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URBAN TRANSPORT POLICY AND THE ENVIRONMENT

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INTRODUCTION

Urban transport is enormously complex. It touches on all aspects of activity – economic, social and environmental. It is, therefore, subject to multifarious pressures. In the economic sphere, domestic vehicle manufacturers and public transport companies want a favourable environment for selling their products. In the social sphere, it is commonly believed appropriate to enforce low public transport fares in the interests of various disadvantaged groups (and sometimes even others). And environmentalists frequently see tightened emission standards as an essential means of improving urban air quality.

All of these appear to be laudable causes. But they interact in complex ways and are frequently not mutually consistent. For example, the attempt to increase public transport supply by partial liberalisation of entry in the bus sector in Delhi certainly increased supply but generated dangerous operating practices and adverse environmental impact; the environmental reaction of attempting to enforce rapid conversion of the bus fleet to compressed natural gas (CNG) has had adverse impact on the frequency and efficiency of public transport.

It is not the purpose of this paper to rake over the coals of these recent policy initiatives. Rather it is to ask why such crises occur and whether there is any key to avoiding them in the future. The thrust of the argument is to emphasise the importance of targeting the most cost-effective ways of controlling urban air pollution (World Bank 2001a); to recognise that there is not always a synergy between environmental and non-environmental objectives of sector policies; and to confront the trade-offs that have to be made. Some of the most popular areas of policy intervention are considered from this perspective, and a set of conceptual and institutional keys identified for improving policy formulation and implementation to reduce the impact of transport on urban air quality.

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SETTING ENVIRONMENTAL PRIORITIES

In order to target the most cost-effective ways of addressing urban air pollution, a sequence of questions must be addressed. Is outdoor air pollution important? If so, what are the most serious pollutants? Does transport contribute significantly to air pollution? What transport activities do most damage?

Significance of Transport in Urban Air Pollution

In the South Asian context, there are clearly some very important non-transport sources of urban air pollution – including extensive use of biomass in homes, garbage and leaf burning, use of diesel generators by commercial establishments, and fixed source industrial emissions. Measured ambient pollutant concentrations and epidemiological evidence suggest that the pollutant of concern in South Asia is fine particulate matter, shown in study after study to be associated with premature deaths and serious respiratory illnesses. Two of the major transport sources of particles in South Asian cities are heavy-duty diesel vehicles and two- and three-wheelers with two-stroke engines. In both cases, but particularly in the case of commercial vehicles, age and poor maintenance may concentrate the pollution impact even further. Reliable emissions inventories and source apportionment studies of respirable particulate matter (particles smaller than 10 microns, referred to as PM_{10}) are not available in South Asia. A handful of studies that have looked at PM_{10} report that transport accounts for about only 10 to 25 percent of total PM_{10} even in cities like Delhi and Mumbai (see, for example, Shah and Nagpal 1997). Studies in other countries have shown, however, that when emissions inventories of ultra-fine particles – the class of particles most damaging to public health – are examined, transport is a significant contributor, because particulate emissions from vehicles are typically in the sub-micron range (Airborne Particles Expert Group 1999). And because particles found in vehicular exhaust are small, numerous, and emitted near ground level where people live and work – resulting in high exposure – addressing transport particulate emissions is a high priority concern for many city governments.

Identifying Priorities within Transport

Whereas transport has been shown to be a significant contributor to urban air pollution, the next step is to identify the best ways to reduce the impact. There are three ways in which this may be attempted.

Reducing Vehicle Kilometres

Even for a constant level of person kilometres, vehicle kilometres can be reduced by increased average vehicle occupancy. For private car users this can

be sought by giving priority to high occupancy vehicles both on the roads and in parking, by developing incentives to ride-sharing and by administrative limitations (such as the "car-free-day" programmes in Mexico City and Bogotá). Increasing public transport share, particularly of the journey to work, reduces total vehicle kilometres, as well as brings down emissions per vehicle kilometre by enabling all vehicles to flow more freely. Vehicle kilometres travelled may thus be reduced by a combination of *traffic management and public transport policy*.

Using Less Fuel per Vehicle Kilometre

While those who have private cars are very difficult to persuade to use public transit, they are not insensitive to cost even in industrial countries. Increased fuel prices have discouraged less essential trips, reduced trip lengths and encouraged purchase of higher fuel economy vehicles. Vehicle taxes and annual licence fees that are based on fuel consumption or pollution characteristics could further be used to prevent overuse of polluting vehicles. The simplest and strongest instrument to affect fuel cost is *taxation*.

Generating Less Pollution per Unit of Fuel

Elimination of lead in gasoline is an important and effective step that all governments can take with relative ease and at low cost. In South Asia, Bangladesh and India have already banned the use of lead in gasoline totally. Beyond lead removal, which is primarily a fuel-focused policy, vehicles and fuels need to be treated as a system for emission abatement. *Regulations* (on emission levels and fuel and lubricant quality) and *fuel and vehicle technology* (which, in turn, is often driven by regulations) are the two principal instruments for reducing pollution per unit of fuel.

A preliminary consideration of the priorities for environmental action in urban transport has thus identified four main types of policy instrument: transit (World Bank 2001b), traffic management (World Bank 2001c), taxation (World Bank 2001d), and regulations and technology. In all cases, with the exception of regulations and technology (although to a lesser extent), the major policy concerns of the responsible agents is not environment. Traffic management units are primarily concerned with efficient traffic movement, public transport operators with providing service at lowest cost, and tax authorities with revenue generation. Nor are these four types of policy instrument independent. Stringent environmental regulations or high fuel taxes will have an immediate effect on public transport operators, and low taxes on dirty fuels will make the switch to cleaner fuels more difficult. Against this background, the crucial question is how these multiple objectives can best be reconciled. Each of the policy areas is, therefore, considered in turn.

TRANSIT POLICIES

Public transport affects urban air pollution both *directly*, through emissions of public transport vehicles, and *indirectly* by providing an alternative to a much larger number of private cars. Policy for public transport must, therefore, aim to minimise its direct air pollution impacts by making it clean and maximise its indirect benefits by making it sustainable and attractive.

In practice, transport users' decisions are primarily motivated by the desire to maximise their own welfare, and are, therefore, sensitive to the time, money and inconvenience costs of transport alternatives. Similarly, transport supply agencies, whether publicly or privately owned, must plan their activities within the constraints of limited resources. If governments try to impose high environmental standards for traditional, regulated, formal sector buses without taking into account the economic costs of those standards, they may make the services too costly for traditional operators to operate at existing fares, yet too costly for many poor users to use at fare levels necessary for financial sustainability. Simply mandating clean technologies is clearly not sufficient. Transit policy must, therefore, be both environmentally sensitive and consistent with public and private affordability. If public transport is not efficient, it is unlikely to contribute effectively to the reduction of urban air pollution.

Making Public Transport Efficient

Traffic Management for Public Transport

Buses typically move at only about two-thirds the speed of cars because of delays in stopping and re-entering the traffic flow. Given the limited density of bus networks, they also involve longer terminal walking times than the private car, with the overall result that bus journeys usually take at least twice as long as equivalent car journeys, accentuating the advantage of the private car and thereby encouraging its use. Although auto-rickshaws offer point-to-point service, they also add to congestion. Mixing public transport vehicles, whether buses or auto-rickshaws, with other vehicle categories, reduces the average speed of traffic compared with what could be achieved if they were segregated. Public transport priorities – dedicated lanes or totally segregated busways – are thus essential to counteract these disadvantages.

The simplest priorities are priority lanes, which exist for buses in several Asian cities such as Manila, Kuala Lumpur and Bangkok. But they have major limitations. They make roadside access to premises more difficult. When they are

operated in the same direction as the main traffic flow, they are particularly susceptible to invasion by other traffic (as bus lanes in Dhaka suffer from cycle-rickshaws), and hence need strong enforcement which they rarely receive. Operation against the direction of flow is more self-enforcing, but can increase pedestrian accidents.

Totally segregated busways using central lanes, along with protected pedestrian crossings at stations, reduce the problems of accidents and access to roadside premises (Halcrow Fox in association with Traffic and Transport Consultants, 2000). And by developing busways as trunk links in a physically and commercially integrated network, the travel time and cost of public transport can be made more competitive with the private car. Although schemes that dedicate existing road space to public transport may be opposed by car users, experience in Curitiba and Bogotá has demonstrated that, with good traffic management to minimise car delays, the approach can be politically popular besides giving environmental and efficiency benefits.

Internal Efficiency

The internal efficiency of formal bus operating companies can often be improved in many ways, including more efficient design of route networks, better cost control and better control of performance on the road. Some of these involve relatively modern technology (such as automatic vehicle location) which is only likely to be employed by large, possibly area monopoly, companies. But this has to be balanced against the losses of efficiency inherent in monopoly operation. While there are certainly some scale economies, both in system planning and in management information systems, there are methods, discussed below, of combining efficient system management with strong incentives to operating efficiency.

Competition

Most public sector operations of public transport are politically controlled and inefficient. Yet allowing small informal sector operators to enter the market to supplement or compete with the existing operator has often been associated with excessive supply (as in Santiago de Chile), use of old polluting vehicles (as in Lima) or dangerous operating practices (as in Delhi). Unregulated competition can clearly be dangerous and inefficient.

But this is not inevitable. Several countries, including Denmark, Sweden, and the United Kingdom, have awarded monopoly franchises of limited duration and scope on the basis of a competitively bid tender. This “competition for the

market" allows the authorities to control the main policy sensitive variables, such as fares and service structures, while mobilising competition to get the desired level of service produced at the lowest possible cost. It has shown reductions in cost per bus kilometre between 20 percent and 40 percent and is now the preferred form of competition in large cities (Halcrow Fox 2000).

Effective competition, either in the market or for the market, is dependent on the commercialisation or complete privatisation of the incumbent parastatal operator, as private operators are understandably reluctant to compete with an agency that can rely on deficit financing by its owner to ensure that it retains its position in the market. The cities that have most satisfactorily reconciled efficient and clean operations with low budget burden are those that have successfully addressed the need to develop effective competition.

Making Public Transport Clean

Choice of Technology

Electric railways are without doubt the least locally polluting form of mass transit. But recent new underground railways have cost between $50 and $100 million per kilometre, which is beyond the resources of most developing country cities. Where existing rail tracks exist, surface rail or light rail transit systems can be constructed more cheaply, but usually have lower capacity (Halcrow Fox in association with Traffic and Transport Consultants 2000).

However, busway systems can yield almost equivalent mobility benefits at about 10 percent of the capital cost for traffic volumes of up to 20,000 peak passengers per lane per hour in the peak direction. By combining busways with cleaner vehicle technology (such as electric trolley or CNG buses), large environmental benefits can be achieved without conflict with the system's financial sustainability. For example, operators of the Bogotá Transmilenio system were required to buy new high quality vehicles to compete for franchises, but claim that the increased efficiency of movement has allowed them to vastly improve service and to increase their profitability without any increase in fares (Hidalgo 2001). There may be valuable lessons here for South Asian cities.

Role of Public Transport Subsidies

The imposition of stringent emission and other vehicle standards, without simultaneously introducing bus priority measures to improve efficiency, tends to increase capital costs without offering any compensating reduction in operating

costs. This raises the problem of reconciling these standards with financial sustainability of service.

In practice, many industrial country cities subsidise public transport fares. While this may be desirable on distributional grounds, it is not considered effective as an environmental policy. First, there is strong evidence that up to half of any subsidy "leaks" to benefit employees in the industry rather than passengers. Second, because most car owners' use of their vehicles is not sensitive to public transport fare levels – cross-elasticity being of the order of 0.1 – the impact on modal split (shifting travellers from private to public transport) is small. Third, since the modal shift is small and the subsidy is paid to all, such use of funds is not a cost-effective way to reduce environmental impact.

Given the poor public image of public transport, subsidies to improve public transport quality might be somewhat more effective in affecting modal choice, particularly in countries where car ownership is restricted to the relatively rich. But even in that dimension, regulatory reform to encourage the use of express or air-conditioned buses to attract higher income patronage is likely to be even more effective than giving subsidies, as experience has shown in cities of varying average income levels, such as Dhaka, Bangkok, Buenos Aires and Seoul.

The most direct approach would be to subsidise cleaner vehicles and fuels. However, the need to ensure financial sustainability still applies. The cleaner vehicles must be capable of being operated reliably and economically. This may require not only an initial capital subsidy but also substantial investment in training and maintenance facilities for the new technology, as well as fiscal effort to keep the price of the cleaner fuel attractive (for example, it is estimated that the price of CNG would need to be about half that of diesel to make CNG operation financially competitive). If that is the case, then it is necessary to ask what alternative policies (for example, investment in busways) might have been introduced at the same cost to the government as the fuel duty loss.

Regulating Competitive Operations

It is frequently argued that competition is the enemy of environmental quality. As mentioned above, deregulated bus sectors contributed to air pollution in Lima, Peru and Santiago de Chile. But that need not necessarily be the case. The replacement of competition "in the market" by competition "for the market" in Santiago allowed the authorities to get the economic benefits of competition without environmental damage by the simple device of setting minimal pollutant emission standards as a condition for holding any franchise, as well as by using

environmental quality above the minimum as one of the criteria on which competitively tendered franchises were awarded.

But for this approach to be effective, it is critical that the franchising authority is technically and administratively able to design and award franchises with sensible environmental conditions and is also able to monitor performance – including vehicle emissions – effectively. There is now a wealth of experience in doing this, both in industrial countries (for example, in cities like Copenhagen and London) and developing countries (in such cities as Santiago de Chile and Bogotá).

Conclusions on Public Transport Policy

Some important conclusions can be drawn from worldwide experience in addressing the environmental implications of urban public road passenger transport.

- Imposing high vehicular emission standards without paying attention to the financial sustainability of public transport operations can undermine their viability with counterproductive effects.
- Improving the efficiency of public transport operations is critical to sustainable environmental improvement.
- Priority in the use of road infrastructure, and particularly the creation of segregated busway systems, is the most effective way of sustaining environmental standards.
- Competition for franchises significantly reduces costs and can be designed to support environmental improvement.

TRAFFIC MANAGEMENT

Traffic management is normally concerned with improving the flow of traffic on the roads. It comprises both "supply side" measures – to improve speeds of existing traffic volumes by better system management – and "demand side" measures – to improve speeds by reducing traffic volumes. Improved traffic flow may also reduce air pollution. Traffic management may require some physical measures, usually referred to as traffic engineering. But since traffic management measures tend to have a short gestation period and low capital intensity, they have the potential to bring about reduction in air pollution in a relatively short term and to be affordable even by poor countries.

The adverse impact of local air pollution is highly location-specific. It is the greatest where most people are exposed. A high level of exposure is the product

of a series of decisions or circumstances that determine the number of trips made, their distribution over space and time, the choice of routes and the driving characteristics of drivers. From an environmental point of view, therefore, the critical features to be addressed by traffic management are: (i) emission rates, and (ii) the location of major traffic flows, particularly congested flows.

Reducing Emission Rates

For any given vehicle, emission levels of various components vary according to the distance travelled and the driving pattern. Most emissions vary broadly with fuel consumption, with the optimum speed on this account being in the range of 60 to 100 km per hour. The most important influence on emission levels for a given vehicle is the driving cycle, with both fuel consumption and pollutant emissions many times higher per vehicle km during acceleration and deceleration than during cruise. Moreover, as catalytic converters depend on heat for their effectiveness, they are least effective during cold start, further accentuating the influence of the driving cycle. Although increasing road capacity to allow driving at free flow speed will generate extra traffic, this generation is unlikely to be of such a magnitude as to outweigh the benefit of reducing variability in driving speed.

Managing Traffic to Reduce Congestion

Traffic mix is a dominant determinant of emission levels because of its impact on variability of traffic speed. This is a serious problem where motorised and non-motorised traffic share road space. Measures to segregate these types of traffic on main thoroughfares is thus as important for environment as it is for safety reasons. In contrast, in residential areas with lower traffic volumes it may be more effective as well as equitable to use traffic calming measures (see below) to harmonise the speeds of different traffic categories at a safe level.

Traffic signal control systems – they are the most common traffic management instruments to achieve traffic flow and safety objectives. However, because they secure their advantages by bringing traffic flows to a stop, some have argued that they are a major cause of air pollution and should be replaced by roundabouts, flyovers and one-way streets. Other commentators have challenged the validity of this claim, arguing that the pollution impacts of traffic signals are highly situation-specific. However, linking of uncoordinated signals to create "green waves" can reduce travel times and emissions by 10 percent, and allowing "nearside turn on red" (left turn where vehicles are driven on the left side of the road) gives another 1.5 percent improvement. Cycle lengths that minimise pollutant emissions

are 50 percent longer than those that minimise delays, and in heavy traffic conditions these extended cycle times can reduce emissions by up to 3 percent. The most efficient are Area Traffic Control (ATC) systems, which link whole networks. These systems can be made traffic responsive on a real time basis, but are more expensive in terms of capital equipment (partly because of the need for more traffic sensing equipment).

Bus priority systems – They change the relative travel times by bus and car and, particularly if supported by parking restraints, encourage people to use the more space-efficient public transport modes. Overall congestion levels may thus be reduced. More importantly, they increase the average and reduce the variability of bus speed. A range of priority measures was shown to reduce bus exhaust emissions in London by between 7 and 60 percent (Table 1). The most effective of the measures, the segregated busway, has subsequently been developed as a mass transit system in Curitiba and Bogotá.

Table 1 : Effect of priority systems on bus exhaust emissions in London

Measure	Proportion of buses affected	Exhaust emission reduction
Peak period bus lane	5%	20%
Contra-flow lane, all day	2%	35%
Signal pre-emption	20%	12%
Segregated bus street	2%	60%
Priority turns	5%	7%

Traffic calming – This is increasingly practiced in industrial country cities primarily for safety reasons. The idea is to reduce traffic to a steady speed consistent with safe operation in the specific location. For main roads, the important instruments are rumble strips or visuals to reduce traffic speeds on approach to junctions. For local roads, a wider range of devices, such as speed humps in the road, raised junction sections, chicanes, and road narrowing can be used to slow traffic to a common speed.

Incident detection – This coupled with prompt appropriate response can reduce congestion significantly. Much congestion in large cities can be attributed to the dislocation effects of what may be relatively trivial accidents. The ability to identify incidents, remove obstructions and redirect traffic can thus be effectively used to improve traffic flow.

Parking Policies

Parking policies have impacts both on the effective supply of road space and the demand for it. In many developing countries, both the highways and the walkways are encumbered with parked vehicles that congest traffic and increase

air pollution. Strong regulation to limit on-street parking to locations where it has no effect on traffic flow is thus likely to be the appropriate "supply side" response. This is often accompanied by the imposition of minimum parking provision requirements in all new developments to create enough off-street parking space to cater for all vehicles wishing to access the development. As long as the costs of parking space are recovered through property rents, parking users can be said to be paying directly or indirectly for the space allocated to parking.

Unfortunately, road space and parking space are jointly demanded so that the provision of off-street parking space may attract new traffic, offsetting the gains from getting parking off the streets. If road space is provided below cost, then jointly demanded good (namely, parking) should be charged more than its full costs in order to avoid excessive vehicle use of roads. For that reason, many industrial country cities use parking pricing and availability as a demand restraint measure. The amount of parking in any area is limited to the maximum level considered necessary to support an "optimal" amount of road use. Pricing and parking supply regulation is used to implement this strategy, which also implies specification of maximum (rather than minimum) parking provisions for new developments.

Restraints on Vehicle Use

Restraints on vehicle use have been used in several cities, both in industrial and developing countries, for congestion and environmental reasons. The most popular restraint measures have been schemes which limit use of vehicles on specific days according to their registration plate number. These have been introduced in many cities including Athens, Bogotá, Lagos, Manila, Mexico City, Santiago, São Paulo and Seoul. There are obvious risks to the "odds and evens" policy (that is, vehicles with registration numbers ending in odd digits cannot drive on certain days, and those ending in even digits cannot drive on other days) and its variants. They may encourage an increase in the number of vehicles owned, and induce more trips by permitted vehicles than would otherwise have been made. In particular, they may encourage the retention in operation of old, high polluting vehicles that would otherwise have been scrapped. But these measures have worked in the short term (Bogotá reports 20 percent increase in average travel speeds). Above all, they have achieved acceptance by the public as a demonstration of commitment by the government to reduce congestion and the related air pollution, and have proved less difficult to enforce than one might have expected. Especially, if they are well designed to discourage peak use and are coupled with public transport improvements, as in Bogotá, they can at the very least give a "breathing space" to develop even more effective policies.

Protecting Sensitive Locations

Ring roads are not a measure of traffic management *per se*, but are often advocated as the basis on which it is possible to introduce environmental traffic management. The basic argument is that by providing adequate capacity to navigate across the town, it will be possible to keep through-traffic out of environmentally sensitive areas. In some small or medium cities that have followed policies of restricting vehicle access to central areas, this has worked well. But in many it has not, for two main reasons. First, improved radial or circumferential trunk road performance increases the number and length of trips made to the extent that total traffic and total emissions actually increase (Detailed evidence of the traffic generating effects of urban ring roads has been assembled in the analysis of the M25 motorway around London). Second, the supporting traffic management necessary to take advantage of the "breathing space" is not actually implemented. This has been a specific problem in Chinese cities, such as Guangzhou and Shanghai.

