The majority of projects suffered extensive time and cost overruns, mostly because of inadequate preparation. In about three-quarters of the projects, major redesign after approval was needed. Poor financial management and delayed and inadequate tariffs were highlighted in every review. Financial covenants were rarely met.

In the World Bank's most recent policy paper on urban development (World Bank 1991), the environmental problems associated with investments in transport infrastructure and their interdependency with other urban issues are reiterated. Despite the Bank's rhetoric on its alleged priority to invest in bus systems, however, the data show that over 80 percent of its funding from 1985 to 1991 was on public works (see Philips 1992).

More recently, the World Bank has started considering non-motorized transport as a relevant issue and has pointed to the potential role of NGOs in promoting it (Oberg 1992). Although it is an interesting issue for the developing world in general, its relevance for highly urbanized countries like Brazil (and the southern cone) is not entirely clear, and its potential contribution should not be overestimated — as it frequently is.

Clearly, urban transport policy in developing countries is typically enmeshed in an environment plagued with macroeconomic, institutional, and political problems. It is impossible to talk about "sound" transport policy without accounting for the interdependencies between sectoral aspects and the macroenvironment in which it operates. In terms of resources, policy, and planning, the strategic importance of international credit institutions — especially the World Bank — will remain great over the coming years. This situation and the international leverage implied may or may not be desirable; but it does stress the importance of continuous public evaluation of both programs and policies.

Chapter 3

Improving Collective Transport

In the previous chapter, we concluded that, to address the key problems of urban transport effectively, in Brazil and elsewhere in the developing world, greater priority must be given to collective transport and the inseparable issues of urban land use. Here, we focus in more detail on the question of collective transport. We diagnose the problems of collective transport in Brazil and indicate possible lines of improvement. The subjects of this chapter are varied but interrelated. For example, pricing and regulation arrangements may be necessary for an integration scheme to work; in turn, integration may be crucial in developing a particular corridor.

We begin by emphasizing the importance of corridors as structural elements within the urban transport system. Alternative strategies are analyzed for increasing capacity and improving the quality of service. Following this, the technical benefits and institutional difficulties of integration are discussed. This issue is often raised in connection with measures to increase corridor capacity. Three tightly connected subjects are then looked at: regulation and ownership, financing, and price policy. The problems raised in these areas have high political profiles; their resolution depends on the ability to reverse the deterioration of collective transport. The real issues are often not what they seem to be at first.

We also briefly review measures to influence transport demand. This involves reducing both overall demand, especially for automobile transport, and peak demand. Intermediate public transport, or paratransit, is also discussed. This mode is prominent in most developing countries, but not in Brazil.

Finally, we review general institutional capability. Institutional weaknesses are a pervasive factor limiting both planning and operation. They involve management, politics, and human resources, and are frequently highlighted by international financing agencies such as the World Bank.

Corridors in Brazil

The urban transport infrastructure is a network, comparable in many ways to other physical networks serving a city: electricity, gas, water, sewers, etc. There is a hierarchy in the capacity of lines and nodal points, ranging from local streets and footpaths to high-volume arteries generally used for longer trips. As cities grow and motorization increases, the need for such a hierarchy in both infrastructure and service also grows.

Here, we concentrate on Brazil and the high end of this hierarchy, starting at 5 to 10 thousand passengers per hour all the way up to 60 thousand per hour or more. In this range, corridors are important structural elements of the transport system and the city itself. As the city evolves, corridor design influences and is influenced by both land use and trip destinations. Their characteristics and how they relate to the network as a whole have an important influence on the cost, quality, and impact of collective transport.

In Brazil, the vast majority of collective transport corridors have buses operating in mixed traffic. At the high volumes of transport frequently found, this mode of operation severely limits the quality of service (trip time, vehicle loading, etc.). Clearly, the performance of these corridors must be improved. Their upgrading, however, will take a major, and likely predominant, share of total investments in collective transport. As such, it merits close attention. There are many competing alternatives, and the choice depends on many site-specific factors. Therefore, we have not defined choices in this chapter. However, we do broadly question the degree of prominence given to rail modes in the official Brazilian strategy for upgrading corridors.

This section emphasizes supply alternatives; however, this does not mean that improving supply is the only strategy, or that a corridor's capacity should always be expanded. Measures to influence trip demand have their place and are also discussed. More low-capacity corridors may be preferable to concentrating heavy passenger flows on a few corridors. However, there are hundreds of kilometres of collective transport corridor in Brazil whose current conditions of use result in heavy socioeconomic costs (such as lost time and high transport costs) and a serious environmental impact. Any significant improvement in Brazil's urban collective transport will have to include the improved performance of these corridors.

In its National Mass Transportation Plan, EBTU (1988b) reviewed the collective transport corridors in many large Brazilian cities. In its coverage of cities, the plan is good; however, many important corridors are not shown. They were possibly excluded because they showed limited promise for light-rail or tramway development — the major focus of the plan. Despite this, the plan briefly analyzes some characteristics of 50 corridors with existing peak demand of 5 thousand or more passengers per hour. Table 24 groups the corridors in terms of peak use. There is a clear "pyramid" — smaller corridors are more numerous and have a greater total extension. Individually, the more heavily used corridors tend to be longer.

Flows in these corridors were projected by the plan to increase substantially, by an average of 33 percent from 1985 to 1995 (Table 25). Such an increase now appears unlikely because of the chronic economic crisis within Brazil. The projected increase tends to be greater as the size of the city decreases. This profile of relative growth will likely be realized. It reflects the

Table 24. Existing bus corridors by size in 23 metropolitan areas of Brazil.

Corridor scale (peak passengers per hour in one direction)	No. of corridors	Accumulated length (km)	Average length (km)
5 000–9 999	19	188.0	9.9
10 000–14 999	16	200.3	12.5
15 000–19 999	8	118.0	14.8
20 000–24 999	3	52.9	17.6
25 000–29 999	2	42.0	21.0
30 000–39 999	0	—	—
>40 000	2	34.0	17.0
Total	50	635.2	12.7

Source: EBTU (1988b).

greater demographic growth in the small and medium-sized metropolitan areas and reinforces the observation that greater attention should be given to this class of city; both within Brazil and internationally, it is relatively ignored. At the international level especially, information tends to be available only for "primary cities," although these do vary considerably in size.

As a result of growth, corridor profiles change. Table 26 shows the distribution of bus corridors by size class projected for 1995. The number of corridors with a peak demand of more than 15 thousand passengers per hour per direction has increased from 15 (Table 24) to 31. Although growth is unlikely to be as high as forecast, this projection gives some idea of how the number of heavily used corridors will evolve over the next decade.

Modal Choices for Corridors

In defining policy for the development of collective transport corridors, the choice of physical mode is critical. The available modes have distinct differences in capacity, cost, and impact.

Corridor modes are customarily split into three broad categories: bus, light rail, and heavy or rapid rail. Based on the

Table 25. Change in peak demand (thousand passengers per hour in one direction) of 50 major bus corridors in Brazil, 1985 to 1995.

City size class[a]	Corridor scale (passengers per hour in one direction)												Total		% increase
	5 000–9 999		10 000–14 999		15 000–19 999		20 000–29 999		30 000–39 999		>40 000				
	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	1985	1995	
A	52.5	66.4	53.0	64.6	17.3	28.4	50.5	60.3	—	—	87.7	102.9	261.0	322.6	23.6
B	17.4	24.7	55.6	73.3	15.6	21.4	51.1	69.0	—	—	—	—	139.7	188.4	34.9
C	13.2	17.9	74.4	100.6	52.0	73.7	22.3	28.2	—	—	—	—	161.9	220.4	36.1
D	61.3	93.0	28.8	37.2	48.6	66.9	—	—	—	—	—	—	132.7	197.1	48.5
Total	144.4	202.0	205.8	257.7	133.5	190.4	123.9	157.5	—	—	87.7	102.9	695.3	928.5	33.5

[a] A, >4 million; B, 2 to 4 million; C, 1 to 2 million; D, <1 million. Class A includes Rio de Janeiro and São Paulo. Class B includes Belo Horizonte, Porto Alegre, Recife, and Salvador. Class C includes Belém, Brasília, Campinas, Curitiba, Fortaleza, Goiânia, and Manaus. Class D includes Baixada Santista, Campo Grande, Cuiabá, Florianópolis, Joao Pessoa, Maceió, Natal, São Luis, Teresina, and Vitória.

Table 26. Bus corridors in 1995 by size class in 23 metropolitan areas of Brazil.

Corridor scale (peak passengers per hour in one direction)	No. of corridors	Accumulated length (km)
5 000–9 999	8	79.7
10 000–14 999	11	104.1
15 000–19 999	14	190.3
20 000–24 999	8	87.0
25 000–29 999	4	75.6
30 000–39 999	3	64.3
>40 000	2	34.0
Total	50	635.2

Note: There is no provision for new corridors that have grown to a scale of over 5 000 passengers per hour.

post-war experience of the industrialized world, these three categories are commonly portrayed as representing an ascending hierarchy of capacity, quality, and cost. However, the truth is rather more complex, especially in the intermediate range of 10 to 25 thousand passengers per hour peak capacity in one direction. Studies in both the developing world (especially Brazil) and the industrialized world have defined new potential roles for bus technology and, to a lesser extent, light rail.

Bus Systems in Mixed Traffic

Circulation in mixed-traffic conditions is overwhelmingly the normal mode of operation for buses throughout the world. It is perhaps because of this dominance that the limits of this mode of operation are frequently (and erroneously) assumed to be intrinsic to bus systems. Mixed traffic will continue to be the main operating mode for urban buses. Even though many high-density corridors will (or at least should) shift to segregated busways or rail modes, this shift will take time.

Analyses to optimize bus operation in mixed traffic have concentrated on improving the traffic environment. In Brazil, various measures have been adopted: exclusive curbside lanes for buses, intersection signal control, and "bus convoys." Apart from improved intersection signal control, which applies to all road traffic, these measures have not been very successful. The term "exclusive curbside lane" is an oxymoron. On a multilane avenue, it is the curbside lane that suffers the most interference: vehicles entering the avenue, deliveries from trucks, taxis picking up passengers, vehicles turning right, etc. Indeed, the "exclusive-lane" concept could almost be seen as a measure to help private automobiles to the detriment of buses. "Convoys" involve a set of buses traveling together and maintaining their sequence. In practice, they have proven to be hard to manage. They seem to be more useful on segregated exclusive bus lanes that lack space for overtaking at bus stops, as in Porto Alegre (Lindau 1987).

Attention to the traffic environment for buses in mixed traffic should be maintained; however, bus characteristics must also become an important variable. Analysis of bus transport in Brazil has been dominated by the image of the "conventional bus." The conventional bus varies substantially in detail from country to country, but its basic size and seating arrangement seem to have been defined decades ago.

Over the past two decades, the image of the conventional bus has slowly begun to change. At the high-capacity end of the market, the possibility of truly exclusive busways has stimulated design efforts. Higher capacity and less route-flexible buses (and trolleybuses) have begun to take on characteristics of rail vehicles (rapid entry and exit, ample standing room). At the same time, "minibuses" and other forms of paratransit have appeared throughout the developing world. They have shown how low-capacity, more flexible vehicles can be advantageous in certain markets. Commercial innovation and penetration at this "low end" of the market has been more vigorous worldwide than at the high-capacity end.

The concept of the bus seems destined to fragment and specialize. However, an important role will remain for buses within the size range of today's "conventional bus." In fact, there is considerable scope for change within this size range. In this direction, Brazilian efforts over the past decade have focused on a new "standard bus." It has characteristics unquestionably superior to the traditional bus, especially in terms of the entry and exit of passengers. Unfortunately, it is also significantly more expensive than the existing standard; as a result, its penetration within the fleet has been minimal. Improved economic conditions and some resolution of the financial impasse in collective transport would help to increase its use.

In the meantime, there will be a large national fleet of "old standard" buses. Can useful and low-cost retrofits be made to this fleet, especially on high-volume lines? Possibilities appear to exist. One promising approach involves passenger flow within the vehicle (seating arrangements, etc.). Besides reducing discomfort (assuming peak passenger loadings do not increase), improved passenger flow could help to reduce the time spent at bus stops.

The time taken in loading and unloading passengers significantly affects overall trip time (hence, service quality and productivity). In some situations, it is also a major factor in local congestion. Vehicle design, ticketing practice, and the vehicle–bus stop interface are all possible elements of a strategy for improvement. Reducing bus-stop time is important for the bus mode as a whole, whether in mixed traffic or on exclusive corridors, where the methods may be different. In mixed traffic, improvements could involve modest changes in vehicle and interface design; they might also involve radical changes in vehicle and station technology combined with a fare system where the passenger pays before entering the bus.

The latter was proposed to the city of Rio de Janeiro by a planning team led by Jaime Lerner, formerly and subsequently the mayor of Curitiba (JLPU 1984). Although pioneers of segregated busway development, the team judged this option to be unworkable for the high-volume corridors serving the oceanfront *barrios* of Copacabana, Ipanema, and Leblon. Thus, they proposed closed stations for preticketing and an elevated platform to permit rapid embarkation and disembarkation.

Suitably modified high-capacity trolleybuses would be the vehicles. Trolleybuses were chosen because of their good acceleration, very important in mixed traffic. Although "suboptimal," the proposal would have significantly improved the collective transport service on these corridors, greatly reduced local air and sound pollution, and increased pressure for tariff integration — a measure that would bring additional benefits.

The government did not act on the proposal. A subsequent administration decided to ignore the bus system and invest in extending the subway through these *barrios*. The result was disastrous. After lavish spending — much more than would have been necessary with Lerner's plan — creating and abandoning disruptive construction sites, yet another administration has given up on the project and spent millions of dollars filling in holes. Meanwhile, the transport system continues to deteriorate. In Curitiba, the concept of the closed station was finally implemented when Lerner returned as mayor. Diesel-driven buses, called *ligeirinhos*, rather than trolleybuses, serve the tubular, closed stations (Fig. 6). The system is strikingly similar to that proposed earlier for Rio de Janeiro.

An institutional change that can benefit bus service in mixed traffic is tariff integration. Such integration would reduce the waiting time of passengers (on the corridor, any bus will do, not just a specific bus, and more feeder buses should be available). It would also reduce congestion caused by other buses on the corridor, a real problem. Measures to integrate tariffs for mixed-traffic bus systems are neither spectacular nor investment intensive; however, they could have a large short-term impact on the quality and cost of service.

Segregated Busway Systems

The concept of segregated busways was first tested some 25 years ago in Europe. It was further developed in Curitiba from the mid-1970s on. Segregated busways were a key element of the "structural transport axes" integrated into the general land-use plan of that city. The success of Curitiba's experience induced

Fig. 6. The ligeirinho, *using an elevated, closed bus stop in Curitiba.*

other cities in Brazil — Belo Horizonte, Goiânia, Porto Alegre, Recife, and São Paulo — to experiment on a limited basis. In the world, Brazil is the country where the segregated busway has become most widely diffused. However, there are also isolated experiences in cities such as Abidjan, Ankara, Bogotá, Hamburg, and Nagoya. The concept has yet to be widely applied in any country, despite these promising experiences (Craknell et al. 1990).

The basic segregated busway usually entails a physically separated lane in the middle of the roadway (Fig. 7). This central position avoids the interference that usually plagues "exclusive" curbside bus lanes. Bus stops are typically 350 to 600 metres apart. The configuration shown in Figure 7 resembles that originally established in Curitiba.

In principle, adaptations to increase passenger capacity are possible. An overtaking lane can be added at bus stops, such as in São Paulo. At intersections, priority traffic signals are common.

