

# Matching supply and demand in India's public transport

Indian cities offer a number of public transport options. Here **David Maunder, Philip Fouracre and Godfrey Jacobs** compare networks in three cities and report on the work of the TRRL's Overseas Unit

The Overseas Unit of the Transport and Road Research Laboratory (TRRL) undertakes research to find practical solutions to the transport problems of developing countries, particularly in the roads sector. The unit's research activities are wholly funded by the Overseas Development Administration as part of the UK Government's overseas aid programme, the research programme embracing most facets of the planning design, execution and servicing of roads and transport operation. Abroad, the unit works where possible with sister research organisations or ministries of works and transport, regarding the building of local expertise as an important part of its work. The results of research and the advice and recommendations derived are made available through reports, scientific papers, handbooks and practical guides.

The Urban Transport and Road Safety Section of the Overseas Unit concerns itself with research into the urban transport problems of developing countries providing evidence to stimulate the introduction of improved transport operations in urban areas with special emphasis on the access and mobility needs of the urban poor. Thus social, economic and financial implications of different policy and investment options within the urban public transport sector are studied, with case studies undertaken in SE Asia, India and, more recently, Africa.

An initial two-year co-operative research agreement was entered into by TRRL and the Indian Association of State Road Transport Undertaking (ASRTU) in 1978, involving the deployment by TRRL of a two-man team in Delhi, working closely with counterpart staff from ASRTU. Subsequently, the co-operative research programme has continued and developed, involving other institutions such as the Indian Town and Country Planning Organisation (TCPO) and CIRT.

Public transport supply in Indian cities is characterised by the multiplicity of modes available for use. Conventional stage carriage buses, largely operated by the nationalised transport sector, compete with various forms of paratransit or intermediate public transport modes (IPT). The latter include minibuses (also known by their trade names like tempo and matadors), tongas (horse-drawn carts carrying about six passengers) and all forms of rickshaw (hand, cycle, auto and motor-cycle). These vehicles are almost universally

in the private sector. Suburban rail also plays a major role in Calcutta, Bombay and Madras and the metro plays a small, but growing role in Calcutta. Conventional buses on contract hire (charter buses) play a significant role in some cities, providing subscribing commuters with a guaranteed home-work-home service.

By international standards the level of provision of conventional stage carriage buses (at between 0.17—0.35 buses per 1000 population) is low. Even in the largest Indian cities the provision is less than half that observed in UK cities (0.77 per 1000 population). This apparent shortfall in provision of conventional public transport services is to some extent made up by the operation of IPT. Two distinct types of IPT are operational: those giving essentially a bus-like service with low fares, fixed routes, stopping points and some semblance of schedules and those giving a taxi-like service with high fares and routes on demand.

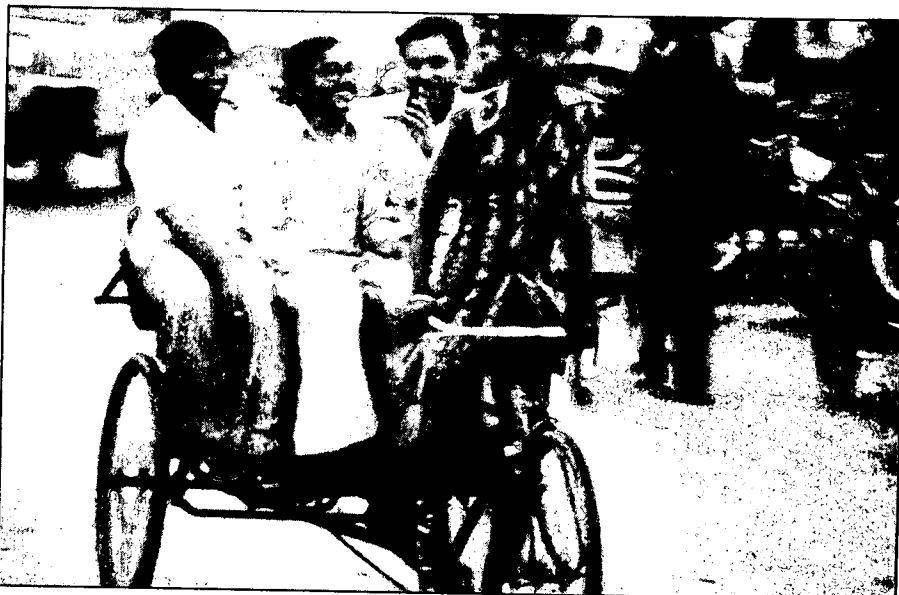
There are no obvious patterns in the supply of public transport except that cities with a deficiency in one type are usually well endowed with another. For example, Kanpur with a population well in excess of one million has few conventional buses (3.3 per 100 000 population) but many cycle rickshaws (3000 per 100 000 population). In general, where IPT exists in a city there tends to be one dominant type. For instance, in the major cities of Uttar Pradesh,