Other restraints on vehicle movements are usually targeted at particular sensitive areas. Spatially, the most common restrictions relate to access to central business districts (CBDs). Pedestrianisation of city centres began to gain popularity in Europe about 40 years ago, and is now a feature of most city centre plans. The "cell system" introduced in Gothenberg, and replicated in some British towns, such as Oxford, uses physical restrictions on cross-centre movements to keep through-traffic out of the CBD. Some schemes also discriminate by vehicle type. The bus franchising system in Santiago limits the number of buses licensed to operate in the CBD. Some European cities specify particular routes for heavy goods vehicles, or, in certain cases, completely ban their access to central premises during the daytime. The difficulty in the case of many developing countries is that important commercial establishments, such as ports and major markets, are located in or close to downtown areas.

Physical restraint measures have hitherto proved more acceptable than direct charges for road use, both in industrial and developing countries. However, their effectiveness appears to have been exhausted, and even industrial countries, such as the United Kingdom and the Netherlands, are now planning the introduction of direct charges. Singapore – which has for many years taxed vehicle ownership very heavily – is now moving towards charges for vehicle use rather than restrictions on vehicle ownership. In the few cases in industrial countries where direct cordon or area congestion prices are charged, part or all of the revenues have been earmarked for public transport improvements. For South Asian cities, which lack resources to finance urban transport, the introduction of direct charges

might thus be expected to have a double attractiveness as a source of finance and also as an instrument of restraint.

One aspect of restraint is particularly important. Both theoretical research and practical experience indicate that a combination of car restraint and public transport improvement appears to work better than either in isolation, at least in their effect on travel to city centres. A coherent policy is, therefore, likely to include a combination of these measures.

Limitations of Traffic Management

Traffic management in industrial countries has been estimated to reduce emissions by 2-5 percent overall, but by much greater proportions in specific corridors or areas. Because of the worse initial situation, the potential in some developing country cities should be much greater. But the danger that improved traffic management may induce more or longer trips has already been noted. Thus, traffic management is likely to realise its potential of reducing air pollution only if it is supported by measures to restrain new traffic generation.

Good traffic management requires effective planning, implementation and enforcement skills which tend to be in short supply in developing countries. Moreover, it is not a guaranteed, one-shot cure for traffic congestion. It needs constant adjustment and enforcement to be effective. The traffic management systems implemented in Mumbai and Manila in the 1980s are now largely out of commission. Here, it may be pointed out that the commitment of the police to maintain effective enforcement of measures is particularly critical in this regard.

Conclusions on Traffic Management

Worldwide experience points to some important conclusions on the environmental impact of traffic management policies in developing countries:

- Because emissions increase disproportionately as traffic gets more congested, the main emphasis should be on traffic system management to improve flow of traffic.
- Because freer flow induces more traffic, environmental benefits will be sustained only if traffic management is accompanied by demand management to limit new traffic generation.
- Traffic management is relatively cheap and quick acting, but requires a high level of political, institutional and human resource commitment to be effective.

- Many developing country cities have inadequate design and implementation skills needed for traffic management.
- Involvement of the police authorities is critical to the successful implementation of traffic management measures.

TRANSPORT FUEL TAXATION POLICIES

Fuel taxation is important for generating government revenue, particularly in low-income countries with poorly developed direct taxation systems. In these countries, taxes on hydrocarbons can account for as much as one-fifth of all tax revenue (Bacon 2001). Fuel taxes are also a reliable revenue source because fuel has a low overall elasticity of demand, and the tax can be collected cheaply.

Taxes on transport fuels typically seek to satisfy multiple objectives. They are usually the responsibility of central government treasuries and are primarily aimed at raising revenue for general (non-transport) expenditure purposes. Occasionally, they may be earmarked for financing road provision and maintenance. As part of central government policy, their redistributive characteristics might also be of great importance. Other objectives of more local concern – such as efficiently allocating resources to and within the transport sector, bringing down congestion, and reducing the environmental externalities of road transport – are often incidental rather than central. It is clearly not possible to achieve so many objectives simultaneously through fuel tax policies alone. The challenge of satisfying these multiple objectives is particularly difficult in low-income countries, where fewer policy instruments are available for the purpose. So, compromises have to be made between the effects of fuel taxation policies on government revenue generation, income distribution, efficient use of roads, and environmental pollution.

Guidance from General Tax Theory

Some useful guidance for evaluating these compromises can be obtained from the general principles of optimal commodity tax theory, which focuses on minimising the loss of welfare to consumers in raising a given sum of money for the government through commodity taxation (Newbery and Stern 1987).

A fundamental principle is that taxes should, as a rule, be levied on final consumption goods rather than on intermediate goods, although if some consumption goods are untaxed, it may be efficient to levy taxes on the intermediate goods (such as diesel) that are inputs to the production of untaxed consumption goods. A complementary principle is the well-known "Ramsey pricing" rule that tax rates on consumer goods should be so set as to be inversely proportional to the goods'

own-price elasticities of demand, in order to minimise the overall loss of welfare. However, application of this principle in its pure form is likely to be distributionally perverse, since the demand for most basic necessities (such as staple foods) is inelastic, while that for non-essential goods is generally more elastic. Hence, if the basic distribution of income is viewed as inequitable, indirect taxes may be structured to have a greater impact on the goods that make up a relatively larger share of the budgets of higher-income households than on the goods that are more important for low-income households.

As far as externalities are concerned, the generally accepted philosophy is that tax rates on goods that have external costs should be adjusted upward to reduce their consumption to a social optimum (Sandmo 1975), and any additional revenue collected be used to adjust general tax rates downward. This is much more preferable to attempting to control the consumption of the good by adjusting tax rates for its complements or substitutes independent of their own polluting characteristics.

Setting Efficient Taxes on Transport Fuels

Now, let us apply these principles to the taxation of automotive fuels. In order to avoid economic distortions, the first of the general principles of taxation discussed above suggests that fuel taxation should be concentrated on gasoline, which is used predominantly by private cars as a consumption good, rather than on diesel, which is used in large quantities by freight and public transport vehicles as a producer good. However, the realities that not all consumption goods (for which diesel is an input) are taxed and that producer goods are associated with transport- and environment-related externalities argue against zero taxes on diesel or subsidies to it.

The principle of equitable allocation of taxes among transport fuels seems to complement that. Given the concentration of car ownership and use in the upper-income groups and weak systems obtaining for direct taxation, a high incidence of taxation on gasoline makes for a very progressive tax. By the same token, where the impact of taxation on diesel has been studied, it has been found to be mildly regressive – that is, the total expenditures of poor households rise more in percentage terms than those of the rich when the price of diesel is increased.

The main problem with differential fuel taxation concerns the effects of inter-fuel substitution. In the long run, diesel, gasoline, compressed natural gas (CNG), and automotive liquefied petroleum gas (LPG) are all technologically possible substitutes. The common combination of a high gasoline tax and a low

diesel tax may encourage vehicle owners to switch from gasoline to environmentally more damaging diesel when they buy or replace light-duty vehicles. To avoid this anomaly, a low tax on diesel fuel might be supplemented by a high tax on light-duty diesel vehicles, particularly those used primarily in intra-city transport. Moreover, imposing very different tax rates on close substitutes, and subsidising certain fuels used by poor households, invites diversion of the low-priced fuel to other sectors and creates an incentive for fuel adulteration. For example, the diversion of rationed, low-priced kerosene to transport uses (as an adulterant in diesel and gasoline) reduces the amount of kerosene available for the poor, who may then be forced to turn to biomass – a major source of indoor air pollution and health damage – for cooking. Because of the significant impact of higher taxation on non-automotive uses of diesel – in rail transport, agriculture and industry, for example – it may be sensible to give rebates on the higher diesel tax to industrial and agricultural users of diesel.

Not all efficiency arguments militate in the direction of high differentiation between gasoline and diesel tax rates. In principle, users ought to pay the long-run marginal costs of road use, including the costs of capital. Many developing countries have poor-quality road systems because of under-funding of maintenance. A fuel tax, or surcharges on the fuel tax that are designated specifically as road user charges, may be the most obvious and acceptable proxy for direct charging, especially when the revenues are transferred directly to a user-managed road fund (Gwilliam and Shalizi 1999). As wear and tear is caused largely by heavy vehicles that are fuelled primarily by diesel, diesel tax might be an appropriate proxy for direct road maintenance charges. Diesel tax, however, has serious shortcomings in this respect. It does not accurately reflect the road deterioration caused by different vehicle categories, and provides inefficient signals on vehicle size and weight. Even within the automotive diesel fleet, a tax on diesel needs to be supplemented by some charge on vehicle axle loadings, preferably levied on the basis of distance travelled.

Structuring Transport Taxation for Environmental Purposes

It is against this rather complicated background that one has to consider the potential of transport fuel taxation as an environmental instrument. One way of assessing this is to look at its efficacy in respect of the three critical dimensions of reducing vehicle kilometres; reducing fuel consumption per kilometre; and reducing emissions per unit of fuel consumed.

In respect of *vehicle kilometres travelled*, high taxation on transport fuels will obviously militate for reduction in trip numbers and trip lengths, as well as

favouring public over private transport modes. Although the mode shift effects themselves may be small, because of the range of different dimensions of adjustment the overall price elasticity of demand for gasoline may be between -0.5 and -0.8, though that for diesel is likely to be considerably lower

In respect of *fuel per kilometre*, a high tax on fuel will obviously encourage the use of more fuel-efficient vehicles. But, as we have seen above, the conditions under which vehicles run, particularly the level of congestion, are the most critical factor. Unfortunately, fuel tax is not efficient as a charge for congestion because variations in congestion over time and space are only weakly reflected in variations in fuel consumption.

In respect of reducing *pollution per unit of fuel*, emissions depend not only on fuel choice but also on vehicle technology, vehicle maintenance, vehicle driving pattern, and location and time of emissions. The high degree of differentiation of environmental damages from the same fuels across various users, technologies and locations also limits the effectiveness of fuel taxes for controlling air pollution (Lvovsky and Hughes 1999).

Conclusions on Transport Fuel Taxation

In the absence of any other direct charges for road use, pump prices of transport fuel should cover the resource cost of the fuel, the costs of road use (both road damage and occupation of road space), and the environmental costs associated with the fuel use if they are not otherwise charged for (note that some might be recouped through differential vehicle taxation).Although fuel taxes can strongly affect fuel consumption patterns, they have other significant welfare impacts, including spillover effects. Some critical guidelines for fuel taxing follow from this:

- More precisely targeted alternatives to fuel taxes should be considered, wherever possible, in view of the limitations of fuel taxes in achieving multiple objectives.
- Environmental externalities should be corrected by taxing polluting goods, not by subsidising non-polluting alternatives.
- There is a strong case for setting the gasoline tax rate above the general tax rate on commodities for the following reasons: rich households spend a higher proportion of their budgets on gasoline than do poor households; gasoline vehicles give rise to a number of externalities; and emissions from gasoline engines may affect poor households more than rich households.

- There is also a strong case for a diesel tax. Although some diesel is used as an intermediate good, the taxation of even this segment of the market is justified if it is the principal way of charging heavy vehicles for wear and tear on the road and if the final goods (for which diesel is an input) are not necessarily taxed.
- Given diesel's high long-run substitutability for gasoline in light-duty vehicles and its strongly negative externalities in urban areas, taxation policies for petroleum fuels should minimise the possibilities for socially undesirable inter-fuel substitution, such as the dieselisation of light-duty vehicles.

REGULATIONS AND TECHNOLOGY

No country has learnt through experience that voluntary programmes, incentive schemes and transport and fiscal policies alone can bring vehicular emissions under control. Regulations specifying limits on emission levels and minimal fuel quality requirements have been one of the key instruments for controlling transport-related air pollution. North America, Europe and Japan have led the world in introducing stringent regulations requiring state-of-the-art vehicle and fuel technology. The question for India and other countries in South Asia is *how* to phase in these standards: which standards should be implemented immediately, which in the medium term, and which should be set aside for long-term planning. An example of a standard that should be implemented as soon as possible throughout South Asia is the one aimed at gasoline lead phase-out. On the other hand, an example of standards that are likely to be introduced with a long time gap is the U.S. Tier 2 emission standards or their equivalent, requiring not only advanced vehicle technology but also ultra-low sulphur gasoline and diesel.

Setting standards involves a number of considerations. Tightening fuel specifications has an immediate impact on the domestic refining industry, while tightening new vehicle emission standards affects domestic vehicle manufacturers. In cases where new emission standards require tighter fuel specifications, such standards have their impact on domestic refiners as well. What kind of standards to set is another important question. Setting emission standards is less restrictive than dictating specific technologies. Examples of technology-specific regulations include a ban on two-stroke engine vehicles, mandating catalytic converters, and a ban on diesel in favour of CNG for certain vehicle types (as in Delhi).

But setting standards is only half the story. Monitoring and enforcement is crucial if these standards are to have a measurable impact on air quality. Enforcing

emission standards for in-use vehicles has been found to be particularly difficult worldwide, and there is no satisfactory inspection and maintenance (I/M) system in operation in South Asia today. The crucial questions for policy makers, therefore, are: what regulations to set when, and how to enforce them.

How to Set Regulations

The regulations introduced must have a reasonable chance of compliance, should be cost-effective, and should avoid imposing hardships on the poor disproportionately, unless safety net measures can be effectively implemented to offset these adverse effects. Whenever possible, suppliers of fuels and vehicles should be given flexibility to seek the lowest-cost options for meeting the specified emission targets. The diesel certification process in California is an example: it allows refiners to come up with much cheaper alternative diesel formulations to the "reference" diesel (set by the state government) meeting the same emission levels, thereby ultimately saving consumers' money. This argues against dictating technology.

However, if there is virtually no chance of a high degree of compliance, the government may feel compelled to introduce technology-specific regulations. Another reason could be when there is a clear and marked difference in emission levels between two technologies, such as between conventional diesel and CNG for particulate emissions. The Government of Delhi and the South Coast Air Quality Management District in California are two local governments that have banned diesel in favour of CNG for buses. There is also a considerable overlap between emission-based and technology-based measures. Emission standards can always be made so stringent as to require certain technologies (such as catalytic converters) and rule out others (such as two-stroke engine technology). The government of Delhi could have effectively mandated CNG in buses by setting extremely tight particulate emission standards for all existing buses, although monitoring by measuring mass emissions would have been too costly and impractical.

In setting standards, the cost of compliance and the probability of compliance are the two key questions. Mandating Euro III (currently in force in the European Union) in South Asia today would not make much sense because of the costs involved in upgrading refineries and manufacturing Euro III compliant vehicles. Further, if automotive fuels are routinely adulterated by kerosene, the emission-reduction effectiveness of mandating such vehicles will certainly be compromised. Another consideration is that supporting infrastructure (to enable the standards or regulations to be met effectively) needs to be in place or else there should be a concrete and realistic plan to set up such infrastructure in time. Two examples

are : (i) making unleaded gasoline available throughout the country before mandating catalytic converters, and (ii) establishing sufficient refuelling capacity before or at the same time as mandating a large-scale conversion to CNG.

Standards that are almost sure to result in high rates of non-compliance are bound to lead to evasion, corruption, "false passes" and the public perception of environmental regulations as fundamentally flawed. It is, therefore, better to set standards targeting a failure rate of about 20 percent, even if that meant setting quite lax standards, and tighten these standards gradually over time, than to introduce tough standards in the name of strong commitment to environmental protection. This principle applies especially to emission standards for in-use vehicles.

Another consideration in deciding where to pitch standards is the distribution of polluters in the vehicle fleet. A study in the United States found that poorly maintained vehicles, which represented 20 percent of all vehicles on the road, contributed about 80 percent of total vehicular emissions (Auto/Oil Air Quality Improvement Research Program 1997). Although similar studies have not been conducted in developing countries, it seems reasonable to suggest that the first priority in controlling transport-related air pollution is to identify, and repair or scrap gross polluters rather than tighten standards for all vehicles.

Lastly, it goes without saying that whatever standards are set should be technically consistent. Mandating oxidation catalysts in buses when diesel available in the market contains 0.7 percent sulphur, or mandating catalytic converters when half the cities in the country do not have a reliable supply of unleaded gasoline, would not only be ineffectual, but, in the first case, would even increase particulate emissions by facilitating the oxidation of sulphur to sulphate.

How to Enforce Regulations

Fuel quality at the refinery gate and emission standards for new vehicles are relatively easy to monitor and enforce, because only a small number of suppliers are involved. Much more difficult is monitoring and enforcing of standards at the retail level for fuel quality (Kojima and Bacon 2001a), and checking of individual vehicles on the road for emission levels.

I/M programmes, if properly operated and corruption free, can mitigate transport pollution and stimulate demand for vehicle repair and maintenance services, especially when they are coupled with standards for in-use vehicles that are made increasingly stringent over time. In South Asia, mandatory inspection as frequently as every three months is required on the books following the "test-every-vehicle"

approach. Although stringent on paper, these I/M programmes are regarded as ineffective for a number of reasons: false passes and fails are common; standards set as well as test procedures are not appropriate for identifying gross polluters; and, in some cases, vehicles do not even have to report to test centres in order to "pass", because test fee collection has become the focus of the programme rather than the cleaning up of vehicles.

Given limited resources, it may be well worth considering targeted I/M programmes that are mandatory only for commercial vehicles above a certain age at a handful of test-only centres equipped with capability for performing loaded dynamometer tests. The rationale is that since high usage polluting vehicles contribute disproportionately to air pollution, limited resources should be concentrated on tackling these vehicles. Until a data base is developed, it is not possible to identify high usage vehicles *a priori*, but vehicle usage may be used as a proxy, and hence the selection of commercial vehicles. Similarly, short of testing every vehicle on the road, vehicle age is probably the most reasonable proxy for pollution characteristics of the vehicles.

In the design of such targeted I/M programmes, there are valuable lessons from other countries on how to minimise corruption among testers and prevent owners of grossly polluting vehicles from using temporary "tuning" just to pass without proper vehicle repair (Kojima and Bacon 2001b). For example, loaded dynamometer tests make it more difficult to "tune" failing vehicles to pass, and the data collected are better suited to identify gross polluters, than in idle or snap acceleration tests.

Once there is a reasonable programme in place for identifying gross polluters, the next question is whether they should be repaired or scrapped. If the cost of repairing the vehicle to reduce emissions to a reasonably low level exceeds the market value of the vehicle, then the vehicle should be scrapped. In the case of repairing, rather than simply repairing to the original vehicle specifications, retrofitting with more recent technology engines and parts may be an effective strategy. Such retrofitting can be mandatory or driven by tighter emission standards. An example is the Urban Bus Retrofit/Rebuild Programme in the United States which targets buses in major cities for retrofitting with a combination of modern engines and exhaust treatment systems (certified to reduce particulate emissions) at the time of engine rebuild.

As for those vehicles that are suitable for retirement, scrappage schemes can be without replacement (cash for scrappage), or with incentives to replace with new, or less polluting, vehicles (cash for replacement). Scrappage with

replacement schemes are most appropriate for public transport vehicles, especially in the context of service franchising. Cash for scrappage may be effective for private cars, but only if carried out on a relatively small scale. In both cases, scrappage schemes will be successful only if introduced in the context of a strong enforcement of operational emission standards.

Conclusions on Regulations and Technology

- Set enforceable standards and requirements and tighten them over time, rather than designing stringent regulations with poor enforcement.
- Ensure that technical standards are consistent (as between fuel quality and vehicular emission standards).
- Consider the distributional and welfare impacts of environmental regulations through consensus building and public consultation mechanisms.
- Consider targeted measures concentrating on largest contributors to air pollution.

ENVIRONMENTAL STRATEGY IMPLICATIONS

In conclusion, let us return to our initial question as to how major environmental policy crises can best be avoided. There appear to be both conceptual and institutional keys to this.

Conceptually, policy interventions to reduce the impact of the transport sector on the urban environment should have the following characteristics:

- *Inclusive motivation.* Air quality is not the only concern of urban transport policy. Interventions to improve it may have some adverse economic and social impacts which need to be taken into account in policy design.
- *Comprehensiveness.* Urban transport involves multiple actors supplying infrastructure, fuels, vehicles and services. Policy interventions must be consistent across these dimensions. For example, mandating the comprehensive use of a fuel for which no adequate distribution network exists will inevitably impose some very high short-term costs and inconveniences.
- *Careful prioritisation*. Mandating best available new technology is seldom cost-effective in developing country cities with a large number

of poorly maintained vehicles. Upgrading maintenance practices and replacing worst engines should be considered first before moving on to a better technology.

- *Technical coherence.* Fuel quality and vehicle technology should be consistent. For example, if fuel adulteration (which could lead to rapid catalyst deactivation) is known to be widespread, then mandating the instalment of sophisticated exhaust treatment devices would not make sense.
- *Practicability*. Most actors involved in urban transport are motivated by concern for their personal welfare. Unless policy interventions are able to mobilise that motivation through the creation of a set of compatible objectives, they will either fail to be effective or will give rise to strong social resistance.

Institutionally, the key is the existence of administrative structures and processes which are capable of foreseeing environmental issues as they arise, designing appropriate strategies to address them, and implementing the necessary measures effectively. The following characteristics seem to be most critical.