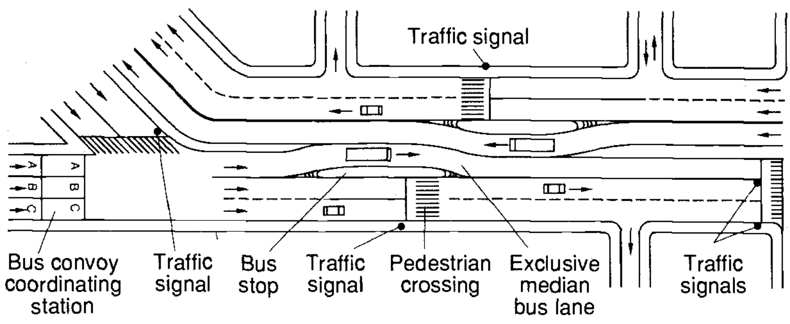

Fig. 7. A typical segregated median bus lane of a Brazilian corridor (without a passing lane at stops) (source: Lindau 1987).

Bus stops and vehicles can be redesigned to speed up the entry and exit of passengers, such as has been done in Curitiba and São Paulo.

Other adaptations can reduce the requirements of the busway and bus stops for road space. An example is the addition of a set of doors on the left side of the bus (all buses have doors on the right) on the recent Vila Nova–Cachoeirinha segregated busway in São Paulo. The unavailability of road space is often a severe challenge to designers.

The capacity of a segregated busway varies from location to location and depends on many factors: the degree of segregation from general traffic, passenger demand, design and frequency of bus stops, and vehicle characteristics, to name a few. The potential performance of optimized busways is still unclear. By itself, the performance of existing schemes is not an adequate guide; none has incorporated all the possibilities available to optimize "at-grade" busways (elevated busways are much more expensive and are not considered here). Nevertheless, the well-designed, operating busways prove that it is possible to carry a large volume of passengers at an adequate velocity.

A recent survey by the UK Transport Road Research Laboratory (TRRL) (Cracknell et al. 1990) concluded that, in general, such busways can carry 18 to 20 thousand passengers per hour per direction at 18 to 20 kilometres per hour. The study also suggests that, with further improvements in design and management, a planning guideline would be 20 to 25 thousand passengers per hour. This is considerably higher than the maximum capacity for busways estimated by Brazil's National Mass Transportation Plan: 15 thousand passengers per hour per direction (EBTU 1988b). This limit, applied uniformly throughout Brazil, is not backed by any analysis. Nor does it appear to account for capacities already reached on some suboptimized lines.

At the high end, potential capacity has been estimated at anywhere from 24 thousand (Armstrong-Wright 1986; World Bank 1986a) to 50 thousand passengers per hour per direction (Giao de Campos et al. 1990). However, these estimates tend to assume substantially more expensive investments, such as elevated busways at intersections. Nevertheless, the more modest estimate of TRRL (20 to 25 thousand) represents a revolution in thinking about the role of buses in the transport of large volumes of passengers. There is an urgent need to confirm and fine-tune estimates of potential capacity.

A well-designed, state-of-the-art busway already represents a major improvement in service for users of collective transport. On the Nove de Julho–Santo Amaro busway in São Paulo, terminal-to-terminal trip time has been reduced from 80 to 50 minutes, with peak passenger flows of 19 to 21 thousand passengers per hour per direction. Over the same route, trip time by private automobile has increased by 10 minutes at peak hour (Lindau and Willumsen 1988). However, the much greater number of collective transport users means that their time saved is about 20 times more than that lost by private motorists.

Existing busways can be improved in many ways, and much can be done in stages. This capability for incremental improvement is one of the attractive features of a busway strategy. Indeed, incremental improvement may eventually lead to the construction of a light-rail system on the busway roadbed, using the existing system infrastructure. This has been proposed by the city of Curitiba (IPPUC 1990). Segregated busways can be seen not only as a competitor to light rail but also, in many cases, as a low-cost precursor.

The capacity for incremental improvement is related to the "resilience" of past busway schemes. Several busways in Brazil have undergone serious changes during their construction or have suffered from political neglect or even hostility with changes in city administrations. Yet, they have all managed to be relatively successful. An excellent example is the Nove de Julho–Santo Amaro busway in São Paulo. In the TRRL international survey, it was cited as having the best design, despite the fact that it is still incomplete. Such resilience is of great value given the political culture of most developing countries, where the continuity of programs and projects is at best precarious when administrations change.

Optimization strategies can focus on vehicles, infrastructure, or system management, and different strategies tend to interact. Beyond increasing busway capacity, they seek to improve service quality and reduce negative environmental impact along the corridor.

Vehicle improvements — Larger vehicles clearly increase capacity. In mixed-traffic conditions, standard bus size is limited. These restrictions are relaxed in the operating conditions of a busway; substantially larger vehicles are viable. In Brazil, larger buses are slowly appearing on segregated busways. The penetration of larger vehicles onto busways is clearly linked to whether they will operate exclusively, a systems-management issue.

The possibility of larger vehicles on a segregated busway reinforces the value of evaluating the basic energy supply for buses operating in the corridor. In Brazil, diesel fuel is used in virtually all buses. It is both the main problem in national petroleum supply and of relatively poor quality (high sulfur content), increasing its impact on air pollution. Air and sound pollution along existing corridors are also problems.

There has periodically been great interest in replacing diesel with another fuel. Today, interest is greatest in compressed natural gas; some cities in Brazil are in the process of converting part of their fleets. Reduced air pollution is the principal advantage cited. However, the program does not specifically target corridors. So, the effect on local pollution will be substantially diluted (only 10 to 20 percent of buses will be converted in this phase of the program). There is a real danger that natural-gas substitution, currently fashionable, will distract local administrators from addressing the basic issues of improving collective transport and reducing the overall environmental impact of urban transport.

Another option is to use electricity in trolleybuses. This could be attractive on busways (EBTU 1984). The comparative advantage of trolleybuses could be greatest in situations that favour larger vehicles, such as exclusive use on busways. Trolleybuses have been considered for busway use in Brazil, but plans have never been fully implemented. The large initial investment and high cost of spare parts are often cited as drawbacks, although a busway with trolleybuses still requires much less investment than a rail system. In environmental terms, trolleybuses are superior to both diesel and natural-gas vehicles; they have much less impact on both air and sound pollution. In Brazil, trolleybus technology suffers from the stigma of having been fashionable in the late 1970s and early 1980s, and then being abandoned. When trolleybuses were fashionable, however, the possible synergism with bus-corridor development was inadequately emphasized. In many ways, this experience parallels the current enthusiasm for natural gas.

Other vehicle adaptations may reduce the time needed for passengers to board and exit at bus stops. Changes could include more space for circulation as well as more and wider doors. Boarding tends to be the greatest problem on high-density corridors, as emphasized in the TRRL study. Corridor capacity on existing busways is 10 to 20 percent higher when most passengers are exiting rather than entering at bus stops between terminals (Cracknell et al. 1990). The most important measure to break this bottleneck is ticket prepayment, at least at key stations.

This may involve changes to the vehicles. However, once the investment has been made in closed stations for prepayment of tickets, it makes sense to invest in vehicles and bus stops that allow passengers to enter or exit from a level platform, as in a subway. Vehicles can be retrofitted, and entry and exit times can be reduced and made virtually equal. The concept was first proposed for mixed traffic and has been implemented with Curitiba's *ligeirinhos*, whose stops are located off the segregated busway.

In São Paulo, the use of elevated platforms on the Vila Nova–Cachoerinha busway led to the innovation of installing doors on both sides of the bus. One side is adapted to platforms; the other to normal stops used when the bus leaves the corridor. Bus retrofitting is relatively cheap (Oliveira et al. 1990). It is an interesting adaptation to restrictions in space and a lack of system integration (where buses must operate both on and off the corridor) — both common conditions.

Integration — The importance of bus-stop design on busway capacity has been highlighted. Elevated platforms, especially with ticket prepayment in closed systems, is one promising approach. The use of platforms implies some way of positioning buses more accurately. The "O-Bahn" road guidance system is often proposed; however, the simpler guidance scheme implemented in Curitiba seems adequate. An overtaking lane at bus stops can also increase capacity, especially if it is desirable to separate "express" and "local" buses. Most busways in Brazil do not have this feature.

A busway is a major architectural intervention with important impacts all along the corridor. Its visual impact, as well as the movement of vehicles and people on and near the corridor, must be considered carefully. A busway is not an isolated engineering investment; it is part of a wider strategy to organize urban space, as exemplified most completely in Curitiba. In this regard, some otherwise successful busways (such as Nove de Julho in São Paulo) have been criticized, criticisms that fortunately appear to have been heeded in subsequent busway development in São Paulo.

System management — Changes in vehicle and bus-stop design, together with prepayment of fares is an important approach to increase capacity and improve service quality. This implies integrating the tariffs of all lines using the busway; in turn, this implies that the method of paying bus operators must be adapted. The most promising approach is for bus operators to be paid for the service provided (vehicle-kilometres driven) rather than for the passengers carried. This type of contract now exists in Curitiba, Recife, and, partially, São Paulo; however, fare prepayment was not the immediate reason.

A corollary to tariff integration may be establishing a hierarchy of transport supply and physically integrating the high-volume busway with lower volume feeder systems. This would allow greater exploitation of the high-capacity busway vehicles. In compensation, it would require more passenger transfers. The trade-off is polemical.

Available capacity can be improved by ordering vehicle flow. In Porto Alegre, Brazil, the "bus-convoy" concept is well developed. It has achieved the highest supply capacity yet registered in this mode. For example, the TRRL survey estimated a peak supply of 39 400 passenger spaces per hour per direction on the Farrapos busway and nothing less than 378 buses with an average commercial speed of almost 22 kilometres per hour. This was achieved in the direction where exiting passengers predominated; when boarding predominated, maximum supply was 31 300 passengers per hour. These flows are maintained without the benefit of overtaking lanes at bus stops.

The Porto Alegre experience provides some valuable lessons. It shows that high vehicle flows can be maintained in an urban environment (road junctions, 390 metres apart; bus stops, 560 metres apart). It shows that this can be achieved through operational measures without great technical sophistication. It also reminds us that estimates of busway capacity are still tentative.

In fact, the Porto Alegre busway has resulted in the availability of considerable spare capacity (Cracknell et al. 1990). In the extreme case of the Farrapos busway, only half the offered capacity is actually used, and some of that is used at crush capacity.

More and more evidence is showing that the busway concept is a widely applicable, low-cost strategy that can drastically improve the quality of collective transport along major corridors. Furthermore, the concept and its application are still being developed. The busway is much more than putting a standard bus on a segregated right-of-way, just as the automobile was much more than just a "horseless carriage." Its major challenges involve system management and institutions. If these challenges can be met, busways represent an important alternative to traditional light-rail systems in upgrading existing corridors (at least those with a load of 10 to 25 thousand passengers per hour). Busways may also be seen as a low-cost precursor to a light-rail system.

Although the technical aspects of the busway are well documented, economic analyses are rare. Differences in location and design philosophy create large variations in investment and performance parameters between busway projects. This makes economic analysis complex. Infrastructure investments and expropriation costs have varied between 1 and 5 million USD per kilometre, with 1.5 to 3.0 million USD per kilometre as the average range (Table 27). There is no question, however, that initial capital investment is substantially lower than it is in light-rail systems.

The most widely available economic analysis was published in 1986 by the World Bank (Armstrong-Wright 1986). Although rather superficial, this analysis suggests a favourable comparison with light-rail systems, roughly 5 to 9 cents (US) per passenger-kilometre versus 8 to 14 cents. The analysis also suggests, however, that costs would be higher than conventional, mixed-traffic bus operation (costed at 2 to 5 cents per passenger-kilometre). Perhaps as a consequence, the World Bank's 1986

Table 27. Infrastructure costs and performance of high-volume corridor modes.

	Cost of total infrastructure (million USD/km)[a]	Max. lane or track capacity (passengers/h)	Avg. commercial velocity (km/h)[b]
Segregated busways			
Grade-level intersection	1–5[c]	15 000–25 000	18–22
Tramway (mixed traffic)	4.5–6	6 000–12 000	10–12
Light rail			
Grade-level intersection	6–8	20 000	15–25
Grade separation at intersection (pre-metro)	7.5–13.5	35 000	25–30
Rapid rail			
Surface (grade separation)	20–25	50 000	30–35
Elevated	45–55	70 000	30–35
Underground	85–105	70 000	30–35

Source: Armstrong-Wright (1986), EBTU (1988b), and IPPUC (1990).

[a] Costs include civil works for way; tracks, signals, and electric power (if appropriate); station, yards, and workshops; and exclude vehicles. Except for segregated busway, costs are in 1986 dollars.

[b] Average velocity, including stops, when carrying maximum capacity.

[c] Estimates for segregated busways are extreme values for earlier busways, with low values from Curitiba. The typical range is likely to be 1.5–3.5 million USD (1988 dollars).

urban transport sector paper did not emphasize or fully explore the busway option.

The analysis underlying this conclusion is flawed. It makes a series of assumptions about corridor management that simply do not match reality. It gives the load factor of buses on the corridor at only 27 percent during rush hour. Or, again, it implies that large buses on segregated busways carry fewer passengers per day than do standard buses in mixed traffic. The analysis also wrongly assumes that buses must be purchased at the time of implementation.

With such assumptions — which are nowhere clearly related to functioning systems — it is not surprising that the busway option looks more expensive. In contrast, experience from the Curitiba busway system (Wright and Sant'anna 1989) suggests that bus productivity is improved and overall costs are probably lower (they will depend on the cost of constructing roadway, station, and other infrastructure and changes in vehicle productivity). The expected improvements in service quality (such as shorter trip times) must also be considered.

Given its promising technical and economic characteristics, there is no doubt that the segregated busway is underrepresented in urban transport planning. Why is this? Cracknell et al. (1990) point to the lack of a strong institutional promoter (outside local government), especially for the key component of the busway "track." Such problems must be identified and addressed if the potential of the segregated busway is to be realized.

Light Rail

Light rail includes a wide range of electrically powered rail systems. As summarized by Armstrong-Wright (1986, p. 11):

> The distinguishing features of light rail systems are (*a*) that passengers usually board from the road surface or from low platforms; (*b*) that the vehicles operate in single units or in short trains at slow to moderate speeds; (*c*) that trackways may be shared with other traffic and may have sections of exclusive right-of-way.
>
> For ease of comparison, these guidelines consider three main categories of light rail systems. They are:
>
> - *Tramways*: simple trams or streetcars on fixed rails, usually operating as single units, in mixed traffic and mostly on city streets.
> - *Light-Rail Transit (LRT)*: light rail vehicles, sometimes articulated, usually operating in trains of one or more units either on street or in segregated rights-of-way, or a mixture of both.
> - *LRT Metro*: light rail vehicles operating in trains, along completely segregated tracks, either on the surface on viaducts, or in underground tunnels. LRT metros have many of the characteristics, including infrastructure costs, of heavy rail systems.

There are no rigid distinctions between these categories, there being a continuum of capacity and cost. Some light-rail vehicle (LRV) designs can operate both on track with street-level boarding conditions (typical of trams in mixed traffic) and on high-speed exclusive track with boarding platforms ("pre-subway"). This flexibility is an attractive feature of light-rail systems, and is a characteristic of the new LRV proposed for Brazil (EBTU 1988b).

Tramway vehicles tend to be smaller and simpler, typically with a capacity of 100 passengers and costing about 300 thousand USD (Table 28). Infrastructure, including signaling, is simple; speed is low, at 10 to 12 kilometres per hour. Maximum capacity in mixed traffic is 6 to 12 thousand passengers per hour, depending in part on vehicle size. With a segregated right-of-way, a capacity of 15 thousand passengers per hour can be achieved. The required investment for track, signaling, and power infrastructure is 3.5 to 5.0 million USD per kilometre, increasing to 4.5 to 6.0 million USD if vehicle yards, maintenance shops, and stations are included (Table 27).

Light-rail transit (LRT) systems usually operate on streets with segregated rights-of-way and either priority signaling at intersections or grade separation (under- or overpasses). Vehicles

Table 28. Urban transport vehicle costs.