cycle rickshaws provide the main public transport option; in Maharashtra state, the auto rickshaw is often the only IPT mode in evidence. In some cities, notably Jaipur and Hyderabad, a variety of IPT is available.

In general the level of supply of public transport increases proportionately with population size. It might be thought that smaller cities would rely more heavily on IPT but this is not substantiated by the data collected by TRRL. IPT accounts for at least 30% of supply in most cities and in some may account for as much as 60-70% of public transport provision.

City form may influence the type of mode which can be employed. Dense compact cities with limited road networks may have a high IPT content because it is physically impossible to operate buses efficiently. In the circumstances, public transport users may incur high public transport unit costs, though their absolute demand for public transport may be low. In more open cities like Delhi, unit costs of public transport are low but users may consume more public transport because of the extra distances involved.

Although most city bus operations are in the nationalised sector there is no uniformity about the institutional arrangement for providing the service. In some cities such as Pune and Bombay, the municipality is responsible for providing the service; in others, like Bangalore and Hyderabad,



A rickshaw in use in Patna



*An overcrowded bus in Delhi.*

the state government controls public transport provision through the State Road Transport Corporation. In Delhi, the union government itself is responsible for stage carriage services.

Private operations do not play a large part in the organisation of conventional stage carriage services in Indian cities. There are some exceptions, notably Calcutta, but generally private operators subcontract to the nationalised sector, as is the case in Delhi. In the IPT sector it is likely that the numbers of cycle rickshaws are stable in those cities where they are operated. There has been a rapid growth in the numbers of auto rickshaws in use in recent years and small capacity minibuses are also increasingly used.

Conventional buses are highly utilised in Indian cities. Because of supply limitations there is little use of peak time extra buses. Thus peak demand is flattened and consequently the limited stock of buses must be run more intensively at times outside what would normally be considered the peak. Average daily vehicle kilometrage per bus in urban areas is 200km, the number of passengers carried per bus is 1350, but as high as 2400 in Bombay where large numbers of double-deck vehicles are deployed. The number of passengers per seat (daily) is approximately 21, with an average load factor of about 0.7. In peak periods load factors over excess 1.0.

Most urban bus operators in the nationalised sector are making losses. For example, in 1984/5 the Delhi Transport Corporation (DTC) incurred a loss of R1.408 billion (£78.2 million) or R535.9 (29.7 pence) per effective km operated. Losses are made good from a number of sources. Many of the state corporations cross subsidise their urban operations from the profitable inter-city operations. The Bombay Electricity Supply and Transport Undertaking (BEST) cross subsidises its bus operations from the more lucrative electricity supply side of its business. The Calcutta State Transport Corporation

(CSTC) receives loans from the West Bengal state government and the DTC receives loans from central government. The loans accumulate from year to year and interest payments become an ever increasing financial burden.

There is little documented evidence about the costs and profitability of private operators of standard size buses, although private operators seem more cost effective than the nationalised sector. Yet, the nationalised sector is more obviously bound by labour legislation governing manning levels and hours and the private sector probably has higher productivity levels for non-technical reasons. The nationalised sector is also more subject to labour pressure on wage rates and employment creation than the private sector.

Any form of road based public transport which is not obviously a conventional stage carriage bus service may be classified as IPT. Output from individual vehicles in the IPT sector may not be high but the importance of IPT is derived from the large numbers of vehicles in use. Unit costs of operating IPT vehicles vary with the vehicle type and its role. A minibus is more expensive per seat-km to run than a large conventional bus; however fare levels (per passenger-km) and load factors (passenger-kms to seat-km) are often higher on the minibus, making it a profitable enterprise. Load factors can be higher because for a given demand level throughout the day it will always be easier to fill a small vehicle than a large one. Fare levels may be higher because the service provided is geared to the more wealthy travellers, ie those prepared to pay extra for speed and/or comfort, or because the conventional fleet operators are more likely to be under pressure to maintain artificially low fares for which they may be receiving some form of subsidy.