- *An integrated urban transport responsibility*. Because of the interaction between different transport modes and functions (traffic management, public transport regulation, land use planning, and so on), it is necessary to have an institutional mechanism to coordinate the various related policies at the urban or metropolitan level.
- *Locally empowered institutions*. The capability to secure effective policy integration depends on the empowerment of the local institutions. Even if air quality standards are set nationally, the design and implementation of measures to satisfy those standards is likely to be most effectively undertaken at the local level.
- *Technical competence.* Effective local implementation will depend on technical competence at the local level. All major cities need appropriate technical competence for policy analysis and design. Central government may contribute by financing the development of local skills, or even by establishing regional or national centres of excellence in scarce skills, but the responsibility for mobilising those skills should be local.
- *Fiscal capability.* Local responsibilities must be supported by adequate finance. This means either local taxing powers or inter-governmental transfers. Direct national government financing of specific functions is likely to distort and weaken local implementation.

All of this may seem a long way removed from tackling the problems of air quality in Delhi. But it is not. Supreme Court intervention may be a short-term way of addressing the issue, but it is not a sufficient or sustainable basis for long-term policy formulation and implementation. Without adequate and effective local institutions, opportunistic policy interventions to serve one interest will continue to trigger consequences that are quite unacceptable in other dimensions.

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URBANISATION IN INDIA : Past Trends and Future Projections

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INTRODUCTION

Sustained economic growth is generally accompanied by urbanisation. As countries develop, cities account for a greater share of national income. According to the World Development Report 1999-2000, urban areas generate 55% of the GNP in low-income, 73% in middle-income and 85% in high-income countries. Other economic and social characteristics associated with the process of urbanisation, include (a) greater commercialisation and dependence on cash income to carry out day-to-day transactions, (b) greater participation by women in labour force, (c) change in lifestyles, (d) greater access to health and educational facilities as well as provision of services viz. sewerage, piped water and electricity that may not be available in small towns and rural areas. Urbanisation also presents many challenges. Urban life requires various services, such as housing, sewerage, water, traffic management, etc. that need substantial financial and managerial resources. In developing countries, population has tended to double in a time-span of a decade or so in a number of cities. As a result, there are problems of sub-standard housing, slums, deteriorating public services, unemployment, congestion, pollution, crime, etc.

THE PROCESS OF URBANISATION

According to Paul Krugman (1994), the process of urbanisation involves a tension between the "centripetal" forces that tend to pull population into urban agglomerations and the "centrifugal" forces that tend to break up such agglomerations. The centripetal forces include (a) natural advantages of certain sites viz. harbours, rivers, centralised location, among others (b) market-related economies e.g. access to markets, products and skilled labour, etc., (c) pure external economies e.g. knowledge spillovers. On the other hand, centrifugal forces comprise commuting cost, higher land/house rents in urban areas,

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congestion, pollution and cost of public services. The shift of people from rural to urban areas mainly reflects the process of industrialisation and changes that it brings about in the demand for labour. Certain conditions in the rural areas e.g. low levels of income on account of landlessness, unequal land distribution, mechanisation of the agricultural operations, natural calamities, such as droughts and floods, in addition to the scope for better job opportunities and higher incomes in urban areas are some of the factors that result in migration from rural to urban areas.

The growth sectors, however, have the tendency to concentrate in or around the cities, despite the difficulties, e.g. significantly higher land prices, higher cost of living, etc. This is on account of several benefits that an urban agglomeration provides viz. advantages of economies of scale and consequent increase in the productivity of a number of activities, higher wages, etc. During the early stages of development, modern industries tend to cluster in large metro cities. The clustering saves on scarce resources and helps industries cope up with initial shortages of skilled labour. Besides, better availability of other crucial inputs viz. technical knowledge, business and financial services, modern communications, transport infrastructure increases productivity in these agglomerations. As industrialisation proceeds, manufacturing activities move into smaller cities that specialise in particular types of industries.

TRENDS IN TOTAL AND URBAN POPULATION IN INDIA

Population in India increased from 361 million in 1951 to 1027 million in 2001. The urban population increased from 62 million to 285 million during this period. Table 1 gives the trends in respect of total and urban population in the country between 1951 and 2001.

Table 1: Urban and Total Population

Census year	Total population (million)	Urban population (million)	Percentage of urban to total population
1951	361.1	62.4	17.3
1961	439.2	78.9	18.0
1971	548.2	109.1	19.9
1981	683.3	159.5	23.3
1991	846.3	217.9	25.7
2001	1027.0	285.4	27.8

Source : Census of India

While the total population increased by 2.8 times in the last 50 years, the urban population increased by 4.6 times during this period. As a result, the share of urban in total population increased from 17.3% in 1951 to 27.8% in 2001. While the density of population for the country as a whole was 274 persons per square kilometer in 1991, in urban areas the population density was 3462 persons per square kilometer. The corresponding figures for 1981 were 216 and 2998 persons, respectively. In 2001, the density of population was 324 persons per square kilometer. The density of mega-cities

has, however, been very high ranging between 8800 and 13500 per square km in Chennai, Kolkata and Delhi. Table 2 gives the rate of growth of rural, urban and total populations.

Table 2 : Rate of Growth of Total, Rural and Urban Population

(Percent per Annum)

Years	Population			URGD*
	Total	Rural	Urban	
1951-61	1.96	1.87	2.35	0.48
1961-71	2.22	1.98	3.24	1.26
1971-81	2.20	1.76	3.80	2.04
1981-91	2.14	1.82	3.12	1.30
1991-2001	1.93	1.66	2.70	1.04
1951-2001	2.09	1.82	3.04	1.22

* Urban Rural Growth Rate Difference
Source: Derived from Table 1.

During the last half a century, the rate of growth of total and urban population has been close to 2.1% and 3.0% per annum, respectively. The rate of growth of urban population increased from 2.35% per annum in the decade 1951-61 to 3.8% per annum in the decade 1971-81 and then started slowing down. It was 3.12% in 1981-91 and 2.7% in 1991-2001. This is in contrast to the rate of growth of rural population, which was in the range of 1.6-2.0 percent per annum in different decades between 1951-2001, averaging 1.82% per annum for the period of 50 years. The long-term difference in rural and urban population growth works out to 1.22% per annum. The difference was the maximum in the decade 1971-81. The slowdown in the rate of growth of urban population during 1981-91 was surprising for many analysts who were expecting the level of urbanisation to be of the order of 27-27.5% as compared to the actual level of 25.7%. Rakesh Mohan (1996) suggests this as a "disturbing signal" and ascribes it to the failure to "cope with the demands of industrialisation and urbanisation in adequate fashion." The rate of growth of urban population slowed down further in 1991-2001. Part of this slow-down could be accounted for by an overall reduction in the growth rate of population from around 2.2% during 1961-91 to 1.93% during 1991-2001. The inability to invest adequately in urban infrastructure, lack of creation of enough jobs, lower rates of emergence of new towns and worsening quality of life in the urban areas, are some of the factors that may have contributed to such a scenario. Visaria (1997) refers to a NSSO survey of 1990, according to which 4.3% of the urban workforce actually comprised residents of adjoining rural areas. It is estimated that if these commuter workers living in rural areas had migrated to urban areas, they would have added 10 million to urban population. This would have raised the urban population to 227 million, accounting for 26.9% of the total population. According to Visaria, "Such commutation is a low-cost alternative to migration. It is partly a response to the acute scarcity of urban housing and is facilitated by relatively inexpensive or subsidised transport facilities."

Population growth in the urban areas can be accounted for by three broad components, namely, (i) natural increase, (ii) net rural to urban migration, (iii)

net classification of localities from rural to urban areas. Table 3 gives the differences in crude birth and death rates and natural growth rate.

Table 3 : Birth Rate, Death Rate and Natural Growth Rate

(Per thousand)

Year	Crude birth rate			Crude death rate			Natural growth rate		
	Rural	Urban	Combined*	Rural	Urban	Combined*	Rural	Urban	Combined*
1971	38.9	30.1	36.9	16.4	9.7	14.9	22.5	20.4	22.0
1981	35.6	27.0	33.9	13.7	7.8	12.5	21.9	19.2	21.4
1991	30.9	24.3	29.5	10.6	7.1	9.8	20.3	17.2	19.7
1999	27.6	20.8	26.1	9.4	6.3	8.7	18.2	14.5	17.4

* Rural & Urban
Source: RGI, (1999 and 2001)

The natural rate of growth of population in urban areas is lower than that of rural areas. Despite this, the share of population in the urban areas been increasing. This can be accounted for by migration from rural to urban areas. Table 4 gives the components of urban growth during 1961-91 on a decadal basis.

Table 4 : Components of Growth of Urban Population

	1961-71		1971-81		1981-91	
	Million	(%)	Million	(%)	Million	(%)
Absolute increase	30.2	100.0	49.9	100.0	57.7	100.0
Net reclassification of localities from rural to urban	4.5	14.9	6.7	13.4	5.3	9.2
Net rural to urban migration	6.3	20.9	9.8	19.6	16.6	28.8
Natural increase	19.5	64.6	25.6	48.3	35.8	62.0
Residual (including errors and change in boundaries)	(-)0.1	(-)0.3	7.8	15.6	–	–

Source : Based on Visaria in Jones and Visaria (1997).

Most of the increase in urban population has been on account of the natural increase in urban population, followed by net rural to urban migration. Reclassification of localities from rural to urban has progressively accounted for smaller share of absolute increase in urban population. The information on migration for the decade 1991-2001, based on the Census conducted in 2001, is not available as yet. However, some information about the migration from rural to urban areas is available from the 55th Round of the National Sample Survey Organisation, conducted during July 1999 - June 2000 (see GOI, 2001). According to this Survey, the net migration from rural to urban areas in the last 9 years has been of the order of around 12 million persons. This seems to be an underestimate, as taking into account the natural growth rate of urban population of around 1.6% per annum between 1991-99, based on information available from SRS, and projecting the population till 2001 on this basis would have yielded a population of around 260 million in the urban areas. The balance of 25 million could be accounted for by net migration from rural to urban areas or on account of reclassification of localities from rural to urban areas.

SIZE-WISE DISTRIBUTION OF CITIES

The number of cities having a population of more than a million persons increased rapidly since 1951. In 1951, there were only 5 UAs/ cities where the population was more than a million, which accounted for 3.3% and 18.8% of the total and urban population, respectively. As against this, nearly 108 million persons lived in 35 urban agglomerations/cities having population of more than one million in 2001. These accounted for 10.5% of total population and 37.8% of the urban population (see Table 5).

Table 5 :Urban Agglomeration/Cities having Population of More than a Million,1951-2001

Census years	No. of Urban agglomerations/ cities with more than one million population	Population (million)	Average population per UA/city (in million)	Population of million plus urban agglomerations/cities as percentage of India's	
				Total population	Urban population
1951	5	11.75	2.35	3.25	18.81
1961	7	18.10	2.59	4.12	22.93
1971	9	27.83	3.09	5.08	25.51
1981	12	42.12	3.51	6.16	26.41
1991	23	71.00	3.09	8.39	32.63
2001	35	107.88	3.08	10.50	37.81

Source: Derived from various census documents

Between 1951 and 1981 only 7 cities were added, to the number of cities having population of more than a million persons. However, in the subsequent two decades, i.e. between 1981-2001, the number of such cities increased by another 23. According to the National Commission on Urbanisation, the number of these cities is expected to increase further to 40 by 2001 (Source: Ashish Bose, 1993 referring to the Report of the National Commission for Urbanisation). However, taking into account the city-wise population for 1991 and the growth rate observed in these cities in the period 1971-81 and 1981-91, Alagh, *et al* (1999) had projected that the number of cities having population of more than a million persons was unlikely to exceed 35 by 2001. The provisional results of 2001 Census have confirmed these projections.

In all, there were 2795 urban agglomerations/ towns in 1951. The number declined to 2270 in 1961 but thereafter continued to increase and, in 1991, there were 3609 UAs/ towns. According to the Census of 2001, there were 5161 towns/cities in the country. While there has been an increase in the number of UAs/ towns in class I to IV, the share of smaller towns continued to decline. The composition of cities, according to size, did not change much between 1991 and 2001 (see Table 6).

In 1951, Class I and II UAs/towns accounted for 6% of the towns in all classes and nearly 55% of the urban population. By 1991, Class I and II cities comprised 17.6% of the total number of cities/towns, while nearly 3/4th of the urban population lived there. The situation in 2001 was not very different when nearly 74% of the urban population resided in Class I and Class II cities. On the other hand, a little over 11% of the urban population lived in nearly 3000 towns each having population of less than 20,000 persons.

Table 6 : Share of Urban Agglomerations/Towns by Size Class, 1951-2001

Census year	No. of cities in all classes	Percentage of cities/towns in size class					
		I	II	III	IV	V	VI
1951	2795	2.7	3.3	11.7	21.8	40.2	20.4
1961	2270	4.5	5.7	19.3	31.7	31.3	7.6
1971	2476	6.0	7.0	22.5	33.4	25.2	5.9
1981	3245	6.7	8.3	22.7	32.4	22.8	7.1
1991	3609	8.2	9.4	25.7	31.4	20.1	5.1
2001	5161	8.2	9.4	26.9	30.2	20.5	4.4

Notes: 1. Excludes Assam and Jammu & Kashmir.
2. The Urban units have been categorised into the following six population size classes of towns based on population:

Size Class	Population
I	100,000 & above
II	50,000 - 99,999
III	20,000 - 49,999
IV	10,000 - 19,999
V	5,000 - 9,999
VI	Less than 5,000

Source : Census of India, provisional population totals, Paper 2, rural-urban distribution, 1991. For the 2001 census, information is calculated on the basis of information available from RG's office on floppy diskette.

Indian urbanisation, therefore, followed an interesting pattern. While the rate of growth of urbanisation declined in the eighties and nineties, the million plus cities and Class I towns continued to grow quite rapidly. The share of million plus cities in the total urban population increased from 18.8% in 1951 to 32.6% in 1991 and further to 37.8% in 2001. The share of Class I towns went up from 44.6% in 1951 to 60.4% in 1981 and to 65.2% in 1991 and declined somewhat in 2001.

Though the process of urbanisation is perceived to be a catalytic agent of economic growth and human resource development, there are several areas of concern too. These arise mainly from the gap between the demand and supply of basic infrastructure services in the urban areas, such as energy, housing, transport, communication, education, water supply, sewerage, health and recreation amenities. As the India National Report to the Second United Nations Conference on Human Settlements held in Istanbul

Table 7 : Share of Urban Population by Size Class-India, 1951-2001

Census year	No. of classes	Percentage of population in size class					
		I	II	III	IV	V	VI
1951	61.63	44.6	9.9	15.7	13.6	13.0	3.1
1961	77.56	51.4	11.2	16.9	12.8	6.9	0.8
1971	106.97	57.2	10.9	16.0	10.9	4.4	0.4
1981	156.41	60.4	11.6	14.3	9.5	3.6	0.5
1991	212.87	65.2	11.0	13.2	7.8	2.6	0.3
2001	279.82	61.5	12.3	15.0	8.1	2.9	0.3

Source: Census of India, provisional population total, Paper 2 rural-urban distribution, 1991. For the 2001 census, information is calculated on the basis of information available from RG's office on floppy diskette.

in 1996 states, "The emerging characteristic of `the city within a city' in mega- and metro-cities is a gap syndrome arising out of inadequate income opportunities and city management response. The manifestations are the fast growth in slum settlements and population, illegal construction and undesirable land-use changes, deterioration in air and water quality, all of which adversely affect the human environment and threaten social order. Pollution, lack of green spaces and increasing vulnerability to disasters, are some of the factors that have seriously challenged the capacities of the cities. In recent years, the police forces in mega- and metro-cities have come under severe and sustained pressures by a wave of criminality which can be traced to the vulnerability of rapidly-expanding cities." Some of the major areas of concern are highlighted below :

PROBLEMS OF SLUMS

A large proportion of the urban population in India lives in slums and shanty towns. The existence of slums essentially reflects urban poverty and despite the efforts to contain the slum-dwellers, their number has been increasing, causing tremendous pressure on urban basic services and infrastructure. Nearly 28 million persons lived in the slums in 1981 accounting for 17.5% of the urban population. In 1991, the number of persons living in slums increased to 45.7 million, thus accounting for 21.5% of the urban population. Nearly 69% of the total slum population in the urban areas lived in Class I cities while Class II cities and other towns accounted for 10% and 21%, respectively. According to the Census of India 2001, there were 40.6 million persons living in slums in 607 towns/cities. Only those towns/cities, which had a population of over 50000 persons as per 1991 Census, were considered for studying the slum population in the 2001 Census. The total number of persons living in such cities, that numbered 607, was 178.4 million. The slum-dwellers accounted for 22.8 per cent of the population in these cities. A large proportion of the slum-dwellers lived in the million plus cities. Of the total population of 70.8 million persons living in 26 such cities (for which the information was available), there were 16.9 million slum-dwellers accounting for nearly 24 per cent of the total population. In cities like Greater Mumbai, nearly half of the population lived in slums. The proportion of slum-dwellers in the total population of cities like Faridabad, Meerut, Kolkata, Thane, Nagpur was in the range of 33-46%. Table 8 gives the slum population in selected cities for the years 1981 and 1991.

Some information about living conditions in the slums is available from the survey conducted by the National Sample Survey Organisation during January - June 1993 (NSSO, 1997). According to this Survey, there were 61 thousand slums in rural areas and 57 thousand slums in the urban areas. Declared slums

accounted for 37% of the slums in urban areas. Ninety per cent of the urban slums were located in the residential areas, 65% had tap as a source for drinking water, 54% had no latrine, 32% had no drainage system, 35% had no garbage disposal arrangements and 83% had no underground sewerage system. The conditions prevailing in the slum areas have been analysed by individual researchers.

Table 8 : Slum Population in Metropolitan Cities (Million)

City	1981			1991		
	Total	Slum	%	Total	Slum	%
Calcutta	9.2	3.0	32.9	11.0	3.6	32.9
Bombay	9.0	3.0	34.3	12.6	4.3	34.3
Delhi	5.7	1.8	31.5	8.4	2.2	26.7
Madras	4.3	1.4	32.1	5.4	1.5	28.1
Hyderabad	2.6	0.5	19.6	4.3	0.9	19.8
Bangalore	2.9	0.4	12.5	4.1	0.5	12.5
Ahmedabad	2.5	0.5	20.3	3.3	0.7	20.3
Pune	1.7	0.3	16.3	2.5	0.4	16.3
Kanpur	1.6	0.6	37.5	2.0	0.4	20.6
Lucknow	1.0	0.3	28.3	1.7	0.3	16.6
Nagpur	1.2	0.4	31.9	1.7	0.5	31.9
Jaipur	1.0	0.3	29.1	1.5	0.4	29.1
Surat	0.9	0.2	25.4	1.5	0.4	25.4
Coimbatore	0.9	0.1	8.7	1.1	0.1	8.7
Cochin	0.8	0.2	24.8	1.1	0.3	24.8
Vadodra	0.7	0.1	15.9	1.1	0.2	18.3
Indore	0.8	0.1	15.2	1.1	0.2	15.2
Patna	0.9	0.6	63.5	1.1	0.7	63.5
Madurai	0.9	0.2	18.0	1.1	0.2	18.0
Bhopal	0.7	0.1	8.5	1.1	0.1	14.0
Vishakhapatnam	0.6	0.2	25.2	1.1	0.3	25.2
Varanasi	0.8	0.3	32.6	1.0	0.2	20.1
Ludhiana	0.6	0.3	51.1	1.0	0.4	35.4

Source : CSO (1999), Compendium of Environment Statistics, 1998

According to a study by Madhura Swaminathan, (1999) "Slums in Mumbai are located in low-lying areas, on steep hillsides, marshy lands, garbage dumps, near cemeteries, adjacent to railway tracks and under high tension wires." The housing units in the slums are generally cramped and have poor ventilation. According to a survey conducted in the Santosh Nagar area of Mumbai, 69% of the households had less than 50 square feet per person to live. In 26% of the households, the area available per person was less than 25 square feet. The use of a slum shelter as a workplace adds to health risks. In the Dharavi slum of central Bombay, there were about 400 leather processing units and they were a major source of air and water pollution. In a survey of a community that lived in the leather processing area, it was noted that wastewater flowing in open drains held hair, worms and other effluents (including acids) discharged after the cleaning of hides. There are several other hazardous activities, such as metal smelting and recycling of plastics that are undertaken in homes. Under such environmental conditions, the storage of food is difficult and the possibility of contamination is high.

ENVIRONMENTAL CONCERNS

Major environmental concerns in urban areas in the country relate to high level of water pollution due to poor waste disposal, inadequate sewerage and

drainage and improper disposal of industrial effluents. The maintenance, replacement and upgradation of existing assets have not received adequate attention. Some of the economic activity has tended to concentrate in selected cities and a number of these have high pollution generating potential. The tanneries in Kanpur, chemical complexes in Mumbai, textile-processing units in Coimbatore, etc. are a few examples. Over the year, air pollution levels in the cities have been increasing mainly because of expansion of motor fleet, which are often poorly maintained, fuel burning for power plants and industrial activity. The problem of air pollution is quite severe in Delhi, which has more motor vehicles on the road than there are in Mumbai, Chennai and Kolkata put together. High levels of indoor air pollution arising from the use of inefficient stoves for cooking probably represents the single most serious health impact of air pollution. Though this is a phenomenon prevailing mainly in the rural areas, the problem is quite severe in some urban areas also, including metropolitan cities.