Vehicle	Total capacity (passengers)	Purchase price (1986 USD)	Investment cost per passenger (USD)	Useful vehicle life (years)
Minibus	18	25 000	1 390	8
Standard bus	80	50 000	625	12
Large, single-deck bus	100	80 000	800	15
Articulated bus	120	130 000	1 080	15
Superarticulated bus	190	150 000	790	15
Simple tram	100	300 000	3 000	20
Light rail	300	800 000	2 670	25
Rapid rail	350	1 000 000	2 860	30

Source: Armstrong-Wright (1986).

are larger (200 to 300 passengers each), cost around 800 thousand USD, and are almost always joined in trains of two to six. Infrastructure, operation, and maintenance are more complex. However, the required investment in track, signaling, and power is not much higher than for tramways: 4 to 6 million USD per kilometre. This increases to 6 to 8 million USD if stations, yards, and shops are included.

The major variable affecting LRT capacity and total cost is the investment in rights-of-way. An LRT with segregated street track but no grade separation at intersections will have a capacity of about 20 thousand passengers per hour with a journey speed of 15 kilometres per hour. Grade separation is likely to cost 1.5 to 5.5 million USD per kilometre, depending greatly on local situations and how much is required (disappropriation costs are not included). With grade separation, capacity may reach 36 thousand passengers per hour with a journey speed of 25 to 30 kilometres per hour. If an elevated or underground track is required throughout the line, right-of-way construction costs will be similar to those of rapid rail systems: tens of millions of US dollars per kilometre (Table 27). It is the nature of the right-of-way that basically distinguishes LRT from "pre-subway" systems.

Until the 1950s, tramways were the dominant form of collective transport in large Brazilian cities. Virtually all have been dismantled and replaced with buses — only one small tramway line remains in operation in Rio de Janeiro. There has been no interest in investing in new tramway systems.

The situation is quite different with LRT and "pre-subway" systems. In Belo Horizonte, Porto Alegre, Recife, and Rio (where construction is paralyzed), lines have been installed or are under construction. All are the "pre-subway" type, generally using existing rail rights-of-way. However, experience to date with these systems has been negative. None has reached anticipated ridership levels whether because of integration problems (Porto Alegre) or simple incompletion of the line (Belo Horizonte). Cost overruns have been common. In Belo Horizonte, the original estimate not only was below the 360 million USD already spent, but another 240 million USD will also be needed to complete the planned line.

Notwithstanding these problems, the National Mass Transportation Plan (EBTU 1988b) has made LRT systems the cornerstone for the future development of metropolitan collective transport. The plan maintains that corridors with flows of more than 15 thousand passengers per hour (in one direction) cannot be adequately served by bus technology, even with segregated busways. On this basis, LRT systems will be needed by 1995 on 31 lines with an extension of 451 kilometres (see Table 26).

To allow local manufacture, a standard vehicle is proposed. The design is of the type we have described: capacity, 300 passengers; cost, 800 thousand USD per car; four cars in a train. In the plan, however, the vehicle is rather confusingly called a "tram," perhaps to emphasize the adaptability of the system to street corridor conditions. For example, the vehicle has a narrow turning radius (25 metres) and can handle relatively steep slopes (6 percent). This emphasis on adaptability distinguishes current proposals from the earlier "pre-subways."

The plan is optimistic about the level of investment required, especially to achieve the performance specified for LRT systems: an average commercial velocity of 30 kilometres per hour with 25 thousand passengers or more per hour. Total infrastructure investment (excluding vehicles) is estimated at 5 million USD per kilometre, more typical of LRT with at-grade intersection crossings and lower performance (see Table 27). In comparison, the LRT proposed for Curitiba has an infrastructure cost of 8 million USD (IPPUC 1990). This line includes a short stretch of tunnel and a few intersections with grade separation, partly because of the need to reduce the grade (slope) of the track. If the claimed performance is to be achieved, investments of this sort will be necessary on many lines. The infrastructure investments cited for Curitiba should be seen as a minimum. They do not include expropriation costs; the pre-existing busway made these costs minimal. In cities without such infrastructure, however, expropriation costs could be significant. In Curitiba, infrastructure cost is also reduced because of the existence of busway stations, which can be used for the LRT.

A major failing of the National Mass Transportation Plan is that it makes only a perfunctory analysis of alternatives, especially of segregated busways. This type of fault is common to infrastructure planning in Brazil. The assumed limit of 15 thousand passengers per hour is probably conservative and certainly cannot be taken as a general criterion. The necessary number and extension of LRT lines is sensitive to estimates of busway capacities. Thus, the 31 lines and 451 kilometres proposed would fall to 17 lines and 261 kilometres if the limit was 20 thousand passengers per hour, or to 9 lines with 174 kilometres at 25 thousand passengers per hour. In practice, such across-the-board limits cannot be applied, but the sensitivity is clear.

The plan has gained considerable support from city governments in Brazil, many of which have prepared LRT proposals. However, many analysts are skeptical of the country's capacity to finance such an ambitious program. Using a more realistic total investment per kilometre (say, an average of 15 million USD for all lines, instead of the 10 million USD in the plan), 451 kilometres would require 7 billion USD. Peak federal investment in all collective transport has never exceeded 690 million USD per year (see Fig. 2, corrected for inflation). Another key source of revenue, international credit, has amounted to less than 2 billion USD (in today's dollars) since 1978.

There is no doubt that LRT has a role to play in Brazil. The question is a matter of timing. The danger is that the plan will distract city governments from vigorously pursuing more modest but financially realistic objectives involving the bus system. Unfortunately, the existing planning literature does not adequately define criteria for selecting strategies and alternative modes, especially in the critical range of 15 to 25 thousand passengers per hour.

Heavy Rail

Heavy-rail systems include both rapid rail (metro or subway) and suburban rail. Rapid-rail systems always operate on completely exclusive rights-of-way and provide the highest capacity currently available (60 to 70 thousand passengers per hour in one direction). Suburban rail systems tend to operate on tracks shared with intercity passenger and freight transport, often use heavier intercity vehicle types, and have more widely spaced actions (typically 2 kilometres, compared with 600 metres for rapid rail). The capacity of suburban rail in a multipurpose rail system depends on the rules of track-sharing, being typically 10 to 20 thousand passengers per hour (Armstrong-Wright 1986).

The distinction between rapid rail and suburban rail is not rigid. With an exclusive right-of-way, an upgraded suburban rail system with metro-type vehicles is similar to rapid rail, including flow capacity. Where possible, this is an attractive option. The cost of upgrading multipurpose suburban rail is 20 percent or less of the cost to construct a new metro. Unfortunately, such opportunities are limited. They involve trade-offs with intercity transport needs and potential conflict between agencies with different jurisdictions. A good example is São Paulo. Practically the entire length of the metro line serving the eastern region of the city runs right beside the pre-existing suburban rail line, operated by the federal railway, RFFSA. It was not possible to negotiate adequate rights-of-way for the rapid rail, with a consequent cost increase of hundreds of millions of dollars.

In Brazil, major suburban rail lines exist only in São Paulo and Rio de Janeiro. By far the most important system is in Rio, serving the low-income northern zone. The new "pre-metros" in Belo Horizonte, Porto Alegre, and Recife used existing intercity rail rights-of-way and are equivalent to an "upgraded" suburban rail line, except that their use for urban transport was minimal before the "upgrading." The old suburban rail services in Rio and São Paulo remain deplorable. Improving their quality of service is a high priority (Wright and Sant'anna 1989).

In Latin America, rapid-rail metros have generally passed through a vogue in the 1960s and 1970s to suffer heavy criticism (Figueroa and Henry 1989). Many have not lived up to expectations, either in terms of passengers carried, relieving congestion, or reaching low-income populations. However, in Brazil, there is little doubt about the cost–benefit validity of incremental expansion of existing metro systems. At the same time, it is probable that no new systems should be started over the next 5 to 10 years. Rapid rail has a definite and steadily growing role to play in collective transport. In a few situations, existing or near-term demand simply exceeds the ability of alternative systems to provide adequate service and the value of new, high-volume rights-of-way becomes very high. As well, over time, the quality demands of users will increase as, hopefully, incomes increase with economic recovery.

The eastern zone of São Paulo is an excellent example. A "dormitory area" of low income, its primary link with the economic centre of the city is a dense "macrocorridor" delimited by the avenues Radial Leste and Rangel Pestana/Celso Garcia, which run roughly parallel about 1.5 kilometres apart for 15 kilometres. It includes the eastern stretch of the east–west metro line as well as a suburban rail line. Down this narrow funnel there is now a peak flow of 88 thousand people per hour in one direction in buses on the two avenues, 68 thousand on the metro, and thousands more on suburban rail. Peak automobile flow on the avenues is also high at about 12 thousand vehicles per hour (Radial Leste is the second busiest vehicle corridor in São Paulo, excluding the beltways).

Thus, the total flow is enormous. The metro is already more or less saturated. The pressure on the metro is such that it is trying to reduce integration with buses. Metros usually try to increase integration, and a common criticism is that they try too hard (so as to generate more passengers), distorting the system from the user's point of view. Thus, a second rapid-rail corridor is needed, upgrading the suburban line. Also, busways or LRT corridors are needed, alternative corridors outside this "funnel" should be strengthened, and local employment should be encouraged, reducing the need for long-distance, work-related transport. All this will be made more urgent if there is a significant increase in incomes in this zone. This would increase automobile ownership, threatening a road system that is already congested.

Conclusions

Because of innovation and financial constraints, there has been a distinct shift in the "domains" for different collective-transport modes in developing countries. "Lighter" modes have achieved higher peak capacities with acceptable service quality. Figure 8 shows a rough comparison. In the industrialized world, the accepted paradigm has changed little since the 1970s. In the developing world of today, perceived capacities are higher. Financial limits, especially in the public sector, and relative investment requirements will tend to maintain this shift over the next decade.

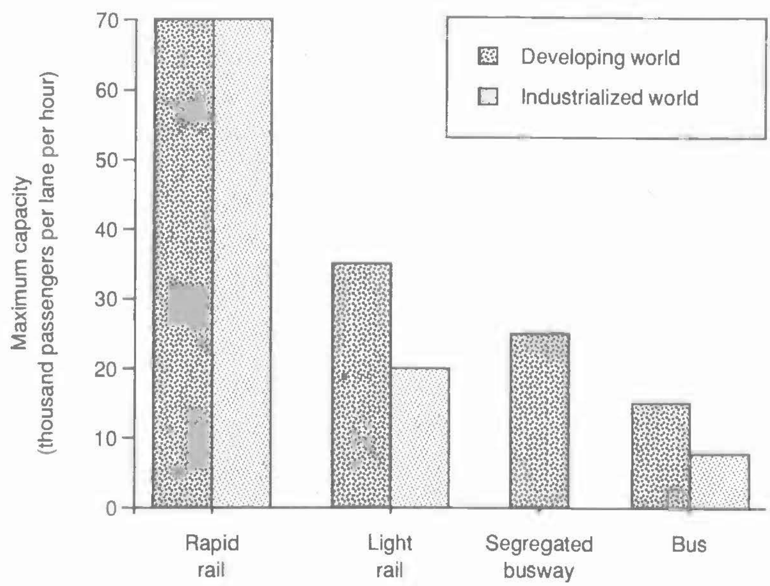

Fig. 8. Perceptions of modal capacities in the industrialized and developing worlds from the 1970s to today (source: Vuchic 1981; Economist *1989b).*

A common feature of both segregated busway and LRT modes — which cover the needs of most corridors — is the critical importance of obtaining and increasing right-of-way exclusivity. Without this exclusivity, an LRT system becomes little more than an expensive traditional tram over key stretches. In most cases, it appears to be feasible to introduce an LRT system into a functioning busway. Corridor planning, then, has valuable flexibility, permitting an incremental approach to expanding capacity and service quality over a wide range of perhaps 10 to 30 thousand passengers per hour. Also, there are closely competitive options (such as the large trolleybus) that help to discipline supplier markets.

The cost of urban space continues to rise. Right-of-way exclusivity is crucial to both bus and rail modes. These two factors suggest that any program seeking to achieve a significant impact over the decade should focus in the short term on obtaining exclusive rights-of-way. In turn, financial and planning limits imply an initial reliance on busway technology. This strategy was successfully followed in Curitiba. But it contradicts the National Mass Transportation Plan, whose preoccupation is with the vehicle; the issue of space is not systematically treated at all.

The passage of time will likely make the acquisition of space in critical stretches more difficult. Opportunities to influence the structural development of cities, especially those of medium size, will diminish. Given the scarcity of financial resources, an LRT-dominated strategy may simply be too slow. This does not mean that LRT has no role. However, it needs to be better defined in relation to bus-system rationalization. The latter has remained something of an orphan despite proven successes, probably because of the relative lack of organized lobbies.

A strategy for corridor development is an important part of urban transport policy, with ramifications for the whole system and, indeed, structure of the city. But it is only one part. Another key objective is to gradually influence automobile use by improving collective transport. First and foremost, however, urban transport policy must improve the service for existing users. They are the majority. Attracting people away from their cars is, in the short term, secondary. The metro systems of London, New York, and Tokyo weren't built for this purpose. Today, however, their existence, combined with the self-limiting effects of automobile congestion, means that many people who would normally use a car do not.

In Brazil and elsewhere, efforts to attract car users to collective transport — "executive buses" for example — have not been successful. They have tended to distract attention from the principal business at hand. Much of the interest in Europe and North America, especially in LRT systems, has this objective — probably correctly, as motorization levels in the North are so high. At the outset, this poses somewhat different objective and subjective standards for design criteria, and this should be kept in mind when comparing busway and LRT strategies, especially over the next decade. Positive, subjective factors such as vehicle comfort (Vuchic 1981; *Economist* 1989b) may be of less relevance in today's developing world. In addition, many of these factors can be obtained to a much greater degree with busway systems than with regular buses.

Integration

For the user of collective transport, integration has two key aspects: physical and tariff. The first involves the transfer from one vehicle or line to another and how this transfer influences service quality. The second involves how this transfer influences the price of the trip. Tariff integration should result in at least some discount relative to the separate purchase of tickets. It can mean no increase in tariff for a transfer, especially in cities with a single, uniform fare. Tariff integration is closely related to overall fare policy. On the supply side, integration — be it physical, tariff, or both — may permit a more optimized allocation of vehicles on lines or stretches of lines, as well as the redesign of lines. It is also relevant to strategies for increasing the hierarchy of collective transport, such as the upgrading of corridors. The development of corridors often brings the issue of integration to the forefront.

In almost all Brazilian cities, and developing-world cities in general, system integration is rudimentary or nonexistent. In principle, integration can improve service quality and system productivity at a low cost; however, it is difficult to achieve. The needs of the user must be front and centre, or service quality may in fact deteriorate for many. Too often, integration is first seen as a way to legitimize heavy investments in a corridor; it can almost become code for eliminating inconvenient competition along the route. Historically, this temptation has been greatest with rail corridors, and it seems to be greater when the corridor itself is ill conceived and suffers a shortfall of demand.

Consequently, the concept of integration is held in great ambivalence by transport planners in Brazil (for example, see Wright and Sant'anna 1989, p. 21). Integration is not something to be undertaken lightly. Wright and Sant'anna (1989) suggest that, in the meantime, the priority should be better "origin–destination" design for individual bus routes. This recognizes that much of the current routing is determined more by the vagaries of route concessions to bus firms in Brazilian cities than by user needs.

Attempts to improve "point-to-point" service are welcome (and can generate useful information on user needs, including integration). However, the logic of origin-to-destination (point-to-point) routing has its own limits. In large metropolitan areas, poles are becoming increasingly diversified and the resulting proliferation of lines could be enormous. The outcome would be more infrequent service in feeder areas and inefficient use of valuable corridor space, a suboptimal solution from everyone's point of view.

Brazil has already gone quite far along the point-to-point routing strategy, even with imperfections (which are likely to be difficult to correct). Along a congested corridor at rush hour, it is common to observe both overcrowded and half-empty buses traveling in the same direction. There can be a substantial, but poorly distributed overcapacity. Meanwhile, the outlying *barrios*, which depend heavily on buses, suffer from infrequent service. A response to this situation is the logic of integration plus corridor development:

- Reduce total vehicle frequency on the corridor (but make most vehicles available to the user, so the user sees a drastically increased frequency);
- Speed up flow on the corridor; and
- Move liberated bus capacity (or some of it) off the corridor and increase frequency of service in underserved feeder areas.