Taxi-like vehicles tend to have high unit operating costs in comparison with both conventional buses and minibuses. Utilisation and carrying capacity of these vehicles

are low. Tariffs, per passenger-km, can be as much as five or 10 times higher than those charged on a bus service for an equivalent journey length. In these circumstances demand for taxi-like services tends to be of an irregular nature with middle and high-income travellers making the most use of these vehicles. However, there is evidence from Indian cities that in those cities where conventional public transport is deficient, the traditional public transport types, though undertaking an essentially taxi-like service, are used on a regular basis by middle-income groups. Even low-income groups make more use of these forms of public transport than their counterparts in cities where conventional public transport is more readily available.

### The Delhi problem

As well as macro studies of public transport provision and use in Indian cities, detailed studies have been undertaken by TRRL of the supply and demand for stage bus services in Delhi. Although the operating environment of Delhi is not typical of all Indian cities, many of the problems encountered by users and operators are similar.

The DTC is a monopoly supplier of conventional stage carriage services in Delhi, indeed the city is virtually dependent on the DTC for mass transit needs. In general, routes are characterised by high load factors, poor profitability, variable reliability and good operating speeds. Load factors in the peak period (in peak direction) are usually in excess of 1.0 and normally 0.5 in the off-peak. Such high load factors throughout the day indicate poor levels of comfort and an inability to meet demand levels. Observed waiting times of passengers range from seven to 19 minutes. The high speeds—an average of more than 20km/h in both peak and off-peak—achieved by DTC vehicles are associated with the good standard of road network throughout the city.

Fare levels are not sufficient to generate the revenues needed to cover direct and variable costs of additional fleet. As demand increased and fare levels remained rigid (fares were increased in 1979 and then again in 1986) so losses have increased to the level noted earlier. The DTC tends to incur losses on all its routes though losses tend to be greater on routes servicing low-income residential areas.

Between 1976/77 many thousands of squatters were removed to colonies located 14-30km from the central areas of the city. Almost overnight the DTC was saddled with the burden of having to provide a cheap mass transit service between these new residential colonies and the city centre. The low fare structure imposed by central government, the heavy investment required to cope with the demand and the long trip lengths contribute to the heavy losses being incurred despite the high level of demand generated at peak periods in

some of these low-income areas.

One of the side effects of the resettlement policy has been to create a captive market for cheap public transport services which can provide high capacity over long-journey distances by urban standards. Most travellers are restricted in the choice of transport by their low income and residential location to DTC bus services. The DTC is obliged as far as possible to satisfy their needs. The long-term implications of developing cheap peripheral land for low-income settlement at the expense of having to provide a cheap, subsidised mass transit system need to be considered carefully. The burden on the DTC has been extensive and will increase as the population of the resettlement areas.

### Travellers' options

The problems of medium-sized cities (population range 0.3–1.0 million) are somewhat different in that public transport currently plays a less important role, catering for 20–33% of total trips made. Travellers have more convenient alternatives like walking and cycling when the trip distances, associated with small cities, are short. Even so, these cities are developing fast and adopting the right policy towards the development of public transport could forestall some of the problems encountered in the larger cities. In collaboration with the ASRTU, CIRT and TCPO, the TRRL has undertaken in-depth studies of three medium-sized cities which have public transport systems representing the broad range of options which have developed in India.

At one extreme, Vadodara has a conventional public transport system based on single-deck and articulated double-deck vehicles. Auto rickshaws are used to provide supporting taxi services. At the other extreme is Patna, which has a skeleton conventional bus service but a significant number of minibuses and auto rickshaws providing bus-like services and a large number of cycle rickshaws. In between is Jaipur which at the time of the study (1982) had a conventional bus system, a minibus network and a taxi service provided by both cycle and auto rickshaws. From an examination of the costs and service levels of these three systems it was possible to classify them broadly as high cost with high service level (Patna); low cost with high service level (Vadodara); or low cost with low service level (Jaipur). One of the main purposes of the study was to assess what impact these variations in public transport characteristics have on the mobility of the urban population, particularly those from the poorer community.