A large proportion of municipal solid waste remains uncollected or is disposed of in open dumps, especially in smaller cities. The dumping of solid waste contributes to land-and-ground water pollution, resulting in associated health problems.

High levels of noise pollution arise out of vehicular traffic, industrial operations, construction, etc. The average noise levels is residential, commercial and sensitive areas (silence zones) exceed the standards prescribed by the CPCB during the day time as well as at night time. Only in industrial areas, the noise levels are within the prescribed limits for a number of cities more so in the night time. In some cities, the noise levels exceed the prescribed standards by over 70%. It is particularly disturbing to note that even in the silence zones, the noise levels far exceed the prescribed standards in almost all the cities for which the information is available. In some cities the noise levels in residential areas and in silence zones even exceed those prevailing in industrial areas. In general, the commercial areas happen to be the noisiest in these cities.

These developments continue to contribute adversely to the quality of urban environment. Exposure to contaminated air, water and food often results in various diseases, such as acute respiratory infections, chronic respiratory diseases, pneumonia in children because of poor air quality and unhealthy housing, diarrhoeal diseases, malaria and other vector borne diseases on account of polluted water, inadequate sanitation and other deficiencies in water management and inefficient collection of household and other waste, etc. Frequent or severe interruption of various human activities by noise exposure can affect human health to various degrees. The main interference effects of exposure to occupational

noise have been those associated with communication and task performance. Poor urban communities suffer an alarming lack of access to basic water, sewage, and rubbish disposal services, which make it virtually impossible for them to reduce contamination of water and food, maintain adequate levels of hygiene, or control insect-vectors of disease. While infant and child mortality are generally lower in urban than in rural areas, the incidence of a number of common childhood diseases, such as diarrhea and respiratory illness could actually be higher. It is all these factors, along with greater concentration of people living in close proximity, that make the cities among the most health threatening living environments, more so for the poor.

URBAN POVERTY

Table 9 gives the percentage of persons living in poverty in the rural and urban areas. It would be seen from the above that percentage of persons living below poverty line has declined from nearly 55% in 1973-74 to about 26% in 1999-2000. With the exception of 1987-88 and 1999-00, the incidence of urban poverty has been at least 5 percentage points lower than that in the rural areas. However, in terms of absolute numbers, there were nearly 320-330 million persons living in poverty till 1993-94. It was only in 1999-2000 that the absolute number of persons living in poverty declined to 260 million. The number of the poor living in urban areas increased from 60 million in 1973-74 to 76.3 million in 1993-94 but declined to 67 million in 1999-2000. On the other hand, the number of the poor living in rural areas declined from 261 million in 1973-74 to 244 million in 1993-94 and further to 193 million in 1999-00. Although income levels in urban areas are generally higher and people have greater access to various facilities and amenities, the poor in these areas may suffer more than the rural households from certain aspects of poverty. Access to accommodation is more commercialised and costly in urban areas and, therefore, the urban poor are typically housed in slums or squatter settlements and often have to contend with appalling overcrowding, poor sanitation, indoor air pollution and contaminated water and other environmental hazards in their homes, surrounding areas and the workplaces. Forcible evictions, floods and chemical pollution are constant threats. As a result, there are greater health risks in the form of higher morbidity, injury and pre-mature death both for children and adults. Available evidence indicates that the childhood mortality,

Table 9 : Population Below Poverty Line (Percent)

Year	Poverty Ratio (Rural)	Poverty Ratio (Urban)	Poverty Ratio (Combined)
1973-74	56.4	49.0	54.9
1977-78	53.1	45.2	51.3
1983	45.7	40.8	44.5
1987-88	39.1	38.2	38.9
1993-94	37.3	32.4	36.0
1999-00	27.1	23.6	26.1

Source : Ninth Five Year Plan, 1997-2002, Volume I
For 1999-2000, Datta and Sharma (2002)

stunting and underweight are generally lower in urban than in rural areas. On the other hand, wasting and morbidity from infectious diseases are higher in the urban areas and the intra-urban differences (in terms of large heterogeneity in poverty, morbidity, mortality and nutritional status) tend to be greater than the rural urban disparities.

CONGESTION IN URBAN AREAS

As stated earlier, the density of population in the urban areas is much higher as compared to that in the rural areas. While the density of population for the country as a whole was 274 persons per square kilometer in 1991 (324 persons per square kilometer in 2001), for the urban areas it was 3462 persons. The density of population in 4 mega cities, namely, Chennai, Delhi, Kolkata and Mumbai was in the range of 8800 to 13500 per square kilometer. Such concentration of people along with that of economic activity lowers the unit cost of providing urban infrastructure (piped water, drainage and sanitation) and services (viz. health care, garbage collection and other emergency services). However, concentration of people can result in several problems, if it is not managed properly. A number of risk factors are associated with overcrowding, such as diseases like respiratory infections (including ARI mortality), measles and tuberculosis. Concentration of infective and susceptible persons in the urban areas often leads to greater transmission of infectious agents.

PROJECTED URBAN POPULATION IN 2020

As stated earlier, urban areas (particularly large cities) have certain advantages and it is the centripetal forces at work, that tend to attract a large number of migrants from the rural areas and smaller towns to the cities. Apart from the pull factors that bring in population to the bigger cities, there are certain push factors that result in higher growth of population in the urban areas. A large proportion of labour force still depends on agriculture. As a result, there are a large number of underemployed workers. Such workers, apart from the unemployed in the rural areas tend to migrate to the urban areas. In addition, the land-use pattern is also likely to affect the future rate of urbanisation. The land available for agriculture is more or less 'fixed' (net sown area remaining unchanged). The only way to 'expand' the land for agricultural operations, is by increasing the irrigation intensity which would result in higher gross cropped area. In addition, rising population would also raise the demand for alternative uses of land, apart from putting greater pressure for agricultural land. Some of these factors could also affect the rate of urbanisation in the country in the years to come.

The Technical Group on Population Projections set up by the Planning Commission, has forecast the total and urban population till 2016. Taking into account the actual population as per the 2001 Census as well as the likely long-term growth of population of 1.4-1.5 percent per annum (between 2001 and 2020), it is estimated that the total population of the country is likely to range between 1335 and 1360 million. Based on the past trends of growth of urban population and its relationship with growth in total population, it is estimated that the urban population in the year 2020 would be in the range of 430-450 million, accounting for nearly 32-33 percent of the total population. Visaria and Mari Bhat (1999) have estimated the total population in the range of 1333-1385 million for the year 2021. The urban population has been estimated by them in the range of 472-519 million, depending on the rural-urban growth difference in population. This would constitute 35.2%-38.7% of the total population.

Urban population in different classes of cities has also been estimated, which is based on the past growth of various categories of cities. On the basis of an urban population of nearly 440 million, the Size Class wise population is given below. It may be mentioned that these projections should be treated as preliminary and tentative as more accurate projections would involve analyzing city-wise data, which is beyond the scope of this paper.

Size Class	Population (million)	% of Urban Population
I	290.0	65.9
II	56.0	12.7
III	50.0	11.6
IV	32.0	7.3
V	11.0	2.3
VI	1.0	0.2

It may also be noted that in Alagh et al. it was estimated that by 2020, the number of persons living in urban areas would reach a level of 465-500 million, i.e. close to half a billion persons. Nearly 3/4th of them would be living in class I cities. However, in view of a slowdown in urban population as per 2001 Census, the estimates have been revised downwards. These estimates assume that along with the slowdown in the rate of growth of total population, there would also be a decline in the growth rate of urban population, though the latter would continue to increase at a faster rate. It is quite likely that the centripetal forces would operate in case of Class I towns and the centrifugal forces would drive the population out of Class IV to Class VI towns.

There are some other estimates that place the likely urban population at much higher levels. According to Mehta (1997), the total population would be 1290 million while the urban population would be 591-689 million (depending on the alternative growth scenario for the economy) accounting for 45.7%-53.3% of the total population. These estimates appear to be on the higher side. The size distribution of urban centres in 2021, as per Mehta would be as follows.

The Ministry of Urban Development has projected the urban population to be of the order of 618 million. Class I cities would account for nearly 80% of the total urban population of the country. The rate of growth of population in Class I cities would be 4% for the period 1991-2020. The elasticity of population in Class I towns with respect to GDP is 0.6 (as the growth for the period 1991-2020 is assumed to be 6.6%.

Table 10 : Size Distribution of Urban Centres (2021)

Size	Number of Urban Centres
>1 million	70
>100,000	500
50-100,000	700
20-50,000	1,200
10-20,000	1,500
5-10,000	630
<5,000	400
Total	5,000

SLUM POPULATION IN 2020

We forecast the slum population on the basis of two assumptions. The first is that the share remains constant in urban population. The second is that the share goes down to the average slum population share in Class I towns which is less than that in the million plus towns. This is an optimistic assumption. Under the first assumption, there could be nearly 118 million persons living in the slums in urban areas if the population is 550 million by 2020. In case of the optimistic assumption, the number of persons living in slums could be 100 million. Thus, there would be nearly twice the size of number of slum dwellers in the country in 1994. This will have implications in terms of squatters, encroachments and population density in slums and adverse effects on physical and social infrastructure including health, sanitation, water supply, etc.

PERSONS LIVING IN POVERTY BY 2020

As mentioned earlier, poverty ratio in urban areas declined from 49% in 1973-74 to about 23.6% in 1999-2000. Besides, urban poverty declined by over 16 percentage points between 1983-84 and 1999-00. This period had witnessed a higher rate of growth in the economy (over 5% per annum) as compared to the period 1973-74 to 1983-84 (4.3%). Based on these trends, it is likely that by 2020, 10-15% of the urban population would still be living in poverty in India. In absolute terms, it would imply that the number of the poor living in urban areas could be close to 50 million persons in 2020 as against nearly 67 million persons in 1999-2000.

URBAN BUS TRANSPORT IN BRAZIL : Regulations and Competition

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INTRODUCTION

The main purpose of this paper is to understand the mechanisms that induce and inhibit competitiveness in and productivity of transit systems in Brazilian cities, in order to support the development of public policies which would promote increase in service quality with reduction in costs and fares.

The first part of this paper analyses the characteristics of the regulations commonly found in Brazilian cities, taking into account the fact that this regulation is what defines the urban bus transport sector's *economic competition space*. Attention is drawn to the fact that the Brazilian regulations, unlike the ones found in almost every other country in the world, rests upon two basic premises: the manner in which services are delegated – *concession per line* to private companies; and the form of remuneration – the *cost-plus* method.

This is followed by an analysis of the main elements of competition found in the sector. Contrary to what might seem true at first, competition is not limited to existing companies, especially because public transport is protected and regulated by different sectors of public office. The existing forms of competition are classified according to the type of regulation and reimbursement model adopted by the companies in each case, stressing that direct dispute for users on the street is not the only, nor the most important, form of competition faced in the sector. The study identifies, defines, and analyses the major forces that shape competition in the Brazilian urban transit market. In order to do so, the methodology proposed by Michael Porter for analysis of competition in free markets has been employed and adapted to fit the reality of a heavily regulated market.

Bearing in mind the importance that the competitive forces have in the market's structural definition, and aiming at the elaboration and implementation of public policies for the sector, some lessons are extracted from this analysis and presented as conclusions.

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MAIN CHARACTERISTICS OF REGULATIONS IN BRAZIL

In Brazilian cities, transit services are provided by several private operating companies and regulated, both economically and technically, by public policy.

In contrast to the informal operators typical of the Third World cities and the monopolies that characterize this service in developed countries#, the private companies that operate bus transport in Brazil are true businesses undergoing a process of heavy growth and concentration of capital. These companies operate in local bus markets, where entry is not free; on the contrary, legal, technical, and economic requirements strongly ward off new operators. Moreover, the elements that shape supply – line routes, quantity, quality, and service fares – are defined, at least formally, by public transportation agencies.

This unique pattern of organization and regulation of urban transit in Brazil, combined with the historical elements that helped shape local markets, resulted in traits that are unique to this sector, in terms of competition and pricing. This pattern also decisively affected the structural configuration of local markets, more specifically, the number of operating companies and their profile.

The Brazilian Model of Economic Regulation

The history of experimentation and change in the organization and administration of urban transit in Brazil bequeathed us closely knit and simultaneously defined models of public regulation – particularly economic regulation – and market structures. The permanence of these models is now being questioned and their demise, as can be seen from frequent crises, is on its way.

Given their strengths and weaknesses, the study of these models becomes a crucial and mandatory step in any attempt to modify the relationship between government agencies and urban transit operators.

What is commonly referred to as the economic regulation model for urban transit in Brazil – and there are only minor differences between this model and the one for long-distance interurban transport – is based upon two fundamental premises: the manner in which services are delegated; and the form in which operating companies are paid.

This trait of urban transport in central countries has recently been changing in several countries.

Services are delegated by means of well-known legal and institutional mechanisms: concession or permission. Generally, the object is each line or service of each individual company. Entry is thus controlled; the access of a new operator into the market does not depend exclusively on its will or on its entrepreneurial capability. Thus, the number of companies active in the market depends on governmental policy, which might or might not favour the entry of new operators. Besides, the spatial disposition of lines and their division among operators always try to assure a company with, if not monopoly, at least exclusiveness of a certain set of itineraries.

The *form of return* in the case of Brazilian companies is similar to the one related to the American tradition known as *cost-plus*: prices are established via the addition, to production costs, of a return rate usually based on the capital invested. Brazilian history and experience have promoted this form of return in such a way as to give rise to a varied set of diversified solutions, peculiar to each city or agglomeration. From this set of solutions, two can be picked out as typical cases and two others as main variations, using the form of payment to enterprises as a parameter.

The Form of Delegation

Delegation by concession and permission

Historically, concessions and permissions were used in Brazil to implement infrastructure projects and provide public services, especially related to railways, ports, water supply, electricity, gas and telephone. These services, however, share a set of common traits not necessarily found in urban public bus services.

In terms of *investments* the former are strongly set apart by the scope of the business, the high industrial scale of each one of the economic entities, and the long period of maturation. In terms of the *market*, it is important to point out the physical isolation and the absence of interference between two concessionaires. In terms of *consumption*, they are characterized by the indivisibility of the service provided and the absence of any possibility of self-provision.

Public bus services do not have any of these traits. On the contrary, investments in this case are relatively small and may be segmental, responding to growth in demand. From the market point of view, bus lines in an urban area usually cross and frequently overlap. In terms of consumption, there is the real and concrete possibility of self-provision, at least for a certain part of the population.

What is remarkable in the Brazilian context is that the same mechanisms of delegation were adopted for services which were so distinct economically. It can be concluded that the classical concession model when transferred to the urban bus model brought with it the underlying assumption that both models were similar. Therefore, although the theoretical debate on the presence or absence of natural monopoly in urban bus services has still not been raised, tradition and inertia have led to the overgeneralization that all public services, including transit, are characteristically natural monopolies.

Concept of natural monopoly with delegation by line

It was in this manner that the mechanisms of concession and permission for services of urban (and inter-urban) transit were consolidated. It should be stressed, however, that the concept of a natural monopoly that was adopted was extremely limited and specific. In fact, this concept is not associated with a company's production, that is, with the possibility one company has – *vis-à-vis* several other companies – of providing a set of transit services that are usually implemented by a network of lines, at the lowest possible average unit cost.

On the contrary, the concept of natural monopoly that consolidated itself is associated with the operation of only one line. This delimits the market and, naturally, demand. The assumption that each line constitutes an isolated market can be made, but concept of network is then lost. The instruments of concession and permission are then used within the range of the line. These instruments were predominantly employed until they eventually formed the basis for the Brazilian model of urban bus regulation.

Form of Return

Cost-plus method

The Brazilian urban bus markets are regulated in terms of supply by government agencies, which decide and prescribe all operational parameters for the service. Therefore, at least in formal terms, the only area where the private concessionaire can optimize production is the operational one. In this context, entrepreneurial returns – and, ultimately, fare pricing – are determined by two basic conditions: (i) coverage of direct operational costs; and (ii) the addition of a rate of return, usually based on the capital invested.

The rate of return is associated with the presence of the concessionaire in the sector. Although usually related directly to the operator's investment, this

rate does not aim exclusively at paying the simple cost of immobilized capital. In a broader sense, it seeks to remunerate the operator for all possible gains inherent in the production of the service, including compensation for risks.

Fares should be established, and this cannot be done differently from an economic efficiency point of view. Thus, the government must specify the product to be provided (by imposing technical operational conditions) and determine the fares, assuming that the operator is producing these services with technical efficiency. In other words, after the product is defined spatially, qualitatively and quantitatively, the operator must have managerial efficiency to provide it at minimal costs.

Consequently, the government must have a thorough knowledge of service production costs. Public policy must not establish extremely low fares, causing losses to operators. It must also not establish fares so as to compensate for inefficiency. On the other hand, establishing excessively high fares will penalize users. The main logic behind this is that an entity may, under special conditions, retain exclusivity over production of one service, but is should never hold the monopoly. Besides, the city should not be allowed to award the monopoly to private entities.

Another consequence, of no less importance, is that in order to carry out these obligations, the government needs to establish a double control. First of all, it must control the operation so as to ensure that the operating company provides users with what it had committed to offer when services were delegated. This control would not raise any problems, provided there is appropriate inspection apparatus, and provided the services are adequately specified.

Secondly, to guarantee that the company is operating at maximum efficiency – a very important aspect in this model – the government must be up to speed on the internal organization of production, that is, the quantity of each element that makes up cost, the ideal combination of these elements and, evidently, the production being carried out – for example, the distance covered – as well as production being consumed – transported passengers, for example.

Experience gained in Brazilian cities, however, raises serious obstacles as to the performance of the government in these matters. First, the last two pieces of information are usually provided by the operating companies and, as such, are unreliable. A strict inspection service has faced severe hindrances, the lack of personnel being the most noteworthy. The use of new technologies of vehicle tracing and on-line demand monitoring is still only a possibility. Second, because

of the differences in size, entrepreneurial management and the manner in which production is organized, the government is still unable to define and impose the ideal composition of production factors.

Forms of reimbursement

The predominant forms of reimbursement for urban bus operating companies in Brazilian cities may, as a rule, be divided into two major groups, with two possible variations. The two forms are: the *Fare Model* and the *Public Revenue Model*.

Fare Model : The company is compensated for its costs by adding up the fares received by the vehicles in operation. It is the oldest model and is still in use especially in small and medium-sized towns.

Public Revenue Model : Its fundamental characteristic is that the sum received by the company, as compensation, bears no direct relation to the revenue collected from the operation of services. Payment value is defined by a contract, in which the operating company pledges to provide a qualitatively and quantitatively specified service, in exchange for returns defined in terms of a previously established *unit of production*.

There is a crucial difference between the two models. In the latter, a company's profitability does not depend on its capacity to address demand, but rather on its capability to maintain real operation costs at levels inferior to the ones established by the controlling public agency. Thus, it is the government that takes all the risks: in case fares are fixed below the average cost per passenger, it will be contractually forced to allocate non-fare funds to ensure the financial balance of the contracts, provided the companies follow the technical dispositions and operational requirements agreed upon.

For the companies, the fare level is irrelevant. Their concerns on the subject, if and when they exist, are related to the possibility of contractual insolvency by the government agency in the case of fares permanently maintained below breakeven point, or in case there is imbalance between supply and demand in short or medium terms, since fares that are high in relation to users' ability-to-pay may give rise to crises in demand, which may cause a reduction in market size.

On the other hand, the first model reveals a basic weakness – services with less demand or lines operating with low frequencies would have in the Fare

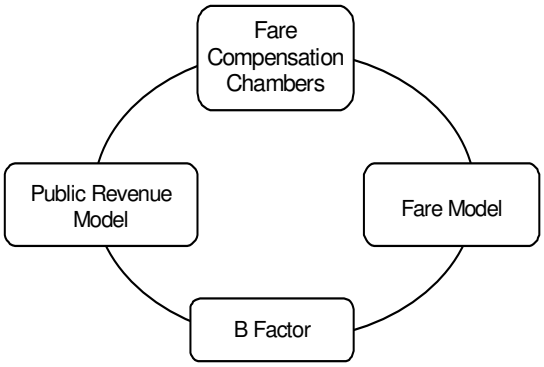
Model a high cost per passenger and thus place fares above the paying capacity of the users. In fact, this is why its use was almost completely banished from larger cities. In the case of a flat fare, the Fare Model would make such lines and services unattractive to the operator, unless he was induced to practice cross-subsidy between the several lines operated. Even so, this alternative is limited by the difference in performance found among the sets of lines conceded to different companies.

Faced with the problems caused by adopting these basic forms, experience in Brazilian bus transport management helped to introduce variants that modified conditions of competitiveness and profitability. That, in a sense, brought these different basic forms closer together. In the first model, there was the creation of *Fare Compensation Chambers* (FCC), and in the second model the introduction of a factor, called *B Factor*, which links reimbursement partially to total number of passengers transported by the company.