To a great extent, this logic has been followed in developing the Curitiba bus system. Today, it is arguably the best in the world. From the beginning, integration was an integral part of its corridor-development strategy. In this, Curitiba is unusual. In Porto Alegre and São Paulo, segregated busway corridors are not integrated. Integration, although desirable, was unnecessary for the segregated corridors to be a success in terms of both cost and improved service. These corridors always had heavy bus flows, and relatively little route changing was necessary at the outset.

Integration is simpler for a segregated busway than for a rail corridor. This further enhances the busway option. A gradual, step-by-step approach is possible. The pressure to integrate should not be urgent, even if it is desirable. This allows time, if necessary, for detailed study of user trips along an existing corridor. As well, the busway option will already involve the bus enterprises in the feeder system. They can participate directly in the benefits of the corridor — it is not intrinsically a competitor. In Curitiba, all operating companies are in the private sector. This represents the largest private-sector contribution to corridor development anywhere in the world, including such well-known privatization cases as those in Hong Kong, London (the

Docklands rail development), and Singapore. It also shows that integration does not depend on state ownership.

To successfully implement full physical and tariff integration of feeder lines with a corridor, several difficult problems must be confronted. First, and most elementary, there must be a mutually agreeable and reliable compensation scheme for the parties providing the feeder and corridor services. This can be difficult, especially where many enterprises are involved, each with distinct interests. In Rio, for example, no integration agreement was reached for years between the metro and the private bus companies; to this day, the Rio metro remains very underused. In São Paulo, the original tariff-sharing agreement between the metro and the bus companies led to systematic shortages of integration buses during the afternoon peak. The payment mechanism meant that the bus companies received a lower percentage of the ticket when it was issued by the metro.

An interesting response to this problem involves a general change in the way bus companies are remunerated. Traditionally, they are paid per passenger, whether the lines are integrated or not. The change would have them paid by the vehicle-kilometre of service provided, with due consideration of costs along different stretches of the route. This change not only enormously simplifies integration but is also interesting for other reasons. Indeed, it represents a fundamental change in the contractual relation between the city government and the (mostly) private providers of bus transport. This scheme has been successfully introduced in Curitiba and Recife (where there is no integration).

Another set of problems involves maximizing service benefits and minimizing service and financial costs to users. Integration must fight an uphill battle. The initial reaction to integration of most users of collective transport in Brazil is negative, and the subject is politically delicate. The planning of where and whether integration should take place, the design of the system, and the implementation should be sensitive to the existing needs of users. Their acceptance will depend on a complex interplay of both quantifiable and more subjective factors (such as the effect of route changes on established shopping routines). Furthermore, the interests of users are not homogeneous; there will likely be winners and losers in every situation.

For the great majority of users, integration should improve service: shorter average trip time, less variation in trip time, and shorter waits. The effect of integration on tariffs will clearly be important; it must be carefully considered in any overall pricing policy. In situations where passengers pass a ticket gate when transferring (the usual situation), a separate "integration" ticket may be issued (Lapate 1987). With bus–bus integration as practiced in Curitiba (closed terminals without a "gate" between modes), tariff unification (a single tariff for the whole system) has been necessary, at least for the integrated lines. Tariff unification is a major issue in its own right, with a strong element of equity. It can be applied with or without integration. Implementing a unified tariff can mean payment mechanisms similar to those for bus–bus integration (such as payment by vehicle-kilometre).

The issue of integration, especially bus–bus, is highly polemical among urban transport planners in Brazil (rail–bus is accepted as more or less inevitable). In many cases, concerns reflect doubts about the feasibility of bus–bus integration. In today's Brazil, integration is certainly demanding in institutional terms. However, with the reform of payment to bus operators ("bus-kilometre" instead of "passengers transported"), much bus–bus integration would be simplified. There are more fundamental challenges, however. Some prominent analysts hold the view that even a well-functioning, integrated bus–bus system (such as that of Curitiba) has been suboptimized exactly because it pursued integration.

When looking at the impact of bus–bus integration on the cost and quality of service (average trip time, reliability of trip time, comfort, local environmental impact, etc.), especially in relation to segregated busways, it is essential to consider the possibilities for the "hierarchization" of transport supply that full physical and tariff integration permits. This is taken for granted in analyses of bus–rail integration but is often forgotten in the case of bus–bus integration. For high-density corridors with feeder networks, segregated busways permit the operation of specialized, large-scale vehicles on the corridors. With integration on these busways, larger vehicles do not imply longer waits. All buses can be used, and they will often appear at average frequencies of less than a minute.

At the same time, local "feeder" buses should have higher frequencies than their "point-to-point" counterparts. This can occur for various reasons. First, with integration, average load factors on the busway can increase, liberating bus capacity for feeder lines. The most dramatic example is the Farrapos (Porto Alegre) busway. Since it is not integrated or hierarchical, only 40 percent of the nominal capacity of 39 thousand passengers per hour is actually used. The average speed of vehicles on the busway could no doubt increase, significantly reducing the number of buses using the corridor (currently 378 per hour at peak, Cracknell et al. 1990).

Second, an upgraded and integrated busway corridor will link the various "service areas" of established lines. For example, there may have been five bus lines serving a given route in, say, "Vila Maria." One came from "Centro," another from "Bela Vista," etc. Now, users descending at the "Vila Maria" integration point have access to all feeder lines instead of just one, just as they have access to all feeder lines in, say, "Bela Vista." In this case, the average waiting time would be one-fifth of the point-to-point approach at each of two stops, and probably less at the integration station for embarkation on the corridor. Reliability, expressed as the distribution of trip times around the mean, should also improve. These effects are synergistic and complement the scale economies that integration and hierarchy allow on a segregated busway (more specialized, large-scale vehicles operating exclusively on the busway).

The influence of integration and hierarchy on the environmental impact of a busway may also be substantial. The full possibilities have yet to be explored. However, the contrast between the nonintegrated Farrapos busway in Porto Alegre and the integrated (and partially hierarchical) Eixo Sul busway in Curitiba is illuminating. The former carries just over 15 thousand passengers per hour in one direction with 378 buses; the latter, over 11 thousand passengers per hour with 94 buses. Thus, at its bottleneck, the Farrapos busway averages 40 passengers per bus; Eixo Sul in Curitiba averages 105 passengers per bus with fewer periods of crush-capacity loading. Now consider, for example, noise pollution. Noise is taken as a proxy for various environmental and quality-of-life impacts on those who live or work along a corridor. A standard diesel bus averages 85 decibels (IPPUC 1990). Just reducing the number of buses will relieve noise pollution. Vehicle specialization could extrapolate this reduction. With trolleybuses — the extreme case of specialization — noise per vehicle could be reduced to less than 70 decibels.

Bus–bus integration in developing countries has received relatively little analysis, despite the lack of consensus on its desirability. The literature is dominated by rail–bus integration. Armstrong-Wright and Thiriez (1987), for example, in a study of bus services undertaken for the World Bank, did not address integration at all. The consolidation of the segregated busway as, in many ways, a new transport mode should stimulate greater attention to bus–bus integration — its advantages are comparable to those widely recognized for similarly high-volume rail modes (Servant 1990).

Integration is a dynamic process. As the urban transport system evolves, needs and opportunities arise. Much of the system may remain unintegrated for years. For example, even in Curitiba, a city that has been developing an integrated system for more than 15 years, more than half of all trips still occur in the unintegrated part of the system (Lerner 1989). It is a complex and politically charged process that involves regulatory, management, and financial issues as well as physical system changes, all of which must account for the characteristics of the transport system as a whole. We have raised some of these issues. A variety of solutions exists; but, by and large, the political will to seek solutions does not. This has been exacerbated by the lack of consensus in the transport-planning community that integration is desirable, especially bus–bus integration. A clearer consensus is needed at this level.

Regulation and Ownership

The bus is the predominant mode of collective transport in Brazilian cities. Bus systems are generally operated by private companies. The regulation of this sector by the government (a municipal function) was long limited to fixing the value of tariffs and defining routes. More far-reaching regulation began in the 1970s, with the cities of Curitiba and São Paulo as pioneers.

The private sector began to get involved in bus systems in the 1920s with dispersed ownership, similar to that in other Latin American cities. The expansion of bus operations was strongly based on self-regulating mechanisms of the competitive market. Even in those cities where public bus enterprises were formed (in some cases reaching back for decades), private participation remained dominant in the sector's evolution.

The basis for the sustained growth of private operations, characterized by free competition and the absence of government control, seemed to weaken in the mid-1970s with the prospect of declining profitability. On the one hand, the first petroleum shock increased fuel prices, significantly affecting operating costs. On the other hand, the income of users began to be squeezed. The 1970s were also marked by explosions of popular discontent with the conditions of collective transport.

It was in this context that governments began to propose more effective regulatory measures for the system and individual enterprises. At the time, the private sector was strongly against regulation. Today, there is a certain consensus on the limitations of pure market mechanisms and on the need for government intervention; the debate concerns the degree and form of intervention.

The key objective of the regulatory measures adopted was to consolidate the structure of enterprises in the sector. In São Paulo, for example, measures sought to decrease the number of firms operating in the sector (promoting mergers) and to diminish the differences between companies that influenced operating costs. At the same time, competition was reduced through the exclusive concession of operating areas, generally for 10 years. Before this, operations were licenced route by route, with precarious rights. Besides eliminating competition and the superpositioning of bus routes, exclusive operation by area permitted the rationalization of garages, maintenance, and administration. The earlier relationship, although precarious, was not detrimental to the operators in the prevailing context of trading political favours. The new concessions formalized and institutionalized the regulatory relationship between operators and the state. In doing so, they brought to the surface latent conflicts.

One of the most visible consequences of these measures was the improved organization of enterprises operating in the sector. In this respect, Brazil is peculiar compared with other Latin American countries. Brazilian enterprises have a reasonably strong structure, although there are notable differences between them regarding efficiency and management.

Another aspect of the private sector's response to regulation has been a substantial concentration of the market. The large number of operating firms makes this concentration appear less than it actually is. In fact, the many operating firms are in the hands of relatively few holding companies. For example, in São Paulo in 1986, with 32 operating companies, 60 percent of the private bus fleet was owned by companies held by six groups. This concentration has helped create a strong tendency toward forming cartels.

Entrepreneurs in bus transport have substantial lobbying power at the municipal level. They influence not only issues such as tariffs but also network planning. Cartels are not only formed at the municipal level, pressure is also felt at the intermunicipal and even national levels. For example, during negotiations in

Campinas in 1989 (in the State of São Paulo), roughly half the bus fleet suddenly disappeared, only to reappear in the neighbouring state of Minas Gerais. The lobbying power of the private companies and its ultimate nature can manifest itself just before an election. Regulatory standards and monitoring are often significantly relaxed. This results in a serious deterioration of service. It is curious that incumbent politicians should let such a sensitive service deteriorate just before an election. This suggests that campaign contributions must be substantial indeed.

The consolidated structure of private enterprise indicates that the regulatory reform of local governments has hardly resulted in suffocating losses for the private sector. Indeed, something like the phenomenon of "regulatory capture" (where the regulating agency is dominated by the groups it supposedly regulates) has often taken place. Nevertheless, by the end of the 1980s there was an idea, widely accepted among the younger generation of urban transport professionals, that more far-reaching and effective regulation would inevitably lead to municipal government ownership. In this vision, profit levels would effectively be controlled by the government, and the private sector would cease to have any interest in operating bus systems.

Those who argued that government ownership would be an inevitable result of more effective regulation generally started with observations about the "entrepreneurial culture" of the sector. In general, these entrepreneurs are based in family groups and began in small commercial activities. The administration of their enterprises has been rather rudimentary, based more on informal opportunities to boost profits than on systematically rationalizing management and operations. In this view, these traits would be fundamentally incompatible with a situation where activities would be monitored and costs and income would be transparent. In other words, the structural advance of Brazilian enterprises in relation to the rest of Latin America (a point of pride in Brazil) would not be as great as first supposed. Even though the enterprises have grown in size, their qualitative evolution has not been nearly as great.

The principal vice of this viewpoint — one that rapidly and easily equates serious regulation with state ownership — is that it obfuscates and paralyzes any serious consideration of policy measures that address the efficiency of collective transport. It becomes a form of self-censorship. To understand the importance of the problem, it must be remembered that the issue of regulation is strongly related to such basic questions as financing and subsidy mechanisms for the sector, as well as integration. Perhaps the "entrepreneurial culture" of these family enterprises will reject change, but we believe that the stakes are such that this risk must be taken. Furthermore, the stereotype of this entrepreneurial culture does not recognize the great diversity of management that exists between firms. Some are organized along modern capitalist lines. History has shown repeatedly that entrepreneurs can adapt; if they don't, other entrepreneurs can occupy their space. This process is occurring in Brazil today. The experience of the administration of transport in São Paulo between 1989 and 1992 showed the capacity of the sector's entrepreneurs to adapt to a new level of regulation.

First, let us consider financing. It is widely accepted, and argued in this book, that increased subsidies for collective transport are necessary and justifiable. Yet, to increase subsidies there must be transparency in application and monitoring of efficacy. No modern capitalist country would accept them otherwise. Brazil is not a modern capitalist country, but such a society is proclaimed as a central, political objective. To achieve the necessary transparency, increased regulation will be needed.

Second, physical and tariff integration implies the transfer of income between distinct operating companies (both public and private) as well as integrated planning and operations. This will also require increased transparency and regulation. The appropriate response to the vices of historic regulation may not be "deregulation" but rather a drastic reform of regulation and its criteria: "reregulation."

Experience with deregulation shows that, after the initial euphoria, the results can be perverse. This is leading some advocates of deregulation to soften their position, as occurred at a seminar on the theme held in Santiago, Chile, in November 1991, by the Economic Commission for Latin America and the Caribbean (ECLAC).

Municipal governments are responsible for the regulation of bus systems. As a result, the degree and forms of regulation vary from one city to another. Several recent experiences indicate a trend toward increased regulation. One of these is the "tariff compensation pool," which functions to equalize the profitability of different enterprises operating in the same city. Equalization of profitability may not, however, be the best way to develop the concept of the "pool." Besides compensating intrinsically less-profitable lines, it discriminates against more efficient enterprises, encouraging "creative accounting" and discouraging operational improvement. Experience with this kind of equalization model in the electricity-supply sector strengthens these doubts.

Another approach seeks to change the terms of contracts with private companies away from the former concessions. Brasília and Curitiba pioneered contracts that remunerate the operating company in direct relation to the number of vehicle-kilometres (with allowances for roadway and traffic conditions). This approach was also tried in Santo André, São Paulo from 1989 to 1992, but has now been largely discontinued. It seems to be by far the most interesting approach. We have already discussed its usefulness for integration. However, in elaborating these contracts, considerable care is required to avoid terms that may inflate tariffs, as occurred in Brasília.

Other contracts have the private company furnish the labour to operate and maintain the transport services, while the vehicles belong to the municipal government. In other cases, competition has been reintroduced on some lines to stimulate operational efficiency.

In some cities, publicly owned operating companies supply some services. One objective in recent years has been to increase the institutional capacity of government to monitor private enterprise. Another objective is to fortify the negotiating position of the municipality. Given the widely held thesis that more effective regulation would cause private enterprise to abandon the sector, some find it prudent to establish the nucleus of public operating capacity. However, in general, public ownership of the system as a whole is not currently a priority, even in municipalities run by socialist governments.

All of these experiments are attempts to find administrative responses to improve the quality of transport. The challenge they confront, and often address, is to find a way for government regulation of the private sector to be both more efficacious and more flexible. As such, these experiments represent an advance in the polemic on regulation: they tend to put aside the dominant vision that equates regulation with state ownership. In Brazil, as in various Latin American countries, there prevailed an often ideological debate of privatization versus state ownership. However, the debate tended to avoid the most pertinent political question today (see Figueroa 1987): Why are attempts being made, often with the support of the World Bank, simply to deregulate rather than reform the regulation of a sector whose operation is already mostly in the hands of the private sector?

Comparative studies are needed to provide a better basis for analysis of the different kinds of regulation. Their effects on the organization, efficiency, and profitability of bus systems need to be more clearly understood. As well, studies are needed to define the relationship between the public and private sectors.