In each of the three cities, conventional public transport, organised by the state, incurs substantial losses. The level of subsidy required to meet these losses ranges from R165 (£9.16) per vehicle per day in Vadodara to R235 (£13.05) in Patna. The better cost performance of conventional

buses in Vadodara reflects the high level of productivity achieved, compared with Jaipur and more particularly Patna. With high utilisation of vehicles and the high number of passengers using the system, the higher daily cost of operating buses in Vadodara is spread over a proportionately larger output. The higher utilisation of vehicles is partly a result of better operational efficiency and possibly the less congested nature of the street network in Vadodara. The higher throughput of passengers will itself be dependent on the better vehicle utilisation, as well as the absence of any competing stage-bus service in Vadodara.

Furthermore, passengers in Patna, and to a lesser extent Jaipur, make longer journeys on conventional buses than they do in Vadodara; as a result the effective capacity of the vehicle is less. While the minibuses of Jaipur and Patna have very similar unit costs, the small six-seat auto rickshaws used to provide bus services in Patna are significantly less cost-efficient. The advantage of these vehicles may be their greater ease of penetration in the congested central areas of Patna. In terms of costs per passenger-km, the total public transport system in Patna is significantly more expensive than in the other two cities due to the high use of cycle rickshaws for short journey lengths. Cycle rickshaws are a costly form of public transport and although their capital investment and operating costs are low, their output is correspondingly small.

### Regional variations

Expenditure on transport varies quite significantly between the high and low-cost cities, per capita expenditure being 50% more in Patna than in Vadodara. Despite the differences in cost in using public transport services, both the household and per capita trip rates were found to be similar in both Patna and Vadodara whereas in Jaipur the rates were considerably lower. In each of the cities 1.2–1.6 million home-based trips are made daily, the majority of which are undertaken on foot, by cycle or by public transport. In both Vadodara and Patna almost one-third of trips are undertaken on the public transport system. Detailed analysis shows that low-income travellers in Vadodara make proportionately more use of public transport than their counterparts in Patna. This can be explained by the differences in the public transport systems: travellers in Vadodara have much greater access to a low-cost bus system than travellers in Patna. Overall, however, the high-income groups of both Patna and Vadodara make proportionately more use of public transport than their low-income neighbours. This pattern is much less pronounced in Jaipur.

The main conclusions of the three city study can be summarised as follows:

- Public transport systems having a large

proportion of cycle rickshaws (Patna) have a relatively high-cost (per passenger-km), low energy consumption and high employment generation

- In contrast, public transport systems based largely on conventional buses (Vadodara) and providing for the same level of use (trips per annum) have low-costs (per passenger-km), high energy consumption and low employment generation
- Overall journey speeds by public transport seem to be independent of the system in use

● While travel patterns are broadly similar in medium-sized cities where the level of service of the public transport system is high (Vadodara and Patna), there is some evidence that small differences in trip making can be partly attributed to differences in public transport costs

● Where the level of service of the public transport system is poor (Jaipur), then irrespective of system costs, travel may be curtailed in comparison with cities having a high-quality public transport system. Furthermore, the use of public transport will be on a significantly lower scale than that found in other cities having a higher service level

● A cheap, high-quality public transport system (as in Vadodara) does find more patronage from amongst the lower income community, in comparison with an expensive high-quality system. The per capita trip rate on public transport by the low-income community in Vadodara is over 25% higher than that of similar groups in Vadodara. Thus the low-income group does appear to benefit considerably from the low-cost system through increased mobility

● Household expenditure on public transport is largely influenced by household income, vehicle ownership and the cost of public transport. Transport expenditure is likely to be significantly higher (20%) for a household in a city with a high-cost public transport system (Patna) than in a similar household in a city with a low-cost public transport system (Vadodara).

By and large urban public transport in India performs well, given the limitations in resources available. In the development of future strategy, however, other options should be considered, embracing the experience of other Third World cities.

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*DAC Maunder, MCT, PR Fouracre, MCT, and GD Jacobs, MCT, are members of the TRRL's Overseas Unit.*