Fare Compensation Chambers : The creation and implementation of this instrument, around 1980, had the specific goal of eliminating the economic imbalance in the operation of different companies, caused by the adoption of a flat fare for the transit services within a city (Pietrantonio, 1989). The existence of such a chamber makes it possible for a company to be awarded deficient services or routes, without raising problems. The deficits can be compensated for by the surplus from other lines, even if other companies operate them. The fares can then be disassociated with the individual average cost per passenger of each line. Global deficits can be covered by funds from other sources. The financial risks of the operation are thus almost eliminated. However, this also eliminates the need for entrepreneurial efforts to address demand adequately and, in extreme situations, even to exert control over revenue evasion (Contreras-Montoya, et al., 2000).

B Factor : This variant, found in the Public Revenue Model, was introduced to revive the operators' concern with raising demands. It is a hybrid model, in which the company's compensation is not exclusively related to costs. Only part of the costs would be directly compensated for (say, 80%); the remaining part of costs (B factor – 20% in the example) would be compensated for according to the fare revenue collected by the company. Note that the higher the costs directly compensated for, the more the variant approaches the Public Revenue Model; and the larger the B factor, the more the variant approaches the Fare Model.

The following chart aims to represent the analytical pattern of the relations between these models.



Finally, while considering the basic traits of regulations, some additional comments need to be made on the delimitation of the market within the Brazilian regulation context.

By principle, the territorial delimitation of the market is a result of the regulation in effect. Only companies that have received delegation to do so may operate. However, within an urban area, several vehicles and lines, operating under different jurisdictions, with delegations to carry out different types of services, may coexist and share roads, stops, and terminals. Also, by principle, legal delegation should be able to bring together services of the same nature though belonging to different markets or sub-markets: urban services would thus be under the jurisdiction of each city, and inter-urban services would be controlled by a state agency. In conurbation areas, however, there would be heavy interference between these delegations. Their proximity and even physical overlapping may create overlapping in the market. Moreover, a change in the fare policy of a city (especially in the core city of the agglomeration) may significantly alter the market's range of lines that form the network under its control. In this sense, the city or, depending on the case, the urban agglomeration should be considered the geographical limit used to analyze competition in the transit market.

THE OBJECT OF DISPUTE IN THE MARKET

Having established the concepts of forms (or models) of reimbursement adopted by urban bus transport markets, it remains to be seen how competition between service operating companies occurs within these forms. Evidently, since this market is regulated and its prices are controlled, competition here presents unique features, moulded in each case by regulations, public experience with control and the manner in which prices are established. Orrico Filho and Santos (1995) point out the following three types of disputes in urban bus transport service operations:

(i) dispute for user or 'street competition';
(ii) dispute for the right to establish production plants; and
(iii) dispute for revenue transference among lines and companies.

Dispute for User

Direct competition for user takes place during operation, that is, on the streets, at the bus stops and at bus terminals. It is rendered concrete by the presence of vehicles in a place and time previously established by government orders. Whenever the company's revenue depends on the number of passengers transported, an incisive, at times aggressive, behaviour to increase the presence of vehicles on the road is noticed. The creation of exclusive areas (or zones) for certain companies to operate in, is a form of eliminating or minimizing this kind of competition. This occurs especially in corridors when, in some instances, excess supply becomes evident. Some well-defined actions can be observed in practice: scheduling adjustment during operation, and drivers' aggressive behaviour at wheel, such as speeding and cutting off other drivers when nearing a bus stop.

This type of dispute is found to a greater or lesser degree in almost all cities, being more evident in cities where there is some sort of link, even if a partial one, between returns and the fare revenue. In the cities of Natal and Rio de Janeiro, there have even been administrative disputes between companies on the grounds of predatory competition. Obviously, if entrepreneurial returns follow the *Fare Model*, this form of competition is crucial to the determination of operational profitability. Adopting a return model partially or entirely based on mechanisms of fare compensation, even under private control, is a means of reducing even eliminating this form of competition. However, the same strategies of dispute for users are observed when the chamber for compensation is not functioning in an efficient manner.

Obviously, the cities that adopt returns based on services rendered (i.e., Public Revenue Model), such as Curitiba and Brasilia, do not show this kind of dispute between operating companies. However, when return follows models with *Factor B*, the dispute for users on the street reappears, although minimized and restricted to areas with a significant overlapping of lines provided by different companies, such as urban corridors.

Dispute for the Right to Establish Production Plants

Since they are not operating in a free market, companies cannot produce any product that they wish to. The entry of new operators, and even the expansion of services of existing operators, can only take place if the governmental entity so delegates. There arises then a dispute for this right. Objectively, this means a dispute to operate a new line or to expand an existing one spatially or operationally (increase in the number of vehicles). This dispute usually occurs in

the legal and administrative fields, together with actions that are carried out by practice. The latter at times reveal procedures outside the legal scope of action.

In the legal-administrative field, this type of competition could and should be characterized by bidding for concession, permission, or any other form of delegating public services to third parties. In reality, however, bidding for bus lines is a rare occurrence in Brazilian cities but when it does happen, it ends up being based on technical criteria in which the pre-existence of a company operating in the area becomes a decisive factor for its selection, or even a reason to waive bidding altogether. In this way, the process of dispute for new lines becomes relatively obscure. It is not clear what actions are taken by companies in their attempt to obtain delegation of services from governmental agencies or influence the elaboration of bidding edicts.

To understand the competitive process, therefore, it is necessary to analyze other factors besides those related to bidding. The determining issues in the dispute for the right to establish production plants are:

Large-scale actions that shape the laws and regulations. These are strong actions that typically aim to prevent new operators from joining the market. This form of competition was found in all the regulations studied. As a general rule, the regulations usually include an article requiring bidding for services, and then follow with a series of reasons dictating why this bidding should be dismissed. These are the so-called *preferential areas*, *operational zones*, *exclusive areas* or *already served areas*: there is always a similar expression that justifies the dismissal (Orrico, Brasileiro and Fortes, 1996).

The fact is that all companies, in any type of activity, aim for the absence of any dispute or competition, since its presence can reduce their profitability. These large-scale actions ultimately share the goal of ruling out the possibility of dispute for new lines.

Another form of action found in the field of laws and regulations is the introduction of a series of regulations that specify a number of technical and economic requirements as a condition to authorize or qualify possible operators. As a result, the entry of new companies becomes more difficult; when new obstacles are not created, previous ones are reinforced.

Legal actions seek to establish jurisprudence based on interpretations or omissions of the law. This is typical in cases of interference between systems administrated by different spheres of jurisdiction. Companies that operate on the

inter-urban level try to ensure their right to transport passengers in urban segments. There have been attempts in large and even small agglomerations to claim this as an acquired right on the plea that the line is already in operation. The opposite is also true: urban companies request an extension to the geographical border of the city in order to collect passengers from the neighboring city. Their purpose is to benefit from possible differences in fares or simply to expand their market.

Market actions, which seek entry in emerging markets. These actions appear as 'requests', the most usual one is an 'innocent' petition signed by the people 'interested' in either the extension of a line 'to serve the neighborhood' or an increase in the frequency of a line due to 'high' demand.

In cities where the government pledges to pay for services rendered and thus effectively controls supply, the use of these mechanisms is very frequent, thus making them strong instruments of political pressure on those responsible for transport agencies.

Acquisition of other companies in order to establish a 'bridge' to a certain market, even if it is in the same jurisdiction.

Company mergers, trusts, or even temporary agreements to increase the political influence of a certain group. An important example, outside the usual regulatory sphere, is that of small operators that have started organizing themselves as cooperatives in the Federal District.

It may be concluded that in cities where the model is 'return for services rendered', direct dispute among operating companies centres on the implementation of new lines, or, in some instances, on increasing the size of the fleet.

Dispute for Revenue Transference between Companies

Another type of dispute arises in the 'return model' where there is some form of redistribution of fare revenue among companies. In this case, since the global revenue is divided among companies according to a certain set of parameters linked to production costs, each company tries to raise its quantitative share of these parameters. In practice, these disputes are made up of administrative or operational actions that permit an elevation in the amount represented in the division share. The companies usually try to raise both the number of vehicles and the mileage of the fleet, since, generally, these are the main parameters applied in the redistribution processes.

There are, however, important variables dependent on certain details in the calculation mechanism. One of them is the reduction of the average vehicle age, since in most instances their coefficient is proportionally higher than the possible real costs. Another common practice is to use more expensive implements so as to obtain benefits when manipulating averages. In general terms, if the amount received is directly proportional to the cost obtained in the spreadsheet, the higher the cost items, the higher is the company's figure in the division of revenues. The most evident signs of this dispute are the increase in global mileage within the systems and an accelerated fleet renewal policy.

In instances where payment to operators is directly linked to a pre-established cost spreadsheet – and this occurs in all systems adopted by Brazilian cities – a particular type of competition arises: the *competition for user income.* All companies elevate their 'spreadsheet' parameters (consumption coefficient, quantitative share in production, etc.), and when put together these costs are increased, thus raising fares so as to increase the sector's global revenue to the detriment of other items of consumption which the user's income would go to.

FORCES THAT CONTROL COMPETITION

According to Michael Porter, there are five forces that control and intensify competition in an industry:

(i) threat posed by new entries;
(ii) threat posed by substitution of the product;
(iii) purchasers' negotiation power;
(iv) suppliers' negotiation power; and
(v) rivalry among current competitors.

This clearly indicates that competition, especially in non-regulated markets, is not limited to existing companies, as might seem at first sight. As a general rule, competitive forces work continuously, trying to reduce the sector's profitability rate. The trend is to set the production and sales price at perfect competition levels. In regulated markets, such as those of urban transit in Brazilian cities, such forces are generally restrained, but not necessarily eliminated, by legal devices. Although rivalry between competitors seems to grow in significance, other factors should also be taken into account not only by operators but also by government entities in any attempt to improve the quality of services available to the people.

Actions targeting a change in the economic structure of the transport services must study (even if not exhaustively) these forces. Below is given an analysis of each of these forces in the market under discussion.

Threat Posed by New Entries

When a new company joins an industry, the result usually is an increase in the system's capacity, as well as expectations of growth and gains of new segments of the market. Even if prices do not fall – which is what usually happens in the case of transit – a new entry may intensify dispute and entail marked changes in relative positions.

The power represented by the threat of a new entry in an industry depends on the existence and magnitude of *entry barriers*. There are seven major sources of entry barriers:

(i) government policy;
(ii) need for capital;
(iii) scale economies;
(iv) cost of changes;
(v) access to distribution channels;
(vi) product differentiation; and
(vii) other cost advantages, unrelated to scale of production.

Among the entry barriers found in the urban bus industry, the major barrier in Brazil is *government policy*. The basic characteristic of this policy is the need for a working licence. The transport agencies, which formulate and execute government policy, decide when, how much and where each one of the products will be provided and what each one of the productive units will produce. In this way, the government limits and even prevents the entry of new operators by controlling licences. Even if there is interest and capital available, a potential company may not enter the market without express authorization of the concerned government entity. This licensing mechanism is such an effective entry barrier that an important part of industrial competition may be attributed to the dispute for such licences.

The Brazilian reality has come up with mechanisms that intensify these barriers. The method of *licences per line* ends up consolidating stale markets. The link between line and company has gone as far as not to allow the transference of vehicles from one part of the city to the other, even when there is an evident imbalance between these areas (excess of vehicles in one and shortage in the other).

Government policy is also responsible for other elements which though considered technical requirements, in practice, strengthen the barriers and reduce the number of possible entries. The best example is that the company must meet

the requirement of a certain minimum size – number of vehicles – in order to be able to operate in the city. In practice, this requirement virtually excludes new companies from bidding. Taking into account the fact that the minimum size required corresponds to the number of vehicles necessary to run a set of lines, it becomes potentially impossible for a new company to take part in the bidding for only one line, since its number of vehicles will always fall short of the required minimum. This type of requirement is usually followed by other economic requirements, such as facilities, as well as servicing and maintenance equipment compatible with the number of vehicles. Once again the result is an elevation in the cost of entry and the consequent reduction, if not elimination, of would-be operators.

It is important to point out that these practices are not natural consequences of the *need for capital*. In fact, they reflect an artificial process brought about by government policy. The operation of urban transit should not require such elevated sums. In principle, the two basic components of capital cost – vehicles and facilities – can be reduced by the use of second-hand vehicles, the possibility of leasing, rented facilities, outsourcing of maintenance activities, and so on. However, as a rule, the bidding process still includes vehicles and facilities as requirements. The barriers posed by these demands are strong and decisive, reducing competition and blocking the entry of would-be competitors.

The study of the Brazilian case has already demonstrated that the reaction to the first of these forces that block new entries is the key to the understanding of the economic structure of the markets. Yet, despite the creation of various types of entry barriers, there is a potential for new operators to emerge, which might turn into a real *threat of new participants* which can bring about important changes in the pattern of competition. Among the major elements found in the reality of Brazilian cities, four deserve special attention:

(i) emergence of operators and operations outside the regulatory pattern;
(ii) appearance of some new duly regulated operators;
(iii) reduction of economic barriers in bidding; and
(iv) approach of companies from related sectors in the market.

Emergence of operators and operations outside the regulatory pattern

Operators generically referred to as *clandestine* are present in several cities. The National Association for Public Transport (ANTP) carried out a survey on the magnitude, importance and treatment of these operators in Brazilian cities. Although it is common knowledge that these companies have existed for a long

time, the number of vehicles found was surprising, and even more so was the organization these companies have at present.

Although the survey conducted by ANTP does not provide precise information, some data help reveal the magnitude of these services. To quote: "If we compare only the number of buses, disregarding the several types of vans also used in informal transport, it may be observed that in most of the cities where the phenomenon is found, the clandestine fleet corresponds to ¼th of the official fleet" (Silva, 1993). This is approximately the same as the percentage found in the city of São Paulo (30%), which has about 10,000 vehicles in the regular fleet.

In Rio de Janeiro, the presence of clandestine vehicles (sometimes referred to as *pirates* and *ghosts*) has long been the object of political strife. Ever since the introduction of the flat fare in the city – which led to a drastic reduction in long distance line fares – an important change has been detected: almost all clandestine vehicles have been shifted to inter-urban connections. This shift can be attributed to the fact that long distance lines in Rio de Janeiro, taking advantage of the cross-subsidy provided by the Fare Compensation Chamber, no longer presented attractive fares to clandestine operators. Inter-urban lines, on the other hand, with their relatively higher fares and lower quality services, opened for these operators a niche in the market.

The presence of vans and other clandestine vehicles in an important metropolitan area –Recife, in Pernambuco State – was studied for the first time in 1984 by GEIPOT – Brazilian Planning Transport Company. Later on, Brasileiro and Colucci (1986) detected in two other Recife's area towns the presence of about 600 units that were responsible for 63% of the internal transit lines in these towns. A later survey carried out by the local sector's employers' trade union detected a strong presence of these vehicles on the major highways that link peripheral cities to the centre of the capital.

In Brasilia, the federal capital, it is estimated that the number of vehicles operating outside the regulatory system adds up to almost 50% of the fleet being operated under government control. Three professional organizations bring together these operators in a sort of embryonic entrepreneurial structure, or perhaps a structure which has not yet been acknowledged as entrepreneurial.

After 1996, the presence of this kind of transport operators became more important in almost every medium and large city of Brazil. Actually, they have been challenging the traditional operators by running small vehicles (between 8

and 17 seats) and reaching, in some cases, a share around 25% of the public road transport market (Santos et al. 2001).

Appearance of some new duly regulated operators

Another important phenomenon that is changing the present pattern of competition in the urban bus industry is the appearance of new duly regulated operators linked to economic groups pertaining to the construction industry – most notably, highway construction. In a bidding carried out in São Paulo in 1994 for the construction and operation of transport corridors, no interest was shown by traditional operating companies, which did not take part in the bidding. Some contractors from the public construction field, prompted by their own shrinking market, launched themselves in what was, for them, a new market. In eleven out of the thirteen corridors offered in the bidding, only one competitor was present.

Reduction of economic barriers in bidding

One possible reason for the lack of interest shown by transit operators in the bidding for these corridors was the fact that the bidding included both the construction and the operation of the corridor. This represented an economic barrier, since the operator was required to have enough capital, or at least the capacity to obtain credit, for a two-year construction project.

Still considering São Paulo, the bidding procedures adopted in the *privatization* of CMTC, the São Paulo Municipal Bus Company (over 2,500 vehicles), help understand the potential for change in the sector's competitive pattern. The bidding was limited to the management of groups of CTMC vehicles, and of the operational infrastructure (garages, equipment, etc.). In dispute were the monthly payments for the use of vehicles (and infrastructure), which would continue to be owned by the city of São Paulo. Economic barriers were, thus, reduced. A potential competitor would only need to have managerial capacity, not a major problem nowadays. All that was necessary was to know where this capacity could be 'bought', since there are a number of highly specialized professionals currently working in this field, most of them linked to transit operators.

Approach of companies from related sectors in the market

An example of companies that perform related services and are now approaching the market of public passenger transportation was seen in the bidding

for collective transport services that took place in Betim (State of Minas Gerais) in 1995. The winner was a company economically related to the garbage collection sector.

From the point of view of the influence exerted on the pattern of real and potential competition between regulated operators, these findings reinforce the previously stated hypothesis that, in case changes occur, and legal and economic barriers (or, at least a significant part of them) are eliminated, there is a great number and variety of companies executing economically close or related activities that would be able to join this market.

Besides entry barriers, there are also exit barriers that may prevent a transport company, even the one suffering from financial problems, from ceasing to operate and seeking new markets. The exit barriers are usually high labour costs or difficulties the company faces in disposing of assets, which might entail great losses or even legal sanctions (poor credit standing, for example). At the opposite end of this problem, in certain situations, the possibility of strategic interrelations with other companies of the same economic group (whether transport operators or not) may be seen as exit barriers.

Threat Posed by Substitution of the Product

Classically, a product may face competition from and even be eliminated from the market by another product that replaces it with advantages. These advantages are not necessarily financial. Urban transit services face continuous competition from other means of transportation. In the social-economic reality of Brazilian cities, walking may pose serious competition for short-distance trips, in case fares are high or itineraries are inadequate. Intermodal integration policies may also reduce the demand for direct lines. Technological advances that eliminate the need for people to move from one place to another would represent the major portion of this type of competition. However, in this particular case, taking into account the social-economic characteristics of the great majority of users, this type of threat is not significant.

Purchasers' Negotiation Power

In free markets, the purchasers' negotiation power aims to reduce the product price and, consequently, lower the market's profitability. This power is stronger when concentrated, that is, when the purchaser acquires large quantities. It is also stronger when the purchaser is completely aware of the production costs. In the case of urban transit, it can be said that purchasers fall into two categories: users and the governmental agencies.

Users are usually too dispersed, have very little power and are unable to exert pressure on prices and quantities, although in some cities their claims receive support from officially organized councils. On the other hand, the spatial organization of urban transport systems usually reduces the choice to only one supplier which leaves users with little – or almost no – possibility of influencing competition.

The implementation of the 'vale-transporte' ('travel voucher') changed this situation from the standpoint of the user (Orrico Filho et al. 1982). This instrument of fare policy made employers buy travel vouchers directly from the transit services: companies pertaining to certain economic sectors, such as civil construction, began to purchase a large number of vouchers every month in order to distribute them among their employees as a work-related benefit. This represents more than a mere concentration of users; it means leverage in negotiations, a force which, though still unable to influence the conditions of competition in the sector, may in the future alter the profitability of the group of companies operating in the city.

The Brazilian reality shows a very strong evidence of reduced negotiation power of the government agencies in terms of prices, that is, in the establishment of fares, and this is partly due to regulations. Note that the public office, besides being unable to exert control over prices and production costs, is forced to cover expected service costs, previously established by means of a price chart (spreadsheet). Another significant issue is the political situation: heavy pressure, particularly the one related to political parties, contributes to the spiraling elevation of total unit costs (Santos E., 2000).

In instances where the government agency gives financial assurance – public revenue model or use of subsidies – the purchasers' role in the negotiations is much more decisive in their attempt to reduce profitability and, consequently, the fares. There are many examples of changes in the relationship between the operators and the public agencies that were caused by changes in the 'return model'.

Suppliers' Negotiation Power

It is not only the behaviour of purchasers – both transit users and governmental agencies – that influences competitiveness between companies. As a rule, the providers of a specific service also interact economically with the suppliers, from whom they purchase input. The suppliers, in turn, aim to raise their own returns, and their actions to that effect may affect the profitability of

the service providers in that market (transit). Two basic types of action warrant mentioning: suppliers may increase the price of the products or services offered – thereby reducing the margin of profit of the buyer – or else threaten to produce the goods or services that the provider (now in the position of buyer) supplies – a clear threat of entering the market.

In the case of suppliers, the transit market presents two unique features that deserve attention. First, there is a distinct structural difference between suppliers and operators in terms of the nature of their economic activity; the former produce goods and the latter provide services. By principle, this means different entrepreneurial cultures, spatial concentration or dispersion of investments, etc., all of which do not make it attractive for suppliers to directly produce urban transit services.