Financial Policy: Transfers and Subsidies

A characteristic of Brazilian financial policy for collective transport is that the mechanisms used for transfers and subsidies commonly lack transparency. Consequently, there is an absence of systematic data. The concepts of transfer and subsidy are themselves controversial; they are only narrowly defined by both public agencies in the sector and private operating companies. Their reports exclude mechanisms such as special discounts for fuel or investments in the infrastructure used. Thus, the question of financing collective transport is intimately linked to political and institutional issues. An increase in the transparency of the sector (for example, to establish new subsidies) implies rearranging the relations of the agents involved. The debate concerning the expansion of financial sources reflects this interdependence.

Here, we will qualitatively describe the principal subsidy and transfer mechanisms employed at different levels of government. The sum of these subsidies is without doubt less in Brazil than in industrialized countries, despite the lack of information available. At the same time, there has been an evolution of the "informal economy" within the sector. This evolution has taken advantage of the distortions caused by high inflation rates and ignored labour legislation, which represents an informal income transfer or subsidy, normally unaccounted for. In general, the attitude of public regulating agencies toward these activities has been complacent.

Urban collective transport only became a serious part of the federal policy agenda in the mid-1970s. From 1979, the agenda was heavily influenced by the emerging economic crisis. The pre-existing tendency toward centralization of the policy process was accentuated, and the urban transport sector was used as a means to contract foreign credit. By the mid-1980s, this approach had been exhausted. The Constitution of 1988 transferred responsibility for urban collective transport from the federal to the local (state and municipal) level, along with most sectors of social policy. Despite the transfer of tax income to the local level, the dimension of the responsibilities assumed has resulted in a shortfall in financing capacity. This has stimulated some innovation at the state and municipal levels in financing urban transport.

The Federal Government

Until the mid-1970s, financing urban collective transport was the exclusive responsibility of state and local governments. A federal role emerged in 1974. The late federal presence in the field of collective transport has been attributed to the previous priority for automobile development that had strongly marked transport policy in Brazil since 1956 (Braga and Agune 1979; Mello 1982; Fagnani 1985). This priority emphasized road-based transport over rail and waterways, and the individual use of the automobile over collective transport. Transport policy became closely associated with the "leading role which the automobile industry came to have in Brazilian industrial development" (Braga and Agune 1979).

The Second National Development Plan, introduced in 1974, sought to change the general development strategy of the country. Within this context, it emphasized a new role for urban collective transport. An institutional and financial basis was created at the federal level for urban collective transport. A fund from designated tax revenues, the Fund for Urban Transport Development (FDTU), was established in 1975. The fund uses, in part, resources that were previously destined for road construction. In the same year, EBTU was formed and a national policy was elaborated. Between 1974 and 1978, the sector had a dependable financial base, although it was rather limited and control was centralized.

The entry of a new federal administration in 1979 marked a profound change in policy. It brought an even clearer subordination of collective transport to macroeconomic policy and implicitly more centralized control. Designated tax revenues for stable investment financing were eliminated. State enterprises in the transport sector (as in other sectors of the economy) were used as instruments to acquire debt. At the same time, transport policy was dominated and rather confused by energy-sector strategies resulting from the second petroleum crisis.

The 1980s saw the steady disintegration of what had been created in the 1970s. The sector's decision-making process was increasingly controlled by "external" agents at the federal level concerned with monetary, debt-management, and energy policies. The increased dependence on external debt financing in the early 1980s is a good example of how this policy transformation marked the sector. External financing accounted for 5 percent of EBTU's income in 1980. This rose to 60 percent in 1984 and 89 percent in 1985. The principal operator of suburban rail lines was the RFFSA/CBTU, and external financing increased from 4 percent of income in 1979 to 44 percent in 1983 and 72 percent in 1984 (Fagnani and Cadaval 1988, p. 45).

The increased share of external debt financing was primarily due to the drastic fall in internal financing. This strategy rapidly led to an untenable financial situation that killed investment capability. For example, the ratio between debt service and investment in EBTU rose from 0.5 percent in 1980 to 71 percent in 1985 and 538 percent in 1987 (Tables 29–31).

The government has had to cover operational deficits and debt obligations of federally owned transport enterprises. Transfers from the Brazilian Treasury totaled 339 million USD in 1987 (Table 29). To compare, total investments by EBTU in 1987 amounted to only 53 million USD. The lack of disaggregation of accounts (for example, cargo vs passenger transport) impedes a more precise evaluation of subsidy destinations.

Suburban train systems in Brazil suffer chronic operating deficits and provide a poor quality of service. In 1988, the

Table 29. EBTU financing, 1980–1988.

Year	Internally generated (%)	Federal transfers (%)	External financing (%)	Other (%)	Total (million 1988 USD)[a]
1980	39.79	54.97	5.24	—	367.9
1981	—	90.42	9.58	—	270.4
1982	—	66.45	30.93	2.62	247.8
1983	—	36.63	46.20	17.17	333.8
1984	—	31.75	60.52	7.73	594.9
1985	2.65	4.44	88.86	4.05	459.6
1986	3.66	67.03	29.14	0.17	444.3
1987	3.64	92.48	3.78	0.10	366.5
1988	5.92	75.63	18.29	0.16	487.4

Source: Fagnani and Cadaval (1989).

[a] Based on Brazilian currency values deflated to 1988 average.

Table 30. EBTU expenditures, 1976–1984.

Year	Investment %	Investment Relative[a]	Debt service %	Debt service Relative[b]	Other expenses %	Other expenses Relative[a]	Total (relative)[a]
1976	98	62.4	—	—	1.5	32.5	61.5
1977	96	100.7	—	—	3.4	116.8	101.2
1978	97	100.0	—	—	2.9	100.0	100.0
1979	96	91.0	—	—	4.1	126.0	92.0
1980	95	72.8	0.5	100.0	4.8	121.5	74.7
1981	91	50.7	4	558.4	4.7	84.9	54.0
1982	82	44.6	13	1 702.2	4.9	87.2	52.7
1983	69	53.8	28	5 468.5	2.9	75.4	76.1
1984	73	92.2	26	7 975.4	0.9	39.0	122.2

[a] Base year, 1978 (100.0).
[b] Base year, 1980 (100.0).

Table 31. The relation of debt service to investment and the evolution of total expenditures at EBTU, 1980–1988.

Year	Debt service/ investment (%)	Total expenditures (relative)[a]
1980	0.6	100.00
1981	4.5	72.22
1982	15.6	70.46
1983	41.4	101.80
1984	35.3	163.50
1985	71.5	129.31
1986	128.3	120.66
1987	538.3	93.01
1988	129.7	127.36

Source: Fagnani and Cadaval (1989).
[a] Base year, 1980 (100.00).

subsidies for suburban trains operated by CBTU amounted to 77 percent of operating costs in Belo Horizonte, 75 percent in Rio de Janeiro, 61 percent in Porto Alegre, 58 percent in Recife, and 52 percent in São Paulo.

These direct subsidies have been complemented by others. One mechanism channels the subsidy through the user. The "transport coupon" was introduced in December 1985 and made obligatory in 1987. In this system, the expense of a worker's commute to and from work is limited to 6 percent of salary. Workers receive transport coupons from their employer at the beginning of each month. The difference between the actual tariffs and the 6 percent limit is passed on to the federal government in the form of deductions on the employer's income tax.

Despite being obligatory, the impact of the transport coupon is limited. It only covers workers in the formal sector. As well, its application has suffered many operational problems, such as multiple tariffs, fragmented administration, and commercialization of the coupons. In 1988, transport coupons accounted for only 10 percent of total collective trips in Rio de Janeiro; in São Luis, 33 percent (Table 32). It was expected that coupons would account for an average of 30 percent of daily trips. Despite legal obligations and the fact that transport tariffs have increased quicker than salaries, this level has not been realized (Fagnani and Cadaval 1988).

Other federal subsidy mechanisms are directed to the specific costs of operators. There are lines of subsidized credit for the purchase of transport equipment at Brazil's national development bank (BNDES). The lion's share (85 percent from 1980 to 1988) has gone to rail systems; less than 4 percent has gone for buses, and 11 percent has gone for trolleybuses (Fagnani and Cadaval 1989). FINEP, the Federal Finance Company for the Study of Programs and Projects, also subsidizes equipment, and is more involved in technological development. Diesel fuel is also subsidized. In 1991, private operators paid 91.7 percent of the standard price; public-sector operators paid 83.3 percent. Also, the standard diesel price itself has historically been subsidized.

Infrastructure investments can also receive federal subsidies. There are specific lines of credit for infrastructure that can economize fuel (FINEP) or that subsidize terminals, garages, and segregated corridors (BNDES and Caixa Econômica Federal). There has been support for technology development, such as for trolleybuses, and for strengthening management capability, such as the Information System for Urban Management (SITURB).

Table 32. Use of transport coupons, 1988.

City	Coupons commercialized per month (thousand)	Passengers transported (% of total)
Aracaju	712	11.8
Belém[a]	7 024	24.5
Belo Horizonte[a]	20 030	32.7
Brasília	4 023	20.8
Campo Grande	871	14.8
Cuiabá	1 063	19.7
Curitiba	6 500	25.9
Fortaleza[a]	5 407	21.8
Goiânia	4 681	22.7
Joao Pessoa[a,b]	1 849	22.3
Maceió	1 330	18.8
Manaus	2 527	19.7
Natal	3 108	30.3
Porto Alegre[c]	6 144	24.1
Porto Alegre[d]	607	NA
Porto Velho	298	12.8
Recife[a]	8 397	25.0
Rio de Janeiro	1 600	10.0
Salvador	8 075	21.6
São Luis	3 194	33.0
São Paulo[a]	29 604	20.0
Teresina	1 488	22.3
Vitória[a]	3 103	25.4

Source: Fagnani and Cadaval (1988).

[a] For metropolitan area as a whole; in other cities, data are restricted to bus services within the principal municipality of the metropolitan area.

[b] From EMTU/Recife and from the Sindicate of Passenger Transport Enterprises of the State of Pernambuco.

[c] For commercialization from the Association of Passenger Transport Enterprises of the City of Porto Alegre.

[d] For commercialization from TRENSURB (NA, not available).

No estimates have been made of the impact of these various federal subsidies. A study of subsidy mechanisms, including a systematic review and evaluation of finances and subsidies in several cities, would be valuable.

In any case, the paralysis in the federal government's implementation of public policy after the approval of the Constitution of 1988 affected the collective transport sector as well. This Constitution consecrated the principle of decentralizing policy responsibility and tax resources. What resulted, in fact, was the destruction of much of the federal apparatus, which had controlled most policy and financial resources, without a corresponding increase in capacity at the state and municipal levels.

State and Local Governments

Most state and local (municipal) transfers and subsidies are for their own public-sector enterprises in urban transport. These enterprises have systematically shown operating deficits. Deficits are covered by the state in the case of metros and some suburban rail, and by the municipality in the case of municipally owned bus companies. The privately owned bus system, which dominates collective transport, is paid for by the users. The most important issues in the private system are cross-subsidies between classes of users and what might be called "informal subsidies."

The operating deficits of the metros of Rio de Janeiro and São Paulo are less than those of the suburban railways previously discussed, and in the midrange when compared with metros elsewhere in Latin America. Revenues are 50 percent of operating costs in Rio and 78 percent in São Paulo; in Mexico City, they account for 27 percent; in Buenos Aires, 63 percent; in Caracas, 107 percent; and in Santiago, 155 percent (Henry 1988). Although these numbers do not reflect the exact situation, as they cover only one year and do not include all capital costs, they do indicate the relative deficit levels of Brazilian metros.

Data for the São Paulo metro permit a long-term analysis. Between 1968 and 1986, internally generated revenue totaled 431.7 million USD (unfortunately, this figure includes some transfer payments between 1976 and 1978); operating costs totaled 779.1 million USD. Thus, over the 11 years from the start of operation in 1975 to 1986, 55 percent of operating costs were covered by revenues (Table 33).

The metro of São Paulo represented a major financial commitment by the state and municipal governments. Between 1968 (when construction began on the first line) and 1986 (when half of the second line began operation), 5.2 billion USD was invested. Of this total, 56.7 percent came from municipal, state, and federal resources; 30.4 percent came from credit operations; and 8.2 percent came from internally generated revenue (Table 33).

The municipal government played a key role in deciding to construct the metro and in financing the first phase of construction to 1976. It had a major impact on municipal finances. In 1974 and 1975, 30 percent of the municipality's total revenues and 84 percent of its tax revenue was absorbed by the metro. After that, the municipality gradually abandoned its leading role in investment, which passed to the state government.

Between 1976 and 1983, the state was responsible for half of government investment, municipal and federal government dividing the other half. Debt financing remained at about 21 percent. The economic crisis that began in the early 1980s

Table 33. Sources and uses of total financial resources for the São Paulo metro, 1968–1986.

	Value (million USD)	%
Sources		
Equity	2 977	56.7
Loans	1 596	30.4
Internally generated	431	8.2
Other	237	4.5
Uses		
Investments	3 122	59.6
Operational expenses	779	14.9
Financial charges	1 236	23.6
Other	104	1.9
Total	5 241	—

Source: Cadaval (1988).

reduced the investment capability of government, and tariff policy restricted their increases to levels below inflation. Consequently, from 1984 to 1986, debt financing (external and internal) absorbed 51.7 percent of total investment. At the end of this period, the State of São Paulo controlled 66 percent of the share capital of the metro, reversing the situation of 10 years earlier.

The example of São Paulo illustrates the major mobilization of capital that is required for metro construction. Whether this investment is justified, however, cannot be determined by financial criteria alone.

In cities with municipally owned bus lines, covering the deficits of these enterprises consumes a significant part of the municipal budget. For example, in 1984, the total expenses of the municipal bus company of São Paulo (including financial charges) were 142 million USD; however, the operation only generated 69 million USD in income. Roughly 19 percent of the São Paulo municipal budget goes to collective transport, a relatively stable figure over the past three administrations. Its municipal bus company tends to operate inherently high-cost lines. It also acts as a normative, regulating agency for the entire bus system — a distinct activity that unfortunately is not separated. Such activities undoubtedly contribute to the deficit. At the same time, there is little doubt that it suffers serious management problems in controlling costs, as do many other municipal bus companies in Brazil. A recent audit estimated that the cost per vehicle-kilometre of the São Paulo bus company was almost 70 percent higher than that of the private bus companies, principally because of higher personnel costs (*Folha de São Paulo,* 10 January 1991). The private companies, which represent about 90 percent of urban bus transport, do not usually receive direct operating subsidies from state or local governments.

There are virtually no more formal subsidies to the bus system. Cross-subsidies between classes of users are, however, important. Some users, such as students or retired people, receive explicit discounts; in effect, they are paid for by other users. Another form of cross-subsidy is the adoption of a standard bus tariff, independent of trip distance. Given the socioeconomic geography of Brazilian cities, where the low-income population tends to live farther from the centres of employment, the single-tariff policy represents a transfer of income from high- to low-income users. This tariff policy, introduced many years ago in São Paulo, is now widespread in Brazil.

From a socioeconomic perspective, the single tariff is easily justified; it is also necessary for effective bus–bus integration. It does, however, present management problems. Being based on the average costs of the system, it penalizes companies with lines that carry passengers over longer distances (or with other characteristics that increase costs). Without compensation, a single-tariff policy can unintentionally worsen service quality on such lines.

Various approaches have been taken to overcome this problem. One is the organization of transfer schemes between companies: the "tariff compensation pools" of Belo Horizonte, Piracicaba, and, originally, Curitiba. This compensation pool seeks to equalize profitability. It transfers part of the income from the more profitable companies to the less profitable ones. In Belo Horizonte, the compensation pool was also used as a mechanism to pass municipal subsidies to private operators. A problem with equalizing profitability between enterprises, as previously discussed, is that it inhibits the microeconomic incentive to increase productivity (Fagnani and Cadaval 1989). Another, more promising approach is for companies to receive compensation based on vehicle-kilometres traveled (with due consideration of roadway and transit conditions). In this case, even though average cost coefficients per kilometre are used, the more efficient enterprises will be more profitable. This system has been implanted in Brasília, Curitiba, Recife, São Paulo, and other cities.