Excluding the workforce, the three main inputs (vehicle, fuel, and parts) are concentrated in an extremely reduced number of producers who have an enormous productive capacity installed in large industrial plants, and whose markets are oligopolistic or monopolistic on a national scale. However, the market relations between these suppliers and the transport operators show agreement rather than antagonism, due to the power of the suppliers. This agreement is reflected in joint venture operations in interface activities, such as vehicle resale, or in related activities, such as fuel transportation. Such long-term agreement follows the logic of maintaining clients.

The vertical economic inter-relationship of production in this industry shows input suppliers and service producers share similar interests. This is in direct opposition to Porter's suggestion that suppliers are potential competitors. The process of price formation – the elaboration of a fare spreadsheet – and the goal of maintaining the economic-financial stability of the contract straighten the relationship between operators and input suppliers, so as to elevate the sector's profitability.

The basis for these common interests is that input prices are established by suppliers in figures higher than the actual ones, thus increasing their clients' profits. Any supplier interested in expanding the level of his activities is interested in maintaining highly capitalized clients. On a secondary level, if we consider how fares are calculated, the quick renewal of fleet also raises the fare and thus the operating company benefits twice: from its profits and from the increase in its property value. It is *even more* interesting for any supplier interested in expanding the level of his activities to maintain clients that not only possess capital but are also *extremely eager to increase the value their property*.

This practice can be clearly observed from the different values listed for the invested capital in vehicles found in the spreadsheets of the agglomerations studied, especially when we consider the similarity between makers and models. Some transport agencies have opted to introduce a factor aiming to reduce the established price and attenuate for this distortion.

Even stronger evidence that shows how the interests of input suppliers and service providers converge is the fact that several companies that operate in transit maintain economic relations with authorized dealers of input manufacturers, particularly, vehicles. In extreme cases, they belong to the same owner or entrepreneurial group.

Another point worth mentioning is that local interests, particularly those of the political parties, may frequently lead to an interest in the purchase of a new fleet. This might function as an accelerator in the fleet renewal process and might also explain why the transport agencies' purchasing power has been reduced, as described above.

Rivalry between Present Competitors

In a free market, rivalry between competitors usually constitutes one of the strongest forces in the competition. Michael Porter classifies this rivalry in three very suggestive types: bellicose, sour and ruthless.

The factors that define the intensity of this competition are many, ranging from direct economic aspects to differences in growth and expansion strategies within the market. In an extreme case, even personal matters may turn into barriers that block the exit of a competitor, who is forced to stay in the market even when it no longer pays to do so.

A detailed analysis of the types of competition found in the cities and agglomerations studied has already been presented in this paper. What remain to be defined are the number and types of present competitors, their position in the market, particularly their strategies as well as their strengths and weaknesses. Recent surveys show the sector's present concentration: micro and small companies – with 5 to 10 vehicles in their fleets – coexist with mega companies that own hundreds of vehicles, and also with entrepreneurial groups of up to 35 companies, which have about 5,000 buses operating in several states of the federation. Needless to say, these companies present different degrees of organizational and entrepreneurial culture, ranging from home scale, or family administration to highly professional administrative structures. A study of the current situation of the competitors is crucial for the formulation of public policies for the sector.

CONCLUSIONS

If we analyze the real conditions for competition in the sector along with the presence and strength of the elements of competition between companies, we find that the three basic forms of dispute coexist: dispute for user, for the right to establish production plants and for transference of revenue from one line to another.

There is a certain *ideology* related to competition, leading us to believe that competition is reduced to dispute for users. However, the basic dispute concerns the *right to establish production plants*, that is, at the core of the competition lies the opening of new lines and/or the expansion of services. The most outstanding evidence for this is precisely the large scope of legal and practical devices that aim to prevent access to the market. The favourite target of restrictions is a potentially new operator.

The dispute for users – observed by the presence of vehicles from many companies in the same physical and economic space, according to the *free entry* or *deregulation* pattern – poses serious operational problems, such as excess of supply, aggravation of urban circulation conditions, and raising of atmospheric pollution rates, besides serious economic consequences, such as private regulation of entry to the sector and elevation of fares. This has occurred in cities that have implemented such economic regulations, especially Santiago, Chile and ten years later Lima, Peru.

The idea that the only possible form of competition in urban public transport is that of dispute for users is, in reality, a myth that helps protect against any attempt at real change that might in some way reduce the profits of the existing operators. It is obvious that this myth clashes with the new paradigms of permanent search for gains in quality, productivity and competitiveness. This becomes even more evident when one believes that the need to transfer these gains to society is a basic requirement for expansion and even for the survival of companies in today's markets.

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URBAN TRANSPORTATION IN DEVELOPING ASIAN CITIES: Some Important Issues in Sustainable Development

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INTRODUCTION

Over the last two decades, there has been rapid population growth and spatial expansion of most Asian cities. Even in the period between 1995 and 2000, a considerable part of which remained overshadowed by the Asia financial crisis, the annual average growth rate of urban population for the Asia Pacific region was 2.67 per cent, greater than the global average of 2.11 per cent. The growth rates of many fast growing cities exceeded 5 per cent. An estimated 37 per cent of the Asian population now lives in urban areas, which is expected to increase to 46 per cent by 2020 and 53 per cent by 2030. In terms of absolute numbers, the urban population was 594 million in 1975, which increased to 1,352 million in 2000 and is projected to increase to 1,970 million by 2020.[1]

This rapid growth of cities has led to a sharp increase in demand for urban transport facilities and services in many cities in the Asia Pacific region. However, several factors have hindered the adequate provision of transport infrastructure and services to match the ever-increasing demand. In many cities, densification and spatial expansion have occurred with little or no development planning, while in some cases the failure of the instruments of governance has resulted in a significant wastage of resources or provision of inadequate and substandard quality of infrastructure and services. Furthermore, the huge capital costs and time required to develop high capacity transit systems have prevented the timely implementation of such systems in rapidly growing urban areas. As a result,

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many cities have relied on road-based systems which have serious capacity constraints, negative environmental consequences and other limitations.

Consequently, a number of cities in the region are facing many problems, including serious congestion, air pollution from transport sources, high rates of traffic accidents and inadequate access to transport facilities by the poor and vulnerable groups, such as people with disabilities. The deteriorating urban environment threatens the "liveability" and productivity of many cities. In some of the major capitals, such as Bangkok, Dhaka, Manila and New Delhi, the situation is so serious that the efficiency of their urban economy is negatively affected, as is the health and welfare of the people living in them.

An important feature of the current transportation system of most of the developing cities in the region is that they are at a transitional stage. They are gradually changing from dependency on low-cost modes to mixed modes with low-cost bus systems and then to a mixed system with heavy bias for private motor cars.

The current trends in development with strong emphasis on supply side measures and with little or no articulation with land-use planning, and overall urban development and management policies are clearly not sustainable on ecological, economic, financial, social and institutional considerations. Many of the transport solutions are also not uniformly effective for the disadvantaged and poorer sections of society. This affects their personal attainment and welfare as well as hinders the overall development process.

In this paper, first the concept of sustainable transport is explained following which some of the major issues in sustainable urban transport development in the developing cities of the region and possible policy responses and actions needed to address them are discussed.

THE CONCEPT OF SUSTAINABLE TRANSPORT

The concept of sustainable transport is derived from the general term "sustainable development" which has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[2] In the case of transport development, this definition implies creating transport systems that provide for safe, economically viable and socially acceptable access to people, places, goods and services, and ensure optimum utilisation of scarce natural resources, and where any negative impacts arising out of these activities are within the capacity of the natural and social

systems to absorb them.[3] In more explicit terms these requirements may involve:

- Efficient use of scarce natural and physical resources;
- Minimisation of capital resource requirements;
- Reduction of the different forms of negative impacts on the environment;
- Reduction of adverse impacts on safety, public health and other social concerns;
- Conservation of energy;
- Social equity;
- Implementation of good governance; and
- Improvement in overall quality of life.

What these involvements can mean to achievable broad objectives of sustainable transport development is now explained.

Economic efficiency – The inherent characteristics of different transport modes require that to improve overall efficiency each mode should be used for what it does best in an overall transport chain. This requires a fundamental change in the traditional way of looking at transportation. A mode should be considered only as a link in the transport chain and the whole issue of transportation from the origin to ultimate destination needs to be considered. For all major passenger and goods movements, integration of concerned modes from the origin to ultimate destination should, therefore, be the strategy of future transport development. Pricing should reflect the true cost of transport facilities and services so that distortions in modal choice, generation of externalities and misallocation of scarce resources can be avoided.

Ecological and environmental sustainability – Transport development should encourage most productive use of natural resources and at the same time minimise their total consumption. It should also promote truly sustainable (modes which do not consume commercial energy or use renewable energy) and more energy efficient modes.

Aim for variety – It means providing a choice of alternatives for a variety of travel needs for the different sections of urban community. This would require encouraging mixed land uses within certain limits at higher densities so that people have the opportunity of living closer to their places of work, and other essential daily activities. In transport terms, this means aiming for accessibility rather than mobility. This can reduce the need of long-distance travel by mechanised modes and people can be more dependent on ecologically sustainable non-motorised modes.

Provide a human scale – The prime element of any transport system is its users. It is important that urban transport development takes everything in human scale. Whether people feel welcome or alien contributes much to the vitality of an area. Urban transport development should aim at creating urban areas where various activities like living, work, schooling, shopping, recreation, etc., and the movement of people and goods, can be carried out safely, efficiently and with amenity.

Social equity – Personal attainment and welfare of the poor and other disadvantaged groups in society much depend on their access to transport services. As such, their basic mobility needs should be an important consideration in transport development and should be carefully balanced against operational and environmental factors.

Improvement of governance – Introduction of wide participation of all stakeholders, including the community and all sections of the people is needed to bring qualitative improvement in planning and decision-making by ensuring transparency, accountability and equity which are some of the core principles of good governance. Participatory approaches to planning can deal with the various issues of cross-cutting nature and accommodate controversial complex interests and opinions from diverse layers of society. Genuine participation can also lead to greater vitality. In fact, without participation of all the concerned actors it may not be possible to implement "hard" policy choices in transport development, such as demand management measures.

Considering as a whole – Some of the above objectives could be conflicting in nature. Their resolution will, therefore, require a creative approach to develop an integrated plan for the whole transport system and its articulation with the overall urban development process. However, in most cases an institutional mechanism and capacity building of urban local governments may be required to prepare such a comprehensive and integrated plan.

MAJOR ISSUES OF CONCERN

In the light of the above discussion, this section reviews the major issues in sustainable urban transport development that most of the cities in the region are facing.

Growing Motorisation

While the level of motorisation in Asian cities is still much lower than the levels in American or European cities, a trend of rapid motorisation is evident

in almost all of them. Apart from a few cities in Central Asia, there has been a considerable increase in the motor vehicle populations of all major cities. However, there are significant variations in the level and rate of motorisation between cities, due partly to differences in income levels and government policy.

For example, the number of road vehicles in Bangkok grew more than seven-fold between 1970 and 1990. The vehicle population of Beijing grew about three-fold between 1991 and 2000, from 540,000 to 1,570,000. Similar trends in growth occurred in Jakarta and Kuala Lumpur. Since the late 1990s, Indian cities have also experienced rapid growth rates of their vehicular population, following the introduction of economic reforms that lowered costs and increased the affordability of passenger cars. For example, Mumbai has registered an annual growth of motorised vehicles of about 10 per cent in recent years, while between 1995 and 2000, Delhi's total motor vehicle population grew from 2.4 to 3.3 million, of which the car population increased from 576,000 to 837,000.[4]

The exponential growth of motorised two- and three-wheelers is another visible trend in Asian cities. In many countries, such as Thailand, Malaysia, and Indonesia, two- and three-wheelers make up over half of all motor vehicles. Bangkok currently has an estimated 2 million motorcycles. Ho Chi Minh City in Viet Nam and Penang in Malaysia have about 300 motorcycles per 1000 persons. The number of these vehicles is expected to grow very rapidly in China, Viet Nam, India and other low-income countries; for example, it is projected that there will be 70 million motorcycles in China by 2015.[5]

It is expected that the developing cities in the region will continue to experience high rates of vehicle population growth, particularly in the case of private vehicles, for many years to come. This is partly due to government policy, which has significantly influenced the growth of motor vehicles in many countries. For example, despite their comparatively lower average income levels, car ownership rates in Bangkok and Jakarta are much higher than in Singapore and Hong Kong. The current problems of urban congestion, air pollution, health and safety issues and other associated problems in many Asian cities have resulted primarily due to unlimited growth of motor vehicles and their unabated use. There are however, other factors, such as planning and institutional problems and governance issues which also have their fair shares for the blame.

Congestion

Congestion is a common mark of motorisation in most growing cities of the region. The central parts of many capitals, such as Bangkok, Delhi, Dhaka,

Jakarta, Metro Manila, and Seoul, are seriously congested, with weekday peak-hour traffic speeds reported to average 10 km per hour or less. One estimate puts the average travel time for work trips in Asia at 42 minutes.[6] In large cities, this can be much higher, as in the case of Bangkok, where the average is estimated to be about 60 minutes. Delays due to congestion account for a significant proportion of the total trip time.

The estimated social cost of congestion could be enormous. A study in 1995 estimated the direct economic costs of congestion in Bangkok at 163 billion baht annually. The total cost represented 27 billion for the additional costs of vehicle operation, 20 billion for additional labour costs, and 116 billion for passengers' lost time.[7] The total cost, however, did not include the cost of damage to the environment or human health. In many cities, the level of congestion is so high that even a moderate reduction could provide significant benefits. A recent World Bank study estimated that a 10 per cent reduction in peak-hour trips in Bangkok would provide benefits of about US$ 400 million annually.[8]

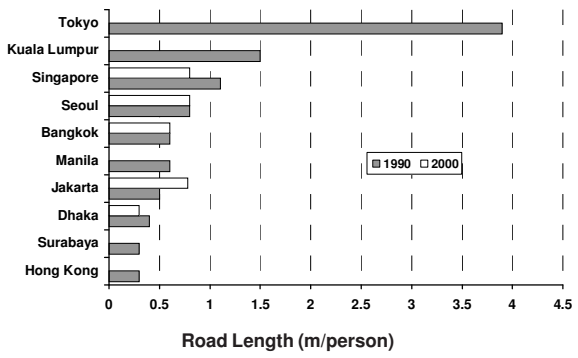
Financial Burden on the Public Exchequer

The growth in motor vehicles has led to increased demand for new and improved road infrastructure and services, which require massive investments of financial and other resources. For various reasons, many governments have found that it is difficult to fund transport infrastructure projects by charging the users directly. Consequently, transport infrastructure development has remained mainly the responsibility of the public sector, putting an enormous financial burden on national and urban local governments. For example, during the Seventh Plan period of Thailand between 1992 and 1996, the total investment for road infrastructure projects in Bangkok alone amounted to a staggering 142 billion baht, or about US$ 5.7 billion. The private sector contribution made up 20.5 per cent of the total.[9]

Despite such investment efforts, Bangkok still enjoys much less road space in terms of road (to total area) ratio and network density compared with Tokyo, London, Singapore, or New York.[10] While any direct comparison of road mileage between cities may not be meaningful due to variation in their physical, social and economic characteristics, and characteristics of the transport system, it can provide some indication about the difference of availability in road infrastructure. As shown in figure 1, despite attempts to create additional road capacities, availability of road spaces has remained far below the level of developed cities and has not changed much during the last decade. In fact, in some cases it has deteriorated. More importantly, as current evidences from developed cities suggest, even achieving their level would not solve the problem.

Health and Safety Issues

Figure 1 : Road length per capita in selected Asian cities in 1990 and 2000



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Vehicular emissions have become a major source of air pollution in many cities. In Bangkok, Beijing, Delhi, Dhaka, Karachi, Jakarta, Manila, Mumbai, Seoul, and Tehran, suspended particulate matter (SPM) exceeds the World Health Organisation guidelines by more than a factor of two.[11] The conditions are no different with respect to the levels of other pollutants, such as carbon monoxide, sulphur oxides, lead and nitrogen dioxide. Such poor air quality conditions prevail despite relatively low levels of motorisation and vehicle use per person, by global standards. The existence of a large number of vehicles with poor emission control standards and the low quality of available fuel are the two primary reasons for this situation.

In some cities, the use of three-wheelers with two-stroke engines has further aggravated the situation. For instance, Dhaka has an estimated population of 70,000 three-wheelers. These three-wheelers emit 30 times more pollutants than a normal car.[12] The cost of pollution in some cities is colossal: the World Bank, for example, estimates that the public health cost from air pollution in Jakarta alone will cost Indonesia US$ 220 million a year. In Bangkok, Jakarta and Kuala Lumpur, the annual costs from dust and lead pollution are estimated at US$ 5 billion, or about 10 per cent of combined city income.[13]

Social and economic costs of accidents are also very significant for developing cities. Economic losses due to road accidents are in the order of 0.2-4% of GDP in the developing megacities.

Other Social Issues

Problems faced by the urban poor – In many countries, access to urban transport services by the poor is a common problem. The problem arises due mainly to lack of affordable appropriate transport services to the poor. It can be more serious in rapidly growing developing cities. As the poor generally live in

marginalised areas and settlements far away from jobs and services, they are often badly served by transport services. In large developing cities, the poor find it difficult to obtain jobs or have access to social services partly because they are required to travel a long distance, which they cannot afford. Their income-earning ability is severely constrained by long commuting time, out-of-pocket costs, and the access and waiting time to available public transport services.

The urban poor and other disadvantaged users are highly dependent on public transport services for their physical access to jobs and services. But there are not many cities in the region where such services are provided and organised to serve the needs of the poor and other groups with special needs.

The urban poor rely heavily on non-motorised transport (NMT), including walking. But conditions for safer use of NMT get least attention and are often neglected. Increased dominance of private cars marginalises or displaces NMT and public transport upon which the poor depend heavily both for making their living and for services. In many cities, transport development remains focussed on private car-centred interventions. The poor and other disadvantaged groups do not benefit much from these types of interventions. Moreover, they are vulnerable to consequences of motorised traffic, such as accidents, and also suffer from the highest exposure to pollution from motor vehicles.

In many cities, the poor also depend upon informal transport, which comes in fleets of a variety of small, low-performance vehicles. The main benefit of informal transport is that it provides much-needed and much-valued mobility for the urban poor as it fills the gap left by the inadequate and poor transit system and serve the needs that transit systems cannot effectively meet. It is also a major source of urban employment in poor economies and may provide as much as 15 per cent or more of total employment.[14] Nevertheless, due to significant negative externalities, such as traffic congestion, accidents, and pollution the social costs of informal transport can also be fairly high. As these services are generally unregulated and unregistered, improvement of conditions for safer operation and use of informal transport is not generally considered within the mainstream policy making and their operation can be constrained due to lack of helpful policies and various restrictions which are harmful for the poor.

Transport needs of women – The transport needs of women are somewhat different from those of men and, as such, they face additional constraints. While inadequate transport services affect all, women travellers can face particular mobility constraints in many cities due to social and cultural norms. Very often the transit service provided in the cities of developing countries are highly

congested, insecure and unsafe. It is difficult for women to compete with men even for a modest space on-board. In the absence of adequate transport, many women are forced to rely on more expensive modes of transport, or to spend more time walking or simply to abandon the idea of making a trip. They may also risk sexual and other forms of harassment. These adverse conditions can seriously limit women's labour force participation and access to facilities and services, which affect their personal attainment and welfare.

Special needs of disadvantaged groups – People with disabilities, children and senior citizens rely heavily on public transport services and pedestrian facilities. However, conventional systems in most cities are not readily accessible to these groups of people. Even pedestrian facilities to accommodate their special needs are generally absent and in many cities this is not even recognised. It is not always true that large sums of additional investments are required to accommodate the special needs. As a matter of fact, the lack of awareness of planners and decision makers about the special needs of this group is the major problem. As an example, a simple ramped sidewalk can greatly facilitate wheelchair movement and at the same time benefit other users. In the absence of proper facilities and services, the basic mobility needs of these groups remain largely unmet which seriously limits their capabilities and affects their welfare.

Issues in Governance and Institutional Problems

Lack of participation by stakeholders in the planning process – A common deficiency in the past practices of urban transport development has been that not all stakeholders have been involved in the decision-making process. The traditional top-down approach to transport planning and the proposed solutions reflect largely professional points of view. Consequently, the policy prescriptions lack general public support and authorities fail to implement many of the crucial "hard" choices particularly related to traffic restraint and demand management measures. Allegations are there that in many cases business interests of the contractors and pecuniary interests of the decision makers have been overriding in deciding about major transport infrastructure projects.

Although changes have been initiated in some countries, institutional mechanisms to ensure the participation of all social groups including women, the poor and other marginal groups in the development process are still largely non-existent. Here participation means, as perceived in an ESCAP publication, contributing to development, benefiting from development, and taking part in decision making about development.[15] While the ways in which the involvement

of all social groups is organised may be open to debate, its justification cannot be underestimated.

Shortcomings of the planning methodology – The conventional transport planning methodology aimed at meeting the mobility requirements of the car-centred societies fails to appreciate the problems and opportunities available in the cities of this region. An alternative accessibility approach to urban transport planning, which addresses the needs of the community rather than focussing on the movement of individuals, deserves serious consideration by the planners and policy makers in the region. Sufficient evidence exists that cities which have followed the accessibility approach to planning, have been more successful in addressing transport problems than cities which have followed the mobility approach.

Traditional planning hardly recognises the special needs of women, the elderly, people with disabilities or any other groups in society. However, needs of these special groups require to be assessed separately to address the issue of social equity.

NMTs including walking remains to be a viable option to meet the basic mobility needs of all groups in a sustainable way. Unfortunately, NMTs have received least attention in traditional urban transport planning due to shortcomings of the planning and project evaluation methodologies, and apathy in public policies in many cases. Consequently, their needs are either overlooked or totally neglected. To articulate the role of pedestrians, non-motorised vehicles (NMVs) and other informal transport, the need for these modes of travel should be assessed separately in the planning process.

Lack of capacity and inter-agency coordination – Many alternatives are available to address the future transport development in Asian developing cities. However, given the constraints, these cities need to consider a gradual/incremental approach with a long-term strategy for all future development in the urban transport sector. In this respect, the need for strategic planning is paramount. Nevertheless, strategic planning founded on a high level of technical and professional competence is seriously lacking in most of the countries in the Asia Pacific region. Decisions are generally taken on an ad hoc basis. The lack of capacity of urban local governments and institutional problems related to inter-agency coordination are the major obstacles to successful strategic planning and implementation. Although lack of technical and professional capacity of urban local governments has often been identified as an issue of major concern, not much has so far been done in this regard.

POLICY RESPONSES AND ACTIONS NEEDED

Governance and Institutional Issues

The role of government – There is a need for change in the role of government. As the private sector can increasingly take on the responsibility for providing, operating and financing transport services, and even some transport infrastructure through concession arrangements, the role of the government as supplier or quantitative regulator will be reduced, but the importance of its functions as the qualitative regulator will increase. The government should also have a strong role in strategic planning based on a vision for future development and creating an environment conducive to private sector participation in the urban transport sector. The strategic plan should define the role of the private sector and guide its participation.

The need for an integrated comprehensive planning process – A fundamental change in the planning process is required to introduce participatory approaches to planning and decision-making. Inclusive "bottom-up" participatory approaches that incorporate community consultation and wide participation by all stakeholders including all social groups, women and other disadvantaged transport users can greatly improve governance in the sector and enhance sustainable urban transport development. They are also more likely to win public support, especially when questions of difficult policy choices and public actions arise, for example, in the case of urban transport demand management. It is vital that all stakeholders be involved in a transparent decision-making process to seek inter-disciplinary solutions to urban transportation problems. A recent work by UN ESCAP in Bangkok is an example in this direction.[16]

Decentralisation of the planning process and devolution of power at the local/community levels are essential to institutionalise participation in a meaningful way. These in turn would require administrative reform, social mobilisation of the poor and other marginal groups, and comprehensive development programmes with a focus on supporting the needs of disadvantaged transport users in society.

Planning methodology – There is a need to develop operational planning methodologies to follow the accessibility approach to urban transport planning in developing cities. Some notable works have already been done.[17] However, more works would be needed to develop suitable methodologies in the areas of assessment of special needs of different social groups, integration of non-motorised modes in the overall system, development of transport chain, integration of public transport modes, and urban goods distribution system. There is another area in

which the traditional methodology has serious deficiency i.e. economic, social and environmental elements are not integrated in the plan/project appraisal process. These elements ought to be integrated in the appraisal process to ensure sustainable development.

Capacity building of urban local governments – Lack of capacity of urban local governments, both in terms of availability of human resources and their technical and professional competence, is a serious problem in many countries. Most of the planners are trained in traditional transport planning, which had been developed in the context of developed countries and is not much relevant for developing Asian cities. The technical and professional competence of human resource is a critical factor in implementing sustainable development. Some of the important areas in which planners need to be trained/retrained include new methodologies as mentioned above, participatory approaches, application of new technology including intelligent transport system for the management of urban traffic, universal design, private sector participation, strategic planning and inter-agency coordination.

Policy Issues

Development of a long-term vision – It is vital for any city to have a vision for transport development. Without a vision, development efforts become ad-hoc, and remain unguided. A vision sets the direction for development and guides the formulation of broad policy measures and strategies to attain certain objectives.

A vision is needed for a long-term balanced and integrated transport system development, which can address the present deficiencies and at the same time meet the future requirements. The vision should be realistic and based on wide consensus of all concerned stakeholders. It should be developed recognising current developments, potentials of growth, and general trends. It should also take into account the changing needs of the people, their aspirations, welfare and affordability, system efficiency, effective utilisation of the existing facility, technological development, and various other issues related to economic, financial, social, ecological and organisational sustainability. Actions in transport development cannot deliver their expected benefits and meet the needs of the people without having such a vision and its accompanying broad strategies.

Sustainable pricing of transport infrastructure and services – Unmanaged growth of motorisation is the root cause of many of today's urban transport problems. Due to imperfect systems of transport pricing, prices do not reflect the true cost of the provision of transport services and facilities. Consequently, this

has led to a waste of resources, insufficient funds to develop and maintain infrastructure, distortions in modal choice and the generation of externalities (pollution and congestion). Ideally, an efficient pricing system should be in place to realise the full cost of travel from the motorists to rectify the current situation. Alternatively, serious consideration needs to be given to the introduction of measures which include, *inter alia*, restraint and demand management measures to control the growth and usage of motor vehicles, particularly the usage of private cars.

For high-density cities in the region, aiming at a transition from their present traffic saturation and dependency on low-cost mixed modes towards a transit city is a more desirable and feasible course of action than allowing uncontrolled usage of private cars, which leads to intractable traffic and environmental problems. Introduction of an efficient pricing system or the imposition of restraints on car usage and pursuing travel demand management (TDM) policies aimed at drastically reducing traffic levels and slowing down the growth of car ownership are crucial for achieving such a transition.

Private sector participation – A regulated private sector aimed at providing transport infrastructure and services can address many of the current problems. Private sector financing is important for project implementation. However, current approaches like the so-called BOT may not be sufficient to solve the problems particularly relating to development of new public transport systems. It is worth mentioning here that despite the rhetoric about BOT projects, the number of such urban transport projects completed is surprisingly very small. Moreover, such projects took place in just five countries.[18] What is needed is various types of long-term partnership arrangements between the private and public sector. Total reliance on the private sector, as the tendency appears to be in some countries, can have undesirable effects. It may at best generate new businesses or replace the existing ones, but may not solve the transport problem. Public policies should focus more on how PSP can deliver investment in the public interest.

Subsidy to public transport – There are arguments in support of providing subsidies to maintain a minimum level of public transport service. Direct targeting could be difficult as most of the poor in developing cities work in the informal sector and may not be concentrated in any particular locality. Providing general subsidies to maintain a minimum standard of transport services for the poor may not always be a good policy instrument. As discussed below, governments may, however, consider providing support to developers in different forms to introduce environmentally friendly new technology or to develop new systems, particularly for infrastructure.

New technology – Adoption and/or formulation of technology standards supported by regulatory and promotional measures can greatly help in optimising vehicle design for emissions, power, efficiency and cost. The technology policy can lead to introduction of cleaner fuels, reduced emissions of GHG gases and other pollutants, banning/restriction of certain engine technology and use of alternative fuels. Promotion of alternative fuel technology for public transport vehicles can be actively pursued through economic incentives and other concessions to their operators.

Planning Issues in Transport System Development

The need for improvement of public transport system – The low quality of public transport services directly affects the poor and other disadvantaged groups in society. Improving the services, particularly bus services, to meet the basic travel needs of these groups at an affordable level can enhance their potential access to social and economic opportunities. As the quality of transport services is generally income-elastic, improvement of basic services has the greatest potential to benefit the disadvantaged groups.

A mixed-mode transport system with a wide variety of integrated public transport modes should be promoted to cater for the needs of different income groups and different types of trips. In a multi-mode/multi-operator environment the utility of public transport systems is greatly enhanced if different systems can be integrated to facilitate unimpeded movement of passengers across a city. Organised facilities to allow convenient interchange between different modes of public transport should be considered.

In the big cities, the prospect for investment in mass transit systems should be secured, if necessary with subsidies or other types of support (such as partial risk guarantee scheme) to the developer(s), to reflect the substantial amount of uncaptured external benefits of such systems. It may be mentioned here that a recent study by the International Finance Corporation has estimated the total external benefits of the BTS rail transit system in Bangkok at about 35 % of the total investment cost of the system which cannot be captured by the developer.[19]

The issue of an integrated transport system – The integration of the formal and informal modes of public transportation and non-motorised transport (NMTs) is vital for the development of a sustainable urban transport system. However, the success of such integration would greatly depend on land use planning. Mixed type of land uses with decentralised developments or multiple mixed-use

centres served by integrated corridors of development can provide high accessibility for most of the services and workplaces and thus reduce the need for long distance trip-making by motorised modes. Limiting the number of long trips by motorised modes could also be a key to the success of integration of NMTs with various motorised modes.

Promotion of NMTs – Since NMTs, including walking, remains to be a viable option to meet the basic mobility needs of all groups in a sustainable way, there is a need to promote safe operation of NMTs. Policies and investments should be directed to enable greater use of NMTs by providing suitable rights-of-way (shared or exclusive) and pedestrian facilities, and devoting attention to safety issues. Creation of pedestrian friendly roads and areas should be a priority in the planning of all cities, irrespective of their size and state of development.

Informal transport – Informal transport does not mean that services be provided by using extremely low-quality vehicles and with no regard for safety.[20] Since informal transport is pro-poor and has the potential to address many of today's urban transport problems, serious consideration needs to be given to their formal recognition, overall integration with the urban transport system. Steps should be taken towards the elimination of all barriers limiting their entry to the market, with the possible exception of primary roads that are already congested and well served by high capacity public transport systems. However, they should also be subject to reasonable safety standards and regulations.

Gender issues – To address gender issues effectively, it is necessary to integrate the transport needs of women into the main stream of transport policy and planning which may be facilitated by the participation of women in the decision-making process.

The issue of equity – Mobility needs of the disadvantaged transport users (in social, economic or physical terms) should be an important consideration in planning and policy development. Promotion of universal design concept, particularly in the planning of new facilities and services should be an important policy decision by the government to make the transport system accessible to all.

Urban Planning : The Essential Link to Build a Physical Foundation for Sustainable Transport Development

This has long been recognised that urban planning and transport planning have strong relationships and that they cannot be considered in isolation since the urban transport is a sub-system of the urban system. Nevertheless, for various

reasons, this is conveniently forgotten when it comes to practice. The issue of road development is a good case in point.

For urban road development, very often considerations remain basically limited to the establishment of a strategic network of primary roads. The issue of secondary roads does not receive much attention and remains neglected. However, the primary roads alone cannot ensure the physical foundation for sustainable urban transport development. Experiences from Bangkok and many other cities in the region suggest that super-blocks created by primary roads always remain deficient in secondary roads. As a result, a chaotic pattern of local roads emerges, which hinders efficient provision of public transport utility and other urban services. The idea that a physical foundation for sustainable urban development can be provided by supplying appropriate road and other infrastructure through public-private partnership efforts (such as land readjustment) has not been duly considered in most of the cities in this region. Strong land development and land use policies can promote the evolution of public transport supportive and environmentally amenable land-use patterns to support sustainable transport as well as urban development.

CONCLUSIONS

Transport planning and urban development efforts in most of the developing cities have not been much in the direction of sustainable development and have largely failed to meet the challenges of rapid urbanisation. A departure from the conventional planning practices is necessary as they are more suited to developed countries and are not very appropriate in the context of developing cities. Institutional weaknesses and issues related to good governance also need to be addressed. To meet the challenges of sustainable development, serious consideration needs to be given to introducing comprehensive and integrated approaches to planning with the participation of all stakeholders, including the marginal groups in society. Governments can initiate necessary legal and administrative measures for institutional development to facilitate such approaches to planning, which, in turn, can tackle many other issues in due course.

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20. With the ease of restrictions and imposition of some regulatory measures, there has been dramatic improvement in both quantity and quality of supply of informal transport by "vans" in Bangkok. These air-conditioned vehicles can seat up to 14 passengers and have rapidly become the transport choice of middle class sub-urbanites who have limited access to private cars. There are now estimated 4,000 vans serving about 100 routes. They provide quality, point to point service, focussed mainly on the work and school trip markets.

TRAFFIC SAFETY AND HEALTH IN INDIAN CITIES

Dinesh Mohan*

INTRODUCTION

A sustainable transport system must provide mobility and accessibility to all urban residents in a safe and environment friendly mode of transport. This is a complex and difficult task when the needs and demands of people belonging to various income groups are not only different but are also often conflicting. For example, if a large proportion of the population cannot afford to use motorised transport – private vehicles or public buses – then they have to either walk or ride bicycles to work. Provision of safe infrastructure for bicyclists and pedestrians may need segregation of road space for bicyclists and pedestrians from motorised traffic or reduction in the speeds of motorised vehicles. Both measures could result, though not inevitably, in restricting the mobility of car users. Flyovers may benefit some car users at some intersections, but they are of no use to pedestrians, bicyclists and bus commuters.

Similarly, measures to reduce pollution may at times conflict with those needed for reduction in traffic crashes. For example, increases in average vehicle speeds may reduce emissions but they can result in an increase in crash rates. Large cars may be safer for their occupants but they are more polluting. However, most public discussions and government policy documents dealing with transportation and health focus only on air pollution as the main concern. This is because air pollution is generally visible and its deleterious effects are palpable. It is easy for most people to discern the linkage between qualities of motor vehicles, exhaust fumes and increased morbidity due to pollution. However, most individuals are not able to understand the complex interaction of factors associated with road traffic crashes. Health problems due to pollution are seen as worthy of public action whereas those due to injury and death in crashes are considered to be the result of individual mistakes. Therefore, policy documents dealing with sustainable development for cities always include options for pollution reduction but rarely for road traffic injury control.

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In this paper we discuss some of the issues concerning urban traffic, public transport, safety and the environment. We illustrate that unless the convenience and safety of non-motorised modes of traffic and bus commuters are ensured it will be almost impossible to design any sustainable transportation system for urban areas. We show that pedestrians, bicyclists and cycle *rickshas* are the most critical elements in mixed traffic. If the infrastructure design does not meet the requirements of these elements, then all modes of transport operate in sub-optimal conditions. However, it is possible to redesign the existing roads to provide a safer and more convenient environment for non-motorised modes. This would also result in improved efficiency of public transport vehicles and enhanced capacity of the corridor when measured in the number of passengers transported per hour per lane.

COMPLEXITY IN URBAN TRAFFIC AND HEALTH

Dealing with technology and health in the public space is much more complex than we think. If your stress test shows that your heart muscles have become weak, you would panic and demand a single magic pill to solve all your problems. However, your doctor will only laugh at your demand. Instead, he will tell you to change your diet, do a set of prescribed exercises every day, alter your lifestyle, *and* take a set of medicines every day. In addition, he will also ask you to monitor your health status periodically and change the drugs accordingly. Tackling traffic flow, vehicular pollution and road safety is no less complex. These problems require the same level of scientific expertise, interdisciplinary cooperation, and long-term attention as any other public health problem.

To solve problems of vehicular pollution, we need to work from first principles. Quite obviously, the most long lasting solution would be less of travelling by the people. This depends mostly on how your city is organised. Mixed land use helps in this regard. Homes, businesses, hospitals, schools, entertainment areas, all need to be intermixed in localities. This is happening more by default than policy in our cities. *Thelawalas* going house-to-house selling things reduce trips; vegetable shops, *dhobis*, *mochis*, *paan* shops, and *tandoor* stands in neighbourhoods eliminate thousands of scooter and car trips. Presence of hawkers on city streets makes it safer for pedestrians and bicyclists, especially women, as crime on these streets reduces. The hawkers serve as permanent eyes of the street and the police officers use them routinely for obtaining information on offenders. Even the existence of poor neighbourhoods cheek by jowl with rich ones may be instrumental in reducing motorised trips and increasing employment. When you shift low-income people to the periphery of a city, many family members are unable to get part-time employment and you have to provide bus

transport to the formally employed. But, those unemployed may take to crime and other self-destructive activities.

A long-term solution is to encourage non-polluting modes of travel. There is only one such mode – human-powered travel. We should design our streets in such a way that walking, bicycling and use of *rickshas* becomes safer and much more pleasant. If it were so, many more people would be using these modes, especially younger people. City planning experience from Beijing in China to Portland in the USA suggests that this is true. Street designs are available which show that segregated paths can be provided for bicycles and *rickshas* on existing arterial roads in most cities. When this is done, even the motorised traffic benefits, because friction reduces, flow becomes smoother and pollution reduces further. Surveys show that even in a city like Delhi almost 50% of the trips are less than 5 km long. If walking and bicycling were safer, many children would not need to go to school by bus or in their parents' vehicles. As a consequence, many parents would be free from chauffeuring their children around. Such policies would not only reduce pollution but would also bring down the number of deaths and injuries due to traffic crashes. At present, all our policies are resulting in exactly the opposite. There is no place on our roads for walkers and bicyclists; you have to walk long distances to cross a road; and free left turns at crossings do not allow for any safe period for pedestrians to cross.

The third strategy is to make public transport affordable, convenient and safe. No Indian city has improved its bus transport in the last decade. Urban buses are still following the designs of the 1970s. The service is unreliable and unsafe especially for children, women, the elderly and the disabled. However, recent developments in communication and computer technology have made it possible to optimise bus operations and provide customer-friendly services at a very low cost. It is now possible for buses to communicate with traffic lights so that they get priority at intersections. Modern urban buses have low floors – only 350 mm high from the road. These buses make entry and exit much safer and faster. None of these options are being planned for our cities at present.

The fourth strategy is to reduce the pollution from vehicles. This is the only area where the government has taken some significant steps. The lead content of petrol has been removed. This will save millions of children from brain damage. In Delhi, two-wheelers are sold petrol premixed with oil at petrol pumps. This prevents bad and excessive oil use and reduces pollution. The diesel being sold in Delhi is less polluting than it used to be earlier. Cars marketed in Delhi now follow more stringent pollution norms. Two-wheeler pollution standards in India are among the most stringent in the world and our two-wheeler

manufacturers are doing a good job of meeting these standards through their R&D efforts in this area. However, much more needs to be done. Such measures must not be Delhi-centric. They must apply all over the country. After all, according to the Central Pollution Control Board, Delhi is *not* the most polluted city in India; there are many others which are more polluted.

It is easy to list the above principles but not so easy to formulate and implement an effective policy in this regard. All policies, like those related to drugs, have side effects. Before prescribing a drug, you have to be certain that the side effects are not worse than the disease. For example, our simple calculations show that all the effects of reducing pollution from buses would be *nullified* if just 10-15% of bus users shift to using two-wheelers or cars.[1] Besides, this shift would also increase congestion. Greater use of two-wheelers would result in more deaths and injuries due to accidents. Therefore, before we make new laws that might increase the cost of buses, we have to make arrangements for cross-subsidisation of public transport. This follows from the 'polluter and user pay principle' based on the idea that those who pollute more should pay for the harm they cause others. Since car users pollute the most per passenger kilometre, use the most road space and comparatively injure more people, they must pay for their comfort that harms others. Two-wheeler users come next and bus users a low third. A pollution and road tax paid by private vehicle users could be utilised for procuring better buses so that migration from buses to two-wheelers and cars is restrained.

It is clear that cleaner air and safer streets will not happen in Indian cities without a great deal of innovation, and without our formulating well thought-out long-term policies. The future committees dealing with these issues would be well advised to consider all the related complex issues as also the side effects of their policies, and perform cost-effectiveness studies before issuing edicts. If this is not done, the air will not be cleaner and the streets will not be safer.

ROAD SAFETY IN INDIA

According to official statistics, 76,732 persons were killed and 324,377 injured in road traffic crashes in India in 1998.[2] However, this is an underestimate, as all injuries are not reported to the police. The actual number injured is estimated to be in the region of 1,150,000 persons with injuries requiring hospital treatment and 5,370,000 persons sustaining minor injuries during this period.[3] The situation in this regard is worsening in India as shown in Table 1. Road crash fatalities and casualties have been increasing over the past twenty years.

Table 1 : Number of vehicles, population and road traffic fatalities in India

Year	Vehicles (million)	Population	Fatalities (thousand)	Fatalities per 1,000 vehicles	Fatalities per million population
1971	1.865	548,159,652	15.0	8.04	27.36
1975	2.472	625,246,123	16.9	6.84	27.03
1981	5.391	683,329,097	28.4	5.27	41.56
1985	9.170	772,196,737	39.2	4.27	50.76
1991	21.374	843,930,861	56.6	2.65	67.07
1992	23.507	861,693,859	59.7	2.54	69.28
1993	25.505	879,279,448	60.6	2.38	68.92
1994	27.660	897,223,927	64.0	2.31	71.33
1995	30.295	915,534,620	70.7	2.33	77.22
1996	33.558	934,219,000	71.9	2.14	76.96
1997	37.231	949,200,000	75.0	2.01	79.01
1998	N.A	965,600,000	80.0	N.A	82.85

Source : Ministry of Surface Transport: Motor Vehicle Statistics & Statistics of Road Accidents in India.