Current Proposals

The financing of collective urban transport is currently the subject of considerable attention and debate in Brazil. One point of consensus is that the volume of transfers or subsidies to the sector should be increased — users are unable to bear the cost of tariff increases in real terms. Thus, the tariff must be distinct from operational costs, and sources of income must be diversified. This is particularly relevant for the bus system, where tariffs are in principle equal to the operating costs.

In contrast, there is little agreement on the subsidy mechanisms to use or the volume of resources to be transferred. The subsidy mechanism can have a major impact on economic efficiency. It can, for example, influence the incentive of the operating company to control costs. One set of questions that has generated controversy concerns the "target" of the subsidy. Should one directly subsidize the operator or the user? Should one subsidize operators indirectly through infrastructure investments?

An increased subsidy to urban collective transport compels political decisions. What are the priorities for allocation between the different sectors of social welfare: housing, health, water supply, and education? Also, choices must be made between social programs oriented toward broad or universal coverage and emergency programs targeted to eliminate absolute poverty. An increased subsidy also raises questions about the roles of the public and private sectors in providing the service, the types of contracts, and the level of regulation. Subsidizing private-sector enterprises implies a greater transparency of accounting, something that private operators refuse to accept (probably because their accounts would not bear an audit). Nevertheless, recently in São Paulo, bus companies accepted greater transparency in the presentation of their costs, until a new administration abandoned this approach. Another concern is the source of the transfers, which may be distinct for operating subsidies and new investments.

At the federal level, the mechanisms used since the mid-1970s are exhausted. The Constitution of 1988 limited federal financial capability. External and internal credit has dried up. In the future, states and municipalities will play a greater role in urban collective transport. Despite this basic change, analysts are discussing new federal mechanisms for transfers.

One school proposes returning to the model of designated tax revenues (such as those that financed FDTU in the 1970s) so as to achieve a more predictable volume of resources. Basically, those revenues came from taxes on petroleum derivatives, whose use is clearly related to the use of urban transport and the costs imposed on it. Those opposed to this model argue that it makes financial administration more rigid, impeding the reallocation of resources with evolving social priorities.

At the local level, one approach being considered is to involve the private sector in financing the infrastructure, along the lines of Hong Kong and London. Such an approach is being discussed for the new stations of the São Paulo metro. These initiatives are recent, and public opinion is still resistant. In addition, the administrative bureaucracy has been a major obstacle, being neither agile in making decisions nor efficacious in control and monitoring — both essential to guarantee the quality of the initiatives undertaken in association with the private sector.

Another approach includes various proposals to increase specific local taxes. Not surprisingly, this meets with serious resistance from those who would be taxed. One proposal is to tax real estate as a function of its accessibility to the collective transport system. Another proposal is to implement a "transport tax." This tax would be paid by the employers of enterprises that are indirect beneficiaries of the system. This proposal was inspired by the *versement-transport* of France.

A final approach being considered is to impose local taxes on the use of automobiles (parking or in circulation). Such taxes would be transferred to a fund for collective transport.

Most of these proposals represent capturing a sort of "user fee" from agents who benefit from the transport system as a whole, but have not paid for that access in activities dependent on the system. In the long term, a logical extrapolation of this philosophy would be "road-space" user charges. Therefore, more and more, the transfer of resources to collective transport would come from other users and beneficiaries of the system, rather than the general taxpayer.

Pricing

The issue of tariffs for collective transport seems like a game in which nobody wins. Public-sector enterprises present systematic deficits. Private-sector operators constantly complain of inadequate tariffs. Users, meanwhile, devote an ever-increasing fraction of their household budgets to transport.

The tariff question has been one of the principal political impasses of the collective transport system over the past 20 years. Setting tariffs and defining tariff policy is a function of three different levels of government: municipal (for buses), state (for metros and a portion of trains and buses), and federal (for the other portion of suburban rail). This mixture brings its own complications. The process has been continuously pressured, on the one hand, by real increases in the total cost of inputs and, on the other, by a decline in the real incomes of most users.

Between 1961 and 1979, minimum salary decreased 33 percent in relation to inflation; over the same period, average collective transport costs increased 52 percent. In 1961, the purchase of 50 bus fares per month averaged 6 percent of minimum salary; this increased to 10 percent by the end of the 1970s, and to 15 percent during the 1980s. In 1990, it was more than 20 percent; by the end of 1991, almost 30 percent. In early 1994, it reached 33 percent in São Paulo.

This relation with minimum salary is a useful, although perhaps overused, indicator. More revealing are systematic surveys of household incomes and expenditures, and transport use. The São Paulo Metro Origin–Destination Survey of 1987 showed a reduced mobility of users and an increase in purely pedestrian trips relative to 1977. It also estimated that the average household income had been cut in half from 1977 to 1987 (Metrô 1989). This has probably been the key factor restricting mobility.

Table 34. Household expenditures (percentage of income) on collective transport by income class, São Paulo.

Monthly income (minimum salaries)	1972[a]	1975[b]	1977[b]
<1	3.4	5.4	NA
1–2	4.3	5.0	11.9
2–4	NA	4.2	7.2
4–6	NA	3.4	4.6
6–8	4.0	3.0	3.4

Note: NA, not available.
Source: FIPE (1972), FIBGE (1977), Metrô (1980).
[a] Municipality of São Paulo only.
[b] Entire metropolitan area of São Paulo.

Unfortunately, no recent estimates of household income and transport expenditures are available. However, a series of estimates for the 1970s is relevant (Table 34). It reflects the rather generalized increase in collective transport costs within domestic budgets, especially among low-income groups. It also reflects a less widely discussed tendency: class segregation. In 1972, the difference in the weight of collective transport expenditures within household budgets between income levels was minimal or "statistically insignificant" up to six to eight minimum salaries (lower middle class, late 1970s). By 1977, this situation had changed dramatically. In the highest income class of Table 34, the share of household income spent on collective transport is less than 30 percent of what it is for the lowest income group. For the lower middle class, the weight of collective transport in household expenditures actually fell between 1972 and 1977; for the poor, however, it almost tripled. This tendency has certainly become more profound since 1977. Thus, whereas 20 years ago the middle class still heavily used collective transport, today the middle class has to a considerable degree abandoned it. Increasingly, it is a service used only by low-income groups.

The lack of a clear policy of subsidies and the institutional difficulties of collective transport have helped to prolong the impasse on tariffs. Consequently, tariff adjustments often result in lockouts, strikes, or popular discontent.

The increasing share of collective transport in users' budgets has not generally been accompanied by improved service. According to a 1988 survey of 12 major Brazilian cities (Table 35), most users feel that service quality is low relative to the price paid. Surveys also show that users are willing to pay somewhat higher tariffs if service quality really were to improve. In the 1980s, planners widely believed that service could be both cheap and good without subsidies. Today, however, this idea has been abandoned.

Tariff policy for the bus subsystem of collective transport is defined by the municipalities or states (where lines involve two or more municipalities). However, two of the most important cost components — fuel and wages — are set by the federal government. In 1984, these two components accounted for 80 percent of total operating costs: salaries and social benefits, 49 percent; fuel, 29 percent. These proportions may change with changing fuel prices or measures affecting labour legislation. Nevertheless, it is clear that a local tariff policy is strongly conditioned by exogenously defined policies that have a major impact on costs.

Table 35. User evaluation (percent) of ticket prices, 1988.

	Too high	Correct	Too low	No opinion
Belém	74	24	1	1
Belo Horizonte	69	27	3	1
Brasília	86	11	2	1
Curitiba	58	37	3	2
Florianópolis	61	38	1	—
Fortaleza	77	20	1	2
Goiânia	70	29	1	—
Porto Alegre	76	22	2	<1
Recife	82	16	1	1
Rio de Janeiro	83	16	1	<1
Salvador	67	30	2	1
São Paulo	80	18	2	—

Source: ANTP (1988).

The method of calculating tariffs differs from municipality to municipality. However, most have adopted a single tariff for all bus lines, independent of the line length. Tariffs are calculated using the average operating costs for the system, which are supplied by the operating companies and may not be accurate. Operating costs per vehicle are then divided by the number of passengers transported per kilometre traveled. The cost per passenger is then adjusted to allow for passengers with special discounts (such as students) or users with integration tickets from rail or metro systems.

The tariffs for suburban trains and metros are not related to operating costs; they are set at the state or federal level. In the case of suburban trains, tariffs have been explicitly "social" and the lowest of any mode. This is changing. In São Paulo, suburban train tariffs are now equivalent to those of the metro and, at times, higher than those of buses. In the case of the metro, tariff adjustments generally follow those for buses, as many passengers use integrated bus–metro services.

The existing mechanisms of tariff integration are limited. With the exception of Curitiba (where bus–bus integration is possible on many lines), they are restricted to combinations of two modes of transport, such as metro–bus or metro–suburban rail. Even then, the passenger's transfer usually increases the tariff (unlike Curitiba). Improving these mechanisms to permit more general bus–bus integration or possibly a single tariff, like the Paris "orange card," does not even figure in today's debate. This is dominated by the question of whether a single tariff for the bus system is preferable to a tariff related to the length of the line.

The most important advance in tariff policy is the recent consensus on the need to disconnect the financing of collective transport from tariff income. This opens the possibility of separating tariff levels from operating costs (especially in the bus system) and the challenge of developing adequate transfer mechanisms. The idea that "indirect beneficiaries" should also pay for collective transport is critical to break the historic tariff impasse where all are losers.

Demand Management

Demand management can broadly be defined as the set of strategies to limit the demand for transportation services. There are parallels with demand management in other kinds of infrastructure, such as energy. One line of action seeks to reduce peak demand. Another seeks to reduce the overall "consumption" of transport services. The effects of both can be short and long term.

Demand management also includes strategies to limit the use of private automobiles, the high impacts of which put this mode in a class by itself. We have discussed various measures of this sort; they include parking charges, restraints on entry to certain areas of the city, road-use charges, fuel taxes, fees and taxes on automobiles, and measures to increase the quality of collective transport. Disincentives to automobile use or measures that limit its modal share can also affect the overall demand for motorized transport with respect to income. The number of motorized trips per household tends to increase not only with car ownership but also with the urban structures that accompany the uninhibited use of the automobile. Here, we emphasize overall transport demand; however, this cannot be cleanly separated from the issue of automobile use.

The problem of transport demand is most visible at peak periods. Urban transport suffers from two massive peaks, dominated by residence–workplace commutes. Figure 9 shows the hourly fluctuation of road trips in São Paulo. The peak problem is worse in the developing world than in the industrialized world because a higher percentage of trips are work related. As in the electrical or telecommunication industries, the supply capacity to handle the peak is the most expensive.

The most obvious solution to this problem is to stagger working hours. This has been done in several cities in Brazil over recent years, including most recently in São Paulo (Pires and Boucinhas 1990). In this respect, however, the urban economy has been relatively rigid. This may change in the future as the economy and technology in the workplace evolve. In the end,

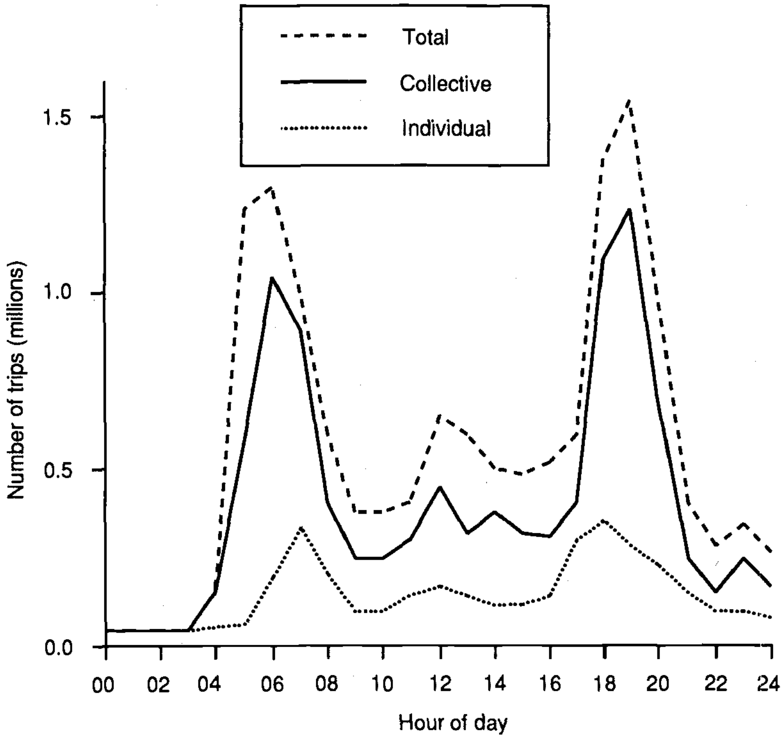

Fig. 9. Variation in trips — individual, collective, and total — during a typical working day in São Paulo, 1987 (source: Metrô 1989).

employers must also feel some net benefit from staggering working hours.

Another approach, which seeks to reduce the cost of peak transport capacity, has been to "privatize" certain blocks of supply. Large employers are encouraged to provide buses for at least some of their commuting employees. In some cases, such an arrangement may be cheaper than maintaining "public" capacity. Drivers can be part-time, spare "tourist-bus" capacity is available, etc.

Increasing fares during peak hour can reduce demand, as the metro in São Paulo has shown. Such policy is widely followed in the industrialized world and is apparently sensible from a broad economic point of view. However, it is almost nonexistent in Brazil, for good reasons. Complex concerns of social equity would have to be addressed — many low-income users have no choice of when to commute. Also Figure 9 shows that the morning peak in collective transport is from 0600 to 0700. From 0700 to 0800, collective transport is in decline; however, it is during this hour that overall congestion is at its worst. This is due to the peak in automobile use. It is senseless to charge users of collective transport for a problem that they do not cause.

Automobiles greatly influence the peak capacity of road infrastructure and the productivity of collective transport. As a result, they are a prime target for peak-hour demand management. The many measures we have mentioned to restrict or charge for automobile use would primarily affect their use in the residence–workplace commute. And, as ownership levels increase, this should remain as the principal thrust of measures to discipline automobile use, for it is peak-period use that has the most negative effects on a city.

There has been little work done on reducing the overall demand for motorized trips (or their length). The subject is, however, gaining attention. Trip demand is a complex function of income, automobile ownership, and the localization of residence, work, services, and leisure. Today, mobility is low, especially in the large urban centres of Brazil. As such, a substantial increase can be expected. However, the degree of increase and the trip lengths involved can be subject to policy. Through factors such as density of residences, workplaces, and services, and their relative locations, urban structure clearly influences motorized trips and their modal division. Housing mobility (the ability to change residence) may also have an effect, especially on trip lengths. There are many possibilities, all requiring detailed study in a range of situations. The best options will appear only gradually.

Intermediate Public Transport

Intermediate public transport (IPT), or "paratransit," refers to a set of collective transport modes that use vehicles smaller than the conventional bus. These vehicles range in size from a standard car to a minibus (capacity is usually less than 20 passengers). Paratransit is common in the developing world, under a profusion of local adaptations and names (Ocampo 1982; Pendakur 1984; Roschlau 1984; Bolade 1987; Patankar 1988; Abeasi 1989; Lee-Smith 1989). World Bank estimates show that the share of IPT motorized trips in large cities ranges from 10 to 20 percent: Ankara and Bangkok, 10 percent; Bombay, Calcutta, and Mexico City, 14 percent; Nairobi, Kuala Lumpur, and Karachi, 17 percent. Some cities are much higher: Buenos Aires and Lima, 28 percent; Manila, 59 percent (World Bank 1986a). These shares are significant. For example, Mexico City's metro and urban rail system accounts for only about 15 percent of all motorized trips. In smaller cities, the role of IPT is often larger (Pendakur 1984; Umrigar et al. 1989). In contrast, IPT is much less apparent in the industrialized world, although there is some interest in its reintroduction.

Among developing countries, Brazil is unusual in that its IPT is poorly developed. This may be due more to the regulatory environment than to differences in the market. The well-organized bus and taxi sectors have historically sought to restrict IPT. Their restrictions have been quite effective. Most countries have tried to put formal restrictions on IPT, but they have not been effective (Pendaku 1984; Roschlau 1984). IPT is a classic "informal-sector" activity, and regulation is limited. In many cities, IPT has mushroomed because conventional bus services are unable to meet demand (Umrigar et al. 1989).

The role of IPT has generated considerable controversy in the developing world. The debate has not been helped by the fact that most analytical models have been designed for conditions in the industrialized world (Vijayakumar 1986). As well, IPT generally involves two rather distinct sets of issues: the optimum vehicle size for different kinds of routes, and the organization and ownership of vehicle fleets and their regulation.

Much work is needed to define criteria for the role and organization of IPT. However, it is likely that, in many cases, the current role of IPT is not optimum for the transport system as a whole. Some reviews suggest that the advantage of IPT is greatest on "feeder" routes, which are shorter and have smaller passenger flows (Vijayakumar 1986; Patankar 1988). In principle, high-volume corridors are better served by larger vehicles, although this does not mean that IPT vehicles should be excluded from such corridors. Some physical integration of modes is desirable and, to some extent, occurs naturally (for example, Mexico City's *peseros* feed the metro — Roschlau 1984).

In Brazil, we must ask if a significant expansion of IPT would be desirable. What roles might be filled? The problems in financing an increase in conventional collective transport make IPT an interesting option, at least in principle. The wide gap in cost and quality of service between buses and taxis also suggests an existing market niche. However, IPT is not well regarded by the transport planners of Brazil. Its emergence tends to be associated with an inadequacy or breakdown of the existing system, a perception with considerable historic basis in Brazil and elsewhere.

Despite this, IPT can be seen as a cost-effective complement to other modes; its introduction need not mean anarchic deregulation (Umrigar et al. 1989). There is some evidence that opinion is changing. The city of São Paulo, for example, is increasing authorization for *lotações*. This is the most common form of Brazilian IPT; it principally serves the periphery, where conventional bus service is worst. A key issue, besides price regulation, is the physical security of the system. No data on relative accident rates are available, but the operating conditions of IPT are widely seen as dangerous. The growth of IPT in Brazil could also help to relieve an important energy problem: the large and growing fraction of petroleum that goes for diesel fuel. IPT vehicles in Brazil tend to use gasoline (Otto cycle engines), something that could be reinforced in the licencing process. This may be one of the most attractive strategies available for replacing diesel fuel.

Different configurations of IPT are possible, serving markets with distinct characteristics (such as income level). In the medium and long terms, IPT may be necessary if collective transport is to compete effectively in an environment of relatively high car ownership. In fact, this is one reason that many industrialized countries are interested in reintroducing IPT.

Internationally, IPT has been the subject of much study, and there is considerable scope for technical and organizational innovation. More work is necessary to define possible roles for IPT. Brazil could be a particularly interesting case.

Institutional Capability

Over the last decade, there has been an increasing emphasis and awareness of the role of institutional frameworks in urban transport. Institutional development — the process of improving the ability of institutions to use the available human and financial resources effectively — is now recognized by key institutions, such as the World Bank, as a crucial element in any strategy for the urban transport sector. Apart from the cumulative process of learning by doing, the reasons for this emphasis have to do with the protracted economic crisis. It has drawn attention to the need to rationalize the use of scarce resources and to rethink the role of the public sector in the development process. The Brazilian experience in institution building in the urban transport sector confirms this argument.

Before the establishment of EBTU and the national system for urban transport (SNTU) in 1976, the sector lacked both coordination and programing. It also lacked a clear-cut financing basis. The establishment of EBTU and SNTU also created a sectoral fund for urban transport, FDTU. Under the aegis of SNTU, the states and municipalities were to create institutions that would form the local system of urban transport in the metropolitan regions. Designed within the framework of SNTU, this local transport system includes the SV (urban roadway subsystem), SC (traffic circulation subsystem), and STPP (bus–trolley–ferry subsystem). A two-tiered system was created in which the federal government (through EBTU and the Urban Transport Secretariat at the Ministry of Transport) was responsible for policy formulation, urban transport coordination, and investment planning; participating metropolitan regions would be the executing branches of the federal programs. In this connection, complex institutional arrangements involving federal and local agencies were established.

Concurrently with the creation of EBTU, the Brazilian Transport Planning Agency (GEIPOT) was created to assist in preparing both urban and interurban transport policies and investment plans. In 1984, CBTU was formed. It took over from EBTU in the area of suburban rail, and is involved in planning, operations, and financing. In 1985, the Ministry of Urban Development and the Environment was established. It took over EBTU and the urban sections of GEIPOT.

Thus, an impressive array of institutions was established in a short time, making it possible to implement an intense program of investment in urban transport. The relative success of the sector, at least during the late 1970s and early 1980s, can be attributed to many factors. First, all levels of government showed a high level of political commitment to the sector. Both mass discontent with transport services and, more importantly, the energy crisis were important reasons behind that commitment. Second, development planning enjoyed prominent status in the Second National Development Plan designed and coordinated by the newly created Presidential Planning Secretariat of the Geisel administration (1975–1979). Third, the World Bank stepped up its involvement in urban transport. The Bank provided the resources for most EBTU programs and, above all, the much-needed technical legitimacy for EBTU activities. The most important aspect of the Bank's involvement was its dissemination of modern methods for project appraisal and supervision within EBTU.

Many problems also exist, however. At the federal level, coordination is difficult because of the many agencies involved (BNDES, CBTU, EBTU, etc.). Also, coordination between EBTU and the metropolitan regions is difficult because of EBTU's centralized nature. At the local level, responsibilities for planning the transport system are fragmented within a single metropolitan region or city. Different agencies, each with distinct organizational structures and classifications, are responsible for the various elements of the transport system: SV, SC, and STPP. Most importantly, the distinct municipalities within metropolitan areas are responsible for various aspects of transport operations, including setting tariffs and designing routes within their territory. Intermunicipal lines, in turn, are regulated by state secretariats or metropolitan agencies in a centralized manner. This has resulted in recurring technical inconsistencies and political and administrative conflicts, both within and between modes, in large metropolitan areas such as São Paulo, which consists of 40 municipalities. Reforms are urgently needed to establish more representative institutions at the metropolitan level.

The shrinking resources available to urban transport have strengthened the positive attitudes toward much-needed administrative rationalization. This is evident in the Fourth Urban Transport Project and, more recently, in the National Mass Transportation Plan. Thus, recommendations have been made for, among other things, the devolution of suburban rail operations and ownership to local agencies and for the improvement of information systems in urban transport at all levels.

For most of its life, EBTU lacked adequate appraisal methods and routines in terms of investment planning. In its early years, it generally reacted to local investment demands and limited its quality control to a more or less perfunctory review of proposed projects. EBTU was basically limited to reviewing the engineering design of each project. It generally ignored program and policy content as well as economic feasibility. The construction of suburban and urban rail systems are cases in point (one of these, the Porto Alegre TRENSURB, was enthusiastically supported by the World Bank). In most cases, the appraisal was primarily based on energy savings; little attention was given to economic feasibility. In a few other cases (TRENSURB is an outstanding case), traffic volume was grossly overestimated.

Poor project appraisal has been a recurring problem in the sector. Surprisingly, no contingency planning or alternative scenarios were incorporated into the recent National Mass Transportation Plan. The bus-corridor option was dismissed without detailed analysis of demand or costs; the light-rail alternative was justified in a simplistic fashion, on the basis of unproven assumptions. If detailed analyses were ever conducted by EBTU's technical staff, it is surprising that they were neither disclosed to the professional and political community nor referred to in the Plan. An active information policy is, therefore, urgently needed.

The economic recession of 1981 to 1983, and the ensuing recurrent fiscal crisis, has highlighted these problems. Today, new institutional innovations in investment planning and implementation management should be encouraged.

Notwithstanding all of these shortcomings, EBTU's experience in Brazil illustrates the importance of establishing a central agency with technical and managerial abilities to coordinate national strategies in urban transport. Such an agency can also act as a catalyst of subnational interventions and, most importantly, as a catalyst in the diffusion of innovations. In Brazil, this last role was made possible through various mechanisms: by training schemes and technical assistance; with publications, technical manuals (EBTU's operations manual was very effective), and particularly the establishment of a technical information network (SITURB); through links with research centres and universities (research grants and awards); and by demonstrating the effects of EBTU's direct actions.

Unfortunately, because of the deepening economic crisis and the transition from military to civilian rule, the sector's information system collapsed. A sustained effort is needed to reverse this trend. While writing this book, we have encountered endless difficulties, gathering updated data on investments and on physical and financial indicators. This is symptomatic of the current disarray and, most importantly, in the diffusion and transparency of information in the urban transport sector. Addressing this problem should be an important priority in any new government agenda and in the portfolios of official development assistance.

In a context of economic crisis and fiscal austerity, the issue of institution building and institutional capability acquires a clear priority in the agenda of urban transport policy. In effect, costly investment in transport infrastructure — including the construction of terminals, the renewal of fleets, and physical expansion of existing networks — is not realistic. Instead, government advisers and institutions, such as the World Bank, point to management rationalization, improving institutional capability, and maintaining existing networks and facilities as central policy issues. Many of the problems discussed in this book — such as system integration between modes and lines, and inconsistencies between urban planning and transport policy — require major institutional changes to be effectively addressed (Ismael 1989).

Azevedo (1988) has looked at the costs of maintaining Brazil's bus fleet. These costs rose systematically between 1975 and 1987, both in real and relative terms (Fig. 10). No substantial reduction in other types of costs was verified. In 1987, maintenance costs were 26.7 percent of a bus company's total operational costs (fuel not included), making it the second most important cost. These figures, in fact, reflect the aging of the bus fleet (in 1987, 45 percent of the fleet consisted of buses manufactured in 1980 or earlier). But, as Azevedo (1988) argues, there is vast potential for improvement; in Brazil, maintenance activities are still rudimentary.

Thus, the problem is twofold. First, how can resources, which are both scarce and stagnant or diminishing, be used more efficiently? Second, how can these resources be mobilized in a context of austerity? The answer to the first question has to do with improved planning, management, and control of urban

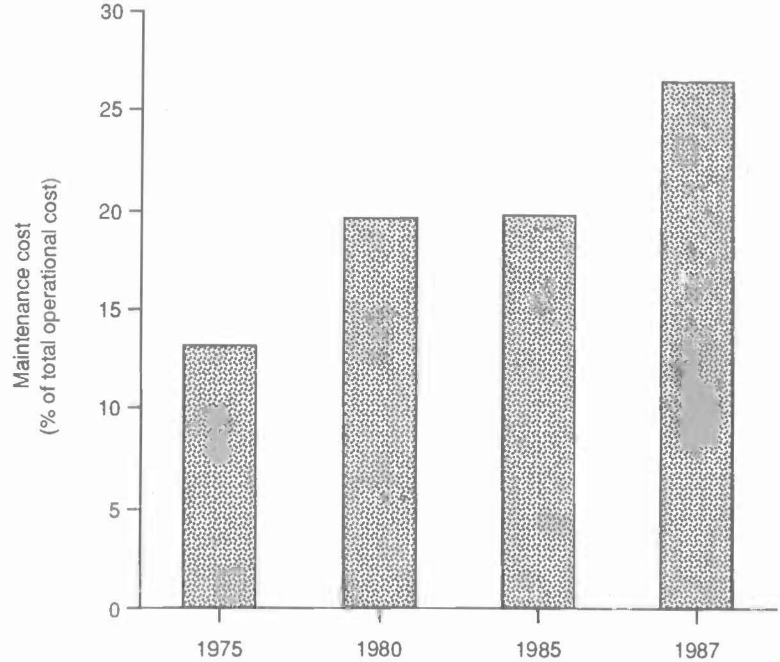

Fig. 10. Maintenance cost of Brazil's bus fleet from 1975 to 1987 (source: Azevedo 1988).

transport operations. The answer to the second question lies fundamentally in improving cost recovery and finding new sources of income (which, ultimately, would lead to eliminating operational deficits). These questions refer to interrelated aspects of the same problem, but they can be analytically separated. Institutional issues, typically, pertain to the first question, but they can also involve cost recovery. Effective law-enforcement measures or billing procedures, for example, have a direct positive effect on cost recovery.

These problems have solutions and some solutions have been recognized and disseminated, most notably by the World Bank. However, one major problem remains: economic crisis. It is frequently accompanied by a relative decline in political commitment to soft issues, such as institutional reform, in favour of pressing financial issues. The costs of these reforms are frequently underestimated. In fact, they are very high in political terms, as vested interests in the bureaucracy and the economy frequently face formidable resistance. Moreover, the low specificity of institutional reforms make them difficult to implement. Staff morale is often low as a result of declining salaries and shrinking resources. As well, the organizational and public status of these organizations is diminishing. The challenge, therefore, is to countervail these tendencies and to implement the changes discussed. They are both feasible (because of their low cost in a context of scarcity) and potentially effective (because of their current strategic importance).

Chapter 4

Conclusions

The large cities of Brazil and other developing countries are experiencing rapid demographic growth and increasing motorization. Urban transport policy faces some serious challenges. Transport is certainly one of the key problems of large cities, being related to issues of equity, environment, and economy. It is a highly visible political issue in metropolitan areas. Investment needs are also relatively large and tend to increase as cities grow in size and degree of motorization. The close association of urban transport with other urban and national issues (such as energy and urban land use) adds an additional degree of complexity.

This book has reviewed the problems in urban transport development, focusing on Brazil. A broad, if still incomplete, range of technical, social, financial, and institutional issues has been considered to provide a more integrated view of the problem. In Chapter 2, some basic factors that condition policy were briefly analyzed: congestion, the value and use of space, the environment, energy, social equity, and financial resources. The analysis showed the very high relative cost of the private automobile in terms of its use of space, environment, and energy resources. The role of the automobile will continue to grow. We have argued, nevertheless, that any strategy to address urban congestion, pollution, and long-term energy trends must include a clear commitment to strengthening collective transport. This is the central message of this book, reinforced by the negative socioeconomic consequences of the existing transport system. Chapter 3 reviewed some of the key issues that must be addressed by a policy to strengthen collective transport.

Financial Constraints

Perhaps the most urgent problem facing the collective transport sector in Brazil is how to secure the financial capability to carry out the investments that will be necessary in the short and medium terms. The implications of this challenge are far reaching. Over the past decade, financial constraints have deepened. At the same time, the need for investment is large and growing, intensified by accumulating deficiencies in past investment and repressed user demand. Even with a substantial increase in investment resources, available capital will be scarce relative to demand. Improvements must be made with limited resources and controlled costs.

Financial recovery is made much more difficult by the heavy internal and external debt common to all levels of government and state-sector enterprises. The exact implications of this debt for urban transport finances are obscure; the little information available does not allow a unified view of the financial situation. It is possible, however, that any realistic increase in sector income would be insufficient to meet both debt service and investment requirements. To some extent, this reflects the situation of Brazil as a whole. Certainly, to create space for investment, every effort will have to be made to reduce the net cost of debt service. This subject, however, goes beyond the scope of this book.

Financial recuperation is also made more difficult by the limited scope for real tariff increases in the short and medium terms. This is due to the small incomes of many users, part of the serious problem of income distribution in Brazil. However, we have also argued that users of collective transport (including bus users), in principle, should not be expected to pay the full cost of the system, as they are not its only beneficiaries. This principle is generally accepted in industrialized countries, if not by their agencies that deal with developing countries. The key issues surround the appropriate mechanisms for making the transfers and their sources.

International financing has an importance that exceeds its share of total investment. An important aspect of official international development assistance (ODA) and credit in the area of urban transport is the overwhelming dominance of the World Bank. Except for Eximbank-type financing, virtually no other actor counts. This dominance even extends to the financing of analytical and planning activities, which require more modest resources. Most ODA agencies of the industrialized world appear to have abandoned the subject. This concentration of activity in the World Bank does not appear sound, especially for planning, analysis, and information. The expansion of such activity, with a more intense and systematic exchange of information and experience, would be very helpful for developing countries trying to respond to the current challenges of urban transport. Other ODA agencies can and should get involved in this process. This conclusion is strengthened by the growing concern with greenhouse gas emissions (especially carbon dioxide) and the importance of transport in any strategy to limit such gases.