This is due partly to increase in the number of vehicles on the road and partly to absence of a coordinated official policy to address the problem. These data show that the number of fatalities has continued to increase, on an average, at approximately the same rate of about 5% a year over the past two decades and the total number of fatalities in the year 2000 can be approximated at about 88,000 persons. The fatality rate per thousand vehicles has remained around 2 for the past few years, whereas the rate per million population has continued to increase and was around 82 in 1998 as against around 27 in 1971.

Table 2 gives the total number of vehicles registered in India and the three highly motorised countries (HMCs), namely, Germany, USA and Japan. These data show that the car population in India as a proportion of the total number of vehicles is much less than that in the HMCs (12% vs 56-82%) and that the

Table 2 : Vehicles registered in India, Germany, U.S.A and Japan (1996)

Country	Two-wheelers	Cars, jeeps & taxis	Buses	Trucks	Other	Total
India	23,111,385 (68.8)*	4,189,367 (12.4)	448,970 (1.3)	4,362,723 (13.0)	1,445,081 (4.3)	33,557,526 (100)
Germany	2,470,450 (4.9)	40,987,547 (82.0)	89,954 (0.2)	2,273,473 (4.5)	1,899,800 (3.8)	47,721,224 (100)
U.S.A.	3,816,000 (1.8)	138,203,000 (66.2)	701,000 (0.3)	64,756,000 (31.0)	1,356,000 (0.6)	208,832,000 (100)
Japan	15,120,000 (17.9)	47,000,000 (55.6)	244,000 (0.3)	22,000,000 (26.0)	118,000 (0.1)	84,482,000 (100)

* *Numbers in parentheses represent row percentages*

proportion of motorised two-wheelers (MTW) is much higher (69% vs 2-18%). These differences in fleet composition affect the traffic and crash patterns enormously. Table 3 shows that pedestrians, bicyclists and MTW riders who are vulnerable road users (VRUs) constitute a larger proportion of road crash victims in less motorised countries (LMCs) than in HMCs. In India, they constitute 60-80% of all traffic fatalities. This flows logically from the fact that this class of road users forms the majority of those on the road. In addition, since VRUs are not protected by metallic or energy absorbing materials, they sustain relatively more serious injuries even at low velocity crashes.

Table 3 : Proportion of road users killed in various modes of transport as a per cent of all fatalities

Country/City (year)	Pedestrians	Bicyclists	Motorised two-wheelers	Motorised four-wheelers	Others
India (Delhi) (1994)*	42	14	27	12	5
Thailand (1987)*	47	6	36	12	-
Indonesia (Bandung) (1990)*	33	7	42	15	3
Sri Lanka (Colombo) (1991)*	38	8	34	14	6
Malaysia (1994)*	15	6	57	19	3
Japan (1992)**	27	10	20	42	1
The Netherlands (1990)**	10	22	12	55	-
Norway (1990)**	16	5	12	64	3
Australia (1990)**	18	4	11	65	2
U.S.A. (1995)**	13	2	5	79	1

* LMCs ** HMCs

The issues summarised above show that India is experiencing a new phenomenon in road traffic patterns and crashes. The same road space is being used by modern cars and buses, along with locally developed vehicles for public transport (three-wheeled scooter taxis), scooters and motorcycles, bicycles, tricycle *rickshas*, and animal and human drawn carts. The infrastructure design based on homogeneous traffic models, has failed to fulfil the mobility and safety needs of this traffic.

The HMCs have never experienced road traffic that includes such a high proportion of motorcycles, buses and trucks sharing the same road space with pedestrians and bicyclists. When the present HMCs had low per capita incomes in the earlier part of the last century, motor vehicles (including motorcycles) were relatively more expensive and not capable of high velocities and accelerations. Therefore, speeds were lower and the number of vehicles using roads was less than that seen today. In a sense, motor vehicle technology, roadway quality and social systems were more compatible. On the other hand, in India, new designs have to be developed for technologically advanced vehicles which have to use

relatively 'less advanced' roadways and enforcement systems. The fact that these patterns are new and that they need to be understood through careful scientific research is not realised by most policy makers. If we just depend on HMC standards and research results for solving road safety problems in India, we may find the outcome highly unsatisfactory.

Road Safety in Urban Areas of India

Non-motorised transport (NMT) constitutes a significant share of the total traffic in Indian cities with a relatively high rate of bicycle ownership and a high proportion of bicycle traffic. Here, the share of NMT at peak hours varies from 30-70%. The proportion of trips undertaken by bicycles range between 15 and 35%, the share tending to be higher in the case of medium and small cities. The patterns of NMT use change with growth in city size. In most NMT-dependent cities, bicycles are used for the entire trip (e.g., commuting, shopping). Every motorised public transport trip involves access trips by NMT at each end. Thus, NMT, including walking, continues to play a very important role in meeting the travel demand in Indian cities and this has to be taken into account as a priority issue when discussing road safety in Indian urban areas.

Some salient statistics regarding road crash fatalities in the Indian cities are given in Table 4. In this context, it may be pointed out that at present less than one in 40 families owns a car in India. The car ownership level in India is so low that even at reasonable economic growth rates (say, 5-7% per year) most families are not likely to own a car in the year 2020. Consequently, a majority of the population in India is not likely to use cars for surface travel in the near future. This low level of car ownership determines the distribution of fatalities by class of road users.

Table 4 : Number of persons killed in road accidents in Indian cities

Cities	Number of Persons Killed		
	1996	1997	1998
Ahmedabad	215	239	218
Bangalore	715	704	726
Calcutta	474	471	454
Chennai	615	749	682
Cochin	144	142	47
Delhi	2361	2342	2123
Hyderabad	342	377	370
Jaipur	263	303	302
Mumbai	405	401	370
Nagpur	217	387	204
Pune	283	329	369
Coimbatore	179	198	N.A.
Indore	174	171	151
Ludhiana	162	N.A.	N.A.
Madurai	110	203	334
Surat	133	152	152
Vadodara	141	142	144
Viskhapatnam	158	218	216
Total	7091	7528	6862

Table 5 shows the proportion of road users killed in different parts of India and Table 6 gives the proportions of vehicles involved in fatal crashes. The data presented in these tables are based on available

national statistics and reports. The data show that VRUs are the main victims both on urban and rural roads. A study by Kajzer, Yang and Mohan also reveals that in India buses and trucks are involved in a greater proportion of crashes than they are in high income countries (HICs).[4]

Table 5 : Proportion of road users killed at different locations in India

Location	Type of road user, per cent								
	Truck	Bus	Car	TSR	MTW	HAPV	Bicycle	Pedestrian	Total
Mumbai	2	1	2	4	7	0	6	78	100
Delhi	2	5	3	3	21	3	10	53	100
Highways	14	3	15	~	24	1	11	32	100

TSR: Three-wheeled scooter taxi; MTW: Motorised two-wheelers, HAPV: Human and animal powered vehicles; + Statistics summary of 11 locations, not representative for the whole country (tractor fatalities not included).

Source: Evaluation of capacity augmentation projects of National Highways and State Highways (2000), Final Report, Ministry of Surface Transport, Government of India, New Delhi.

Analysis of crash patterns shows that self-segregation of the modes is not sufficient to ensure the safety of vulnerable bicyclists. While mid-block crashes are not usually of serious concern in homogeneous regimented traffic conditions, this category dominates in Indian cities.

Table 6 : Proportion of vehicles involved in fatal crashes*

Location	Vehicles involved, per cent					Total
	Truck	Bus	Car	TSR	MTW	
Mumbai	52	16	24	3	5	100
Delhi	40	33	16	4	7	100
Highways	65	16	15	1	3	100

Only those cases included where details were known, totals for these vehicles only, others not included.

Source: Evaluation of capacity augmentation projects of National Highways and State Highways (2000), Final Report, Ministry of Surface Transport, Government of India, New Delhi.

The overall statistics for bicycle fatalities in Delhi show that 60% of such fatalities occur at off-peak time when traffic volumes are lower but motor vehicle speeds are higher. Forty per cent of fatal bicycle crashes take place during peak hours when traffic volumes are significantly higher and speeds are lower (20-30 km/h). Of the peak-hour bicycle fatalities, 62% involve collisions with buses or trucks. In addition, of all bicycle fatalities, 73% occur at mid-block. Buses and trucks are involved in a higher proportion of fatal crashes with pedestrians and bicyclists than that of non-fatal crashes. Motorised two-wheelers and cars have a higher involvement in non-fatal crashes than in fatal crashes. This is generally true both for urban and rural areas. These data show that in India safety policies must focus on issues concerning the safety of VRUs and their interactions with trucks and buses. These issues may be summarised as follows:

(i) Around 15% of the total road traffic fatalities in India occur in 23 major cities.

(ii) In the major cities, MTWs comprise approximately 70% of all vehicles and constitute 20-30% of fatalities.

(iii) Heavy vehicles like trucks and buses are associated with 50-70% of fatal road crashes in urban areas.

(iv) The non-motorised transport road users consisting of pedestrians, cyclists and other slow moving vehicles are the most vulnerable group and account for 60-80% of the fatalities.

(v) Between 8:00 pm and 4:00 am, crash rates are higher compared to the density of traffic. This may be due to the prevalence of higher vehicle speeds, low visibility, low conspicuity of vehicles, and alcohol.

(vi) The issues concerning safety of non-motorised transport have not been given adequate importance. Policies need to be developed so that these groups are included as an integral part of traffic in the planning of new highways and in the area planning schemes.

(viii) There is need for greater analysis of the characteristics of road traffic crashes involving NMT users in order to design suitable countermeasures.

TRAFFIC PATTERNS AND PLANNING ISSUES

In Indian cities, 45-80% of the registered vehicles are MTWs. Cars account for 5-20% of the total vehicle fleet in most cities. The road network is used by at least seven categories of motorised vehicles and NMVs. Public transport and paratransit is the predominant mode of motorized travel in mega-cities and carry 20-65% of the total trips excluding walk trips. Despite a significant share of work trips catered to by public transport, presence and interaction of different types of vehicles create complex driving environment. The present design of vehicle technology does not take into consideration this environment where frequent braking and acceleration cannot be avoided.

Preference for using buses for journey to work is high among people whose average income is at least 50% more than the average per capita income of the city as a whole.[5] Whereas increase in fares may or may not reduce the ridership levels, it will affect the modal preference of a large number of lower income people who spend 10-20% of their monthly income on transport with the present level of fares. A survey shows that nearly 60% of the respondents in low-income areas find the minimum cost of journey to work trips by public transport (less than US cents 10 per trip) unacceptable.[5] Even the minimum cost of public transport trip accounts for 20-30% of the family income of nearly 50% of the city

population living in unauthorized settlements. This section of the population is very sensitive even to the slightest variation in the cost of public transport trips. In areas of outer Delhi, NMVs and pedestrians on some of the important intercity highways with comparatively higher trip lengths show that a large number of people use these modes not out of choice but rather due to lack of other options. Even a subsidized public transport system remains cost-prohibited for a large segment of the population. Market mechanisms may successfully reduce the level of subsidies, but they would also eliminate certain options for city residents.

In addition, many indigenously designed vehicles (IDVs), such as three-wheeled scooter taxis, vehicles fitted with single cylinder diesel engines (designed for agricultural use) are present on the roads of Indian cities because of the absence of efficient and comfortable public transport services and their low capital and operating costs. The *tuk tuks* in Thailand, *becaks* in Indonesia and *jeepneys* in Philippines serve a similar purpose. These IDVs operate as paratransit modes and provide affordable transport, thus serving a very important and useful purpose in the context of social sustainability. However, they have unique safety and pollution problems that the West has never experienced. They have high emission levels, but cannot be substituted easily by modern vans or buses because of economic and financial implications. However, at least three-wheeled scooter taxis are now being equipped with four-stroke petrol engines or CNG engines with the result that emissions per passenger from these vehicles are less than those from cars. Yet, safety, efficiency and environment friendly technologies for these vehicles have not assumed priority for research in India or any other country.

Increase in Use of Public Transport

Construction of metro rail systems is considered an important countermeasure for reducing congestion and pollution. Almost all mega-cities in Asia have plans to construct such systems. However, the cost-effectiveness of such projects in low-income countries is doubtful. Two major studies done to understand the performance of metro rail systems by the World Bank and the Transport Research Laboratory (UK) have drawn the following conclusions:

> "*It is difficult to establish the impact of metros on traffic congestion, in isolation from other factors. However, there appears to be impact in 10 of the 12 cities for which information exists. In one of the remaining two, Sao Paulo, the impact was short-lived, while time will tell whether this is also the case in Manila. The general conclusion is that contrary to expectations metros do not appear to reduce traffic congestion. The passengers are mostly*

captured from the buses, but the reduction in bus traffic is not proportional and represents only a small part of the total traffic. The relief to traffic congestion is short-lived because private traffic rapidly grows to utilise the released road capacity. There has been very little shift from car use… In most cities in most developing countries, it will not be possible to justify metros rationally… In these cities we have sought to direct attention to their priorities and actions to improve the bus and paratransit system which will result in achievable improvements".[6]

"Several developed countries have industries for metro systems facing lack of demand at home. Part of their foreign policy is to make soft loans to support these industries. At the same time, in the developing countries, governments are interested because, (1) a large construction project will bring jobs, (2) a metro system seems modern, and (3) because the cost will not be borne until the project has been built; even then the financing may be about 3 percent. A reason not to invest, financial discipline is often not regarded as important. There was money to be made, prestige and political power to be won… Short term and long term motivations lay behind the construction of the metro. Firstly, there was the desire to immediately improve political fortunes. In the longer term there was a desire to build a monument to those holding office at that time."[7]

The experience from Chinese cities supports the conclusions that building metro systems does not necessarily reduce congestion and decrease private transport use. The metro system in Beijing takes only 11% of the public passenger transport volume and a report from Beijing states: "As the advanced track transport system is enormously expensive and requires long construction period, it cannot be taken as immediate solution".[8] Shanghai has built a 22.4 km metro line which carries only 1% of the total number of passengers in the city.[9] The number of public transit vehicle equivalents increased by 91% between 1993 and 1997, but the total number of passengers carried decreased by 53% in the same period.[10] Guangzhou has finished construction of a metro line but details of change in the surface traffic are not available. The city has increased availability of public transport standard vehicle equivalents by 97%, but total number of passengers carried has increased only by 62%. In the light of this experience, Wu and Li conclude:[10]

"*Although the central government is actively promoting the Chinese built underground carriages and equipment, the cost of construction and operation for metro is still too high to bear for*

> *most cities. Urban rail transport is vital to the megacities like Beijing, Shanghai, Gunagzhou and Tinajin. But for other cities or even the outer areas of the upper mentioned cities, alternatives should be considered including bus-only lanes, improved trams, elevated or ground rails and suburban rails…As a matter of fact, the already built metros in some cities have not become a means of commuting for the middle or low income class."*

The experience of designing and running a high capacity bus system in the city of Curitiba in Brazil is a very good example of what is possible in planning public transportation systems at a fraction of the cost (5-10%) involved in providing metro lines.[11] Special bus and bus stop designs have been developed in Curitiba to make access to buses easier, safer and faster. This is combined with provision of segregated bus lanes where necessary, traffic light priority for buses and moving buses in platoons. Many bus priority lanes around the world carry 15,000-20,000 passengers in one hour in each direction, and experiments show that modern specially designed bus systems can carry up to 25,000-30,000 passengers in one hour in each direction.[12, 13] An intelligent mix of electric trolley buses and buses running on diesel and alternate cleaner fuels could take care of pollution problems. The availability of modern computer networks, communication systems and latest transport technology hold great promise for making high capacity bus systems more efficient and user friendly. Even the highly industrialized countries did not have these options available to them in the past decades with the result that very little serious research and development work has been done to optimise designs for mega-cities in low-income countries. Any investment in this direction should prove to be highly rewarding.

NEED FOR IMPROVING THE QUALITY OF PEDESTRIAN AND BICYCLE ENVIRONMENT

In the light of the above discussion, an exclusive focus on building flyovers, expanding road space only for motorized vehicles, and mandating bus and fuel technologies may not be a sustainable option for cleaner and safer cities in India. In all Indian cities, NMT modes constitute a high proportion of the entire traffic. Unless these modes are given importance and roads are specifically designed to meet their needs, they would make the movement of motorised modes less efficient. In addition to bicycles, non-motorised carts and *rickshas* are used for delivery of goods like furniture, refrigerators, washing machines, etc. Semi-skilled workers, carpenters, masons, plumbers, postmen and couriers use bicycles or walk. Therefore, at present there is great demand for bicycles and other NMT modes which is likely to continue in the future also. This situation is not explicitly

recognised in policy documents and very little attention is being given to improving the facilities for non-motorised modes. Technological solutions based on improving fuels, engines and vehicles must be accompanied by improvements in road cross-sections and provision of segregated facilities for non-motorised transport.

A large proportion of the decrease in road traffic injuries and deaths in HMCs is a result of the availability of cars, which provide much greater safety to the occupants in crashes, and a reduction in the number of pedestrians and bicylists on HMC streets and highways. Recent estimates from UK suggest that the number of trips per person on foot fell by 20% between 1985-86 and 1998-99.[14] Such trends suggest that reduction in pedestrian, bicycle and MTW fatalities could be largely because of the reduction in the exposure of these road users and hardly due to the fact that the road environment has been made 'safer' for them. Mohan and Tiwari also show that though buses and trucks are involved in a much greater proportion of crashes in LMCs than in HMCs, relevant safety standards for these vehicles are lacking here.[15] In particular, a strong case can be made for evolution of pedestrian friendly fronts for buses and trucks, but such issues are not being given any priority at present.

Better facilities for pedestrians and segregated bicycle lanes would also result in enhanced efficiency of the public transport buses that can be given the curbside lane or central two lanes as per the site demand. Physically segregated lanes also improve the safety of the vulnerable road users by reducing the conflicts between motorised and non-motorised modes. This smoothens traffic flow and hence reduces pollution. The data clearly indicate that if public transport use has to be promoted in Indian cities, much more attention has to be given to the improvement in safety levels of bus commuters and the non-motorised transport segment of the road users. This is particularly important because promotion of public transport use would also result in an increase in the number of pedestrians and bicycle users on city streets as every public transport trip involves two access trips which are mostly walking or bicycle trips. Unless people actually perceive that they are not inconvenienced or exposed to greater risks as bicyclists, pedestrians and bus commuters, it will be difficult to reduce private vehicle use. However, in Indian cities, non-motorised modes already constitute a significant proportion of all trips. It will, therefore, be difficult to increase the share of public transport and non-motorised modes unless these modes are made much more convenient and safer. It is clear that unless safety of pedestrians and bicyclists is ensured, it will be very difficult to promote the use of public transport as a means of reducing pollution or improving safety.

CONCLUSIONS

Buses and non-motorised modes of transport will remain the backbone of mobility in Indian cities. For the control of road traffic crashes and air pollution, the use of buses and non-motorised transport has to be given importance. This would be possible only if the following conditions are met:

Public Transport

(i) The cost-effectiveness of metro rail systems be evaluated very carefully. Current evidence suggests that metro rail systems, especially the construction of two or three lines at great cost, do not help in reducing private vehicle use, congestion or pollution.

(ii) Designing and development of modern and sophisticated high capacity bus systems be given priority in large cities.

(iii) Introduction of bus engine and transmission technologies that ensure clean burning and efficient combustion at different passenger loads without increasing bus fares as it would result in shift to private modes. Besides, bicycle driving should also be encouraged.

(iv) The increase in fares because of using more expensive buses is likely to shift bus passengers to cars and two-wheelers and thus increase total pollution. The government must put in place a comprehensive policy of financing of public transport, including cross-subsidies. This could be achieved by invoking the 'polluter pays principle'. The data show that cars and two-wheelers have the highest pollution per passenger transported. Therefore, owners of cars and two-wheelers must be made to pay a pollution tax, the proceeds from which could be used for financing more efficient bus transport.

(v) The safety and efficiency of bus transport and its attractiveness for users could be increased substantially if modern low-floor buses are inducted in the urban fleets.

Facilities for Non-Motorised Transport and Road Safety

(i) Every round trip by public transport involves four non-motorised trips and at least two street crossings. Therefore, greater use of public transport cannot be ensured unless use of roads is made much safer for pedestrians and bicyclists.

(ii) All arterial roads must have segregated lanes for non-motorised transport and safer pedestrian facilities.

(iii) Urban road design characteristics must ensure the safety of pedestrians and bicyclists by a wider use of traffic calming techniques, keeping peak vehicle speeds below 50 km/h on arterial roads and 30 km/h on residential streets and shopping areas, and by providing convenient street crossing facilities for pedestrians.

(iv) The above recommendations have to be considered in an overall context where safety and environmental research efforts are not conducted in isolation. We have to move towards the adoption and implementation of schemes that improve all aspects of human health. The authors of a report on integration of strategies for improving safety and environment published by the OECD suggest the following guidelines for policy makers:[16]

- Ask leading questions about safety and environmental goals at the conceptual stage of the project and look beyond the immediate boundaries of the scheme.
- The safety and environmental consequences of changes in transport and land use should be made more explicit in technical and public assessments.
- There should be simultaneous consideration of safety and environmental issues by involving all concerned agencies.

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