Changes in the Physical System

We have paid considerable attention to modal choices for corridors. Corridors are a crucial part of the urban transport system. Choices with respect to their development (including the relative priority for private automobiles and collective transport) affect not only the characteristics of the transport system but also the evolving structure of the city itself. It is along and around the corridors that problems of congestion and pollution are most severe. The greater part of investments to improve collective transport is made on corridors. A key choice in the planning of such corridors is the mode (bus, rail) to be developed.

More attention should be given to the possibility of using bus modes for increasing the capacity or improving the quality of service on corridors. Buses are used on the overwhelming majority of corridors in Brazilian cities. Experience, much in Brazil itself, has shown that investment in the bus mode can result in a large improvement in service, with a large volume of passengers (15 to 25 thousand per hour on segregated busways), at a fraction of the cost of rail-based modes. In many cases, at least, a busway can be a precursor for a rail line. As well, the vehicles themselves may remain privately owned, further reducing the need for public-sector investment. Given the severe financial situation of the sector and the hundreds of kilometres of corridors needing attention, this low capital intensity is an attractive characteristic. In the practical politics of Brazil's big cities, however, such relative austerity is often seen as a disadvantage.

A valorization of bus modes, especially segregated busways, does not mean that rail modes will become irrelevant. A reassessment of roles is needed at the national level, based on analyses of the specific transport systems of various cities.

The upgrading of corridors often raises the issue of integrating lines and tariffs. As discussed, this issue is controversial in Brazil. Some experience has been unsatisfactory. Implementing an integration strategy is a complex and evolutionary process. It raises pricing and regulation issues, and requires a thorough understanding of user needs. Outside Curitiba, bus–bus integration has not been put into practice in Brazil (although some multimodal integration does exist). We have argued that integration can both improve service (shorter trip time, less crowding) and reduce costs. Opportunities for bus–bus integration should be sought and pursued.

Other measures that can improve service quality and increase capacity at a relatively low cost include the following:

- *Rationalization of bus lines* — Many existing lines do not optimize the use of bus capacity from the point of view of users or the system as a whole.

- *Traffic management*— Many possibilities exist for improving vehicle flow. These often involve limiting the use of urban space by private automobiles or charging them for its use.
- *Maintenance*— Improved maintenance can reduce operating costs, energy consumption, and pollution emissions.
- *Improved vehicle design and matching to route needs* — There are possible roles for vehicles both larger and smaller than the conventional bus, improved circulation of passengers, and an improved bus–bus interface.

The attractiveness of some of these options could be amplified through technological evolution in general and information technology in particular.

Demand management is also important. Attention is focused on reducing the rush-hour peak, which is especially severe given the predominance of work-related trips in a developing country such as Brazil. Although rescheduling work hours to spread peak demand is an attractive and low-cost option for the transport system, it encounters resistance among employers. Long-term changes in urban structure will also influence trip demand and destinations. Land-use planning should be closely related to transport-systems planning. The benefits of this policy can be seen in a city such as Curitiba.

The Institutional Dimension

To finance and effectively implement changes in the physical system, many political and institutional issues must be dealt with. Regulation, ownership, pricing and subsidy mechanisms, and strengthened planning and administrative capabilities are all important.

Regulation and ownership are two highly related and frequently confused issues. In debates on ownership, often what is really at stake is the adequacy of regulation mechanisms. The dominant mode of collective transport in metropolitan areas, the bus, is overwhelmingly in private hands in Brazil and many other developing nations. As such, the ownership question is not so much whether to privatize but whether state ownership should expand. After all, virtually all collective transport in the industrialized world is owned by the state.

Private ownership is not necessarily undesirable. Several factors militate against a rapid expansion of state ownership in bus systems. The cost of public expropriation or substituting private capacity is significant and may conflict with other investment priorities. There must be resulting gains in efficiency for users to benefit. However, state enterprises are often poorly managed. Efficiency may actually decrease, increasing the subsidies needed simply to maintain service.

The negative characteristics of the private system may be largely due to inadequate regulation. Various innovations are now being tested in Brazil (including by municipal governments that favour state ownership). If successful, these innovations may make private ownership more compatible with the needs of both the system and the public. However, to what extent will the entrepreneurial class accept effective regulation? Resistance to such proposals is generally fierce, although subsequently, firms often find the measures taken to be acceptable. Regulation is often seen as simply greater interference by the state. In fact, it is probably the only viable alternative to increased state ownership. Reform of regulation, or "reregulation," appears to be more appropriate than "deregulation."

Pricing is another key issue. Users of collective transport should not in principle be expected to pay the full cost of the system as a whole; they are not its only beneficiaries. There are also important equity issues in pricing. A clear pricing policy and transparent mechanisms for subsidizing the sector are necessary.

Subsidies may come from the general revenue of the state treasury, and this source will undoubtedly be necessary. However, it is better to emphasize more specific transfers from other users and beneficiaries of the system. They would include automobile users and owners of property whose value is increased by transport improvements. Such "tied" tax transfers are not popular among mainstream economists; however, they would help to explicitly incorporate the higher "externalities" (use of space, pollution, carbon dioxide) caused by automobile users as well as the externalities of investments in collective transport. The revenues address problems to which the tax itself is related. Such a policy is more economically efficient, probably fairer, and politically more attractive than using general tax resources. Financial planning, which is crucial in a sector with long lead times, also becomes more predictable. Various sources have been suggested: the most viable of these are parking fees, transport fuel taxes, and timely property assessments for taxation in areas affected by infrastructure improvements.

The choice of subsidy mechanism is important. It can influence the efficiency of the recipient enterprise, be it private or state owned. Subsidies often have the undesirable effect of increasing real costs (by relaxing the arduous discipline of cost control). In turn, this can result in a greater demand for subsidies. The prospect of subsidization can also distort investment decisions.

The literature on different strategies and mechanisms for subsidizing the sector is inadequate. Given the considerable interest in new taxes (carbon dioxide taxes and automobile user fees are appearing on the agenda), it is apparent that this area is in need of new policy-oriented analysis.

Another issue involving subsidies is the profile of tariffs with respect to the distance traveled by users, especially in the same mode. To what extent, and how, should users cross-subsidize each other? In Brazil, as in most developing countries, the key mode in question is the bus. In this mode, some degree of cross-subsidization is unavoidable because of the necessary simplicity of fare collection. We have argued for a broad "unlinking" of individual trip costs and tariffs for two basic reasons: equity and system management.

As a whole, users of collective transport have a much lower income than automobile users. Those who travel farthest on collective transport are overwhelmingly among the disadvantaged.

There is a desperate level of socioeconomic inequity in the cities of Brazil, with potentially dangerous consequences for the social fabric. Together, cross-subsidies and sector subsidies to urban collective transport may be one of the best mechanisms in a strategy to reduce broad inequity. They may also relieve some of the pressure felt by the poor to occupy more accessible locations at subhuman densities.

"Unlinking" bus fares from trip length also greatly facilitates the physical and tariff integration of the bus system. Curitiba, the only city in Brazil to integrate a large part of its bus system, adopted this tariff philosophy. Even with substantial advances in income and information-control technology, it is difficult to imagine a viable, integrated bus system without a single, uniform fare. Bus–bus integration in the cities of Brazil and other developing countries is likely to be a gradual process. Eventually, however, it will bring considerable benefits to the users of the system. The model of Curitiba and its contract with private bus owners, as detailed earlier in this book, will serve as a useful starting point for policy analysis.

In an environment characterized by scarcity, discontinuity, and uncertainty, institutional strength is crucial. In general, there are two key strategic goals in the global planning of urban transport: to mobilize new financial resources and to use existing resources more efficiently. Institutional strengthening is central to both these goals. Enhancing efficiency involves improving the planning and targeting of objectives, promoting better inter- and intra-agency coordination, rationalizing transport operations and their monitoring, and establishing effective maintenance procedures. Finding and consolidating new sources of income also requires institutional change. Whereas the direct financial costs of such change are low, the political and administrative challenges are substantial. In Brazil during the 1980s, the political context for addressing these challenges changed, especially at the local level. The deepening of democratic processes, the decentralization of responsibility and authority stimulated by the Constitution of 1988, and the crisis of central government institutions have pushed local governments to seek feasible solutions to their problems. This trend, although by no means universal, is sufficiently widespread to be promising (Pacheco 1991).

Brazil in an International Context

The problems of Brazil's metropolitan areas are similar to those encountered in other developing countries, especially in Latin America. The trends and characteristics of these problems are in stark contrast to the situation in most of the industrialized world:

- Motorization levels (automobiles per thousand inhabitants) will grow substantially, and there is strong urban demographic growth, especially in large and intermediate-sized metropolitan areas.
- The great majority of the urban population uses collective transport.
- Income distribution and mass poverty are serious problems.
- Institutional capabilities and conflicts are serious constraints.
- Financial resources for investment are more limited.

There are, of course, large differences between developing countries and their cities. Differences in income and urbanization are much larger than among industrialized countries. There is, however, considerable similarity in broad trends, as well as the qualitative points just mentioned. The urban population tends to be highly concentrated in the large urban centres. In Latin America, the percentage of the population in urban centres of more than 2 million people is already higher than in North America or Europe and is likely to continue growing for some time. When cities reach this size, diseconomies of scale are becoming important for many kinds of essential infrastructure, including transport. The demands for investment in metropolitan infrastructure tend to intensify relative to the level of income and infrastructure in the country as a whole. A reversal of this trend, toward "metropolitan hypertrophy" (to be distinguished from urbanization in general), would be beneficial.

Within this general context, Brazil presents some peculiarities. First, the development of the automobile industry has been a high priority of general economic policy for the past 30 years. Relative to per-capita income, the level of automobile use is high (income distribution may also play a role). One of the many consequences of this legacy is that the political power of the automobile lobby has been and will likely continue to be very strong. Second, private-sector bus transport is relatively consolidated in organized companies. In part, this is due to the historically weak presence of IPT or paratransit modes. Third, by the standards of most developing countries, public institutional structures and human resources are more developed in Brazil. However, as with the rest of Latin America, they have suffered appreciably from the country's prolonged political and economic crisis. Finally, on issues related to urban transport, national energy policy has had a greater impact in Brazil than in most developing countries. For example, the alcohol program has had an impact on the environmental debate. From the mid-1970s to the early 1980s, many investment priorities in urban transport were dominated by energy criteria, often applied simplistically.

The experience of Brazil is nevertheless relevant to other developing countries, and vice versa (with, for example, paratransit). This book has described and analyzed, for both a national and international audience, the problems and choices for urban transport in Brazil. We have tried to take a broad view, considering factors ranging from technology to environment to finance. It will be useful not only for transport and urban planners but also, and perhaps especially, for professional communities concerned with energy and the environment. These groups are likely to become increasingly concerned with urban transport policy; but they tend to have an incomplete view of the issues involved. Relatively little synthetic analysis is available on developing countries.

There is a need for a greater exchange of useful information, analyses, and experience between countries and between cities within countries. This is true not only in the developing world but also, albeit to a lesser extent, in the industrialized world. Needs range from the general — comparing the interactions of urban structure, income, and transport use — to the specific — the performance of a particular innovation. Today, information flow is spotty and seldom comparable. More concerted international action is needed.

Throughout most of the world, urban transport planning has for decades been oriented predominantly to accommodating the increasing use of the private automobile, although there have been significant differences in emphasis. Automobile use will continue to grow in developing countries, but it is increasingly questionable whether the results of this growth will be either desirable or sustainable. The local externalities (such as pollution, congestion, and equity problems) are being more acutely felt and, in the long term, energy and global environmental problems (like the greenhouse effect) are beginning to weigh heavily. Improving such things as pollutant emissions and fuel efficiency can ease some of these problems; however, the automobile's large demand for space seems technically less flexible. The problem of space will become increasingly important; the value of urban space, more apparent. The results of this competition, fixed in long-lived infrastructure, will also influence the long-term possibilities for urban structure and the transport system.

A special long-term problem concerns greenhouse gas emissions. The possibility of global warming and its consequences is a growing international preoccupation. The problem has a planetary dimension, making it a key factor in international and, especially, North–South relations.

By far the largest anthropogenic source of greenhouse gases in the world is fossil fuels for energy (50–60 percent — USEPA

1989). Measures to limit fossil-fuel consumption (or, more accurately, fossil-fuel greenhouse gases) are being actively studied throughout the world. Energy use for transport is widely seen as the most difficult to limit. The global analyses are only beginning to consider the structural choices discussed in this book, such as more collective transport relative to private automobiles or land-use planning and its effect on trip demand. This reflects a long-standing bias in the energy sector: policy analysis has almost exclusively concentrated on changes in vehicle characteristics (such as kilometres per litre of fuel). We have argued that "structural" changes in urban transport can significantly affect energy consumption. They deserve much more attention than they have received. As well, many of the changes discussed are desirable whether or not greenhouse-gas emissions are ultimately a severe constraint. Such multiple objectives are attractive in a situation still characterized by basic uncertainties.

Developing countries will have their hands full with more immediate problems. This book has shown the seriousness of such problems in Brazil. However, their amelioration frequently involves a questioning of the automobile orientation, which has implicitly or explicitly dominated the evolution of urban infrastructure since the 1960s. This view does not deny increasing levels of automobile ownership; it seeks to limit and put a more accurate price on automobile use while improving the conditions of both pedestrian and collective transport. Pedestrians have suffered from the uninhibited invasion of urban space by the automobile, with significant socioeconomic costs to the low-income majority. The question is, however, more subtle than just a competition between automobile and collective transport. Various examples (such as Curitiba and Singapore) suggest that moving away from the traditional priority of the automobile to a new strategic posture benefits the large majority, including automobile users (especially when households are considered). The productivity of the urban space also improves, making this a win–win situation.

Thus, the long term and the short term begin to meet, as do international and local concerns. These interconnections deserve more attention both in developing countries and in the industrialized world. The North has a special responsibility. It dominates the evolution of technology and has incomparably greater financial and information capabilities. Most planning paradigms originate in the industrialized world. Trends in the North also heavily influence attitudes in the developing world, conditioning the adoption of innovations. However, in the final analysis, responsibility rests with the governments and elites of the developing world.

Meeting the challenges and opportunities described in this book will require both innovation and realism. In political circles, urban transport must be given the priority it deserves. After all, it is part of the daily struggle for the immense populations of the developing world.

Acronyms and Abbreviations

ANTP	National Public Transportation Association of Brazil
BNDES	National Bank for Social and Economic Development
CBTU	Brazilian Urban Rail Corporation
CO	carbon monoxide
CO_2	carbon dioxide
CODATU	Conference on the Development and Planning of Urban Transport in Developing Countries
EBTU	Brazilian Urban Transportation Agency
ECLAC	Economic Commission for Latin America and the Caribbean
EEC	European Economic Community
FDTU	Fund for Urban Transport Development
FINEP	Federal Finance Company for the Study of Programs and Projects
GDP	gross domestic product
GEIPOT	Brazilian Transport Planning Agency

HC	hydrocarbon
IDB	Inter-American Development Bank
IDRC	International Development Research Centre
IPT	intermediate public transport
LRT	light-rail transit
LRV	light-rail vehicle
NGO	nongovernmental organization
NO_x	nitrous oxides
OAS	Organization of American States
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
PAN	peroxyacetyl nitrate
RFFSA	Federal Railway Corporation
SC	traffic circulation subsystem
SITURB	Information System for Urban Management
SNTU	national system for urban transport
SO_2	sulfur dioxide
SO_x	sulfur oxides
STPP	bus–trolley–ferry subsystem
SV	urban roadway subsystem
TRRL	Transport Road Research Laboratory (UK)
UITP	International Union of Public Transport
UN	United Nations
USD	United States dollar
WHO	World Health Organization

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