

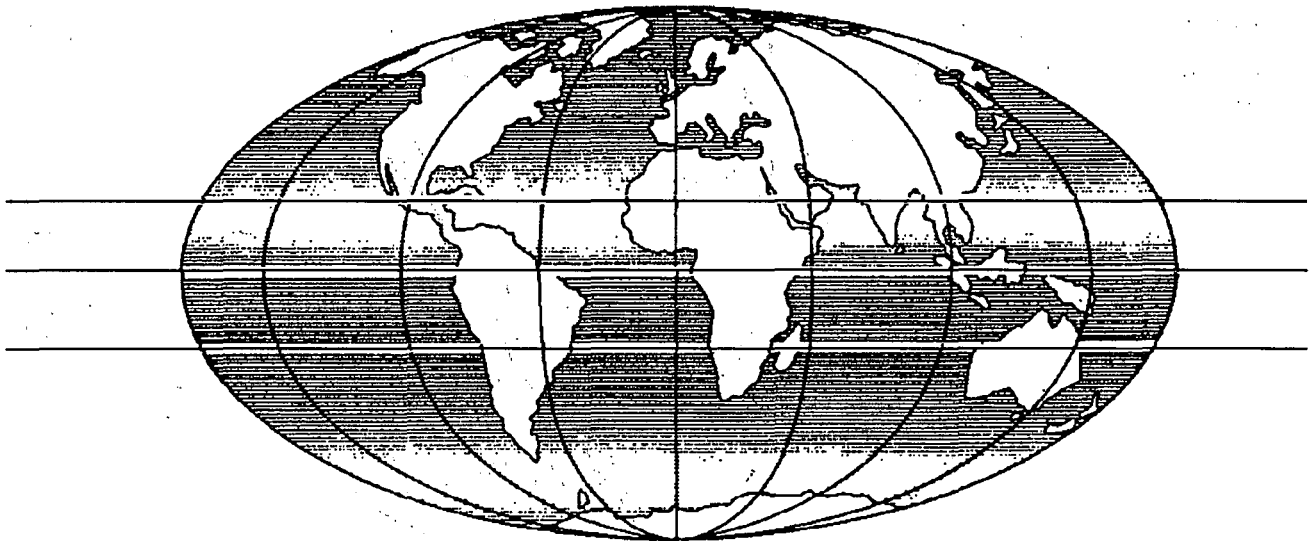


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TRAVEL CHARACTERISTICS IN DEVELOPING CITIES

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1. INTRODUCTION

The travel demand forecasting process is a fundamental operation within any urban transport planning exercise. The aim is to predict mode demand for some time in the future by extrapolating present travel behaviour mechanisms, growth potential and changing socio-economic circumstances. Simplifying, explanatory models are used to aid this task. Different mathematical formulations have been developed but the structure of these models tends to take a common, deterministic form which involves four stages: trip generation, trip distribution, modal split and traffic assignment, with all their implicit assumptions.

Output from the early travel demand models does not seem to have stood the test of time and they have been widely criticised for being unable to predict the future to any degree of accuracy (eg. Atkins, 1977). Evidently it is inappropriate to base major investment decisions on poor forecasts. The complexity of the forecasting process and the resulting inflexibility in model output to rapidly changing circumstances in the urban scene have also brought much criticism.

Failings as major as these often led to the planning of transportation becoming little more than a short-term reactive process, largely maintaining the status quo. However, the burgeoning demand for car travel, failing public transport and warnings of global environmental disaster have led the transport planning community to re-examine the possibility of long-term pro-active planning once again. As Ortuzar and Willumsen (1990) noted 'the trend away from long range planning was rather unhelpful as the need for evaluating large infrastructure projects did not abate in all those years'. As a result some, like Ortuzar and Willumsen, have advocated the use of models which can be continually updated both in terms of data and refinement of the model formulation. Others (eg. Foster, 1991) have emphasised a need for simple, less accurate models which can be processed quickly and used to examine 'not only the potential outturns, but also the alternative dynamic paths which might lead towards that outturn'. There are also some who propose the development of simplified integrated land-use and transportation models which can be used to examine broad urban development options and their interaction with transport (eg Miyamoto, 1991). Whatever the way forward, there seems to be a need for a greater understanding of the complexities of travel demand. Atkins (1987) describes this as 'getting closer to the data' and placing 'less reliance on the manipulation of data and the development of models and much more emphasis on interpretation of the raw data itself'. This is perhaps not least the case in developing cities where change can be very rapid and the future very

uncertain (Stopher, 1980). It is also the case that the nature of travel in developing cities is not well documented. Whilst there is some consensus as to broad travel characteristics little is known about the travel behaviour of the individual, what influences his travel decisions and how travellers respond to changed circumstances. In the absence of this knowledge, predicting the outcome of even short-term policy changes (for example, public transport fares increases) is just as hazardous as predicting the outcome of long-term investment.

The purpose of this paper is to collate material from a number of sources to try to clarify what is known about travel patterns, the commonality in findings and where research is still needed to help answer unresolved issues. The main factors likely to influence travel demand are examined in turn. These are: city structure; socio-economic characteristics of the traveller; transport facilities available to the traveller. By way of introduction, this section finishes with a short resume of the broad nature of travel in developing cities.

Daily trip rates per capita will typically lie within the range 0.8-2.0; part (though how much is unclear) of this large variation must be attributable to differences in definition and/or to poor survey technique. Because incomes are low, the majority of trips will be undertaken on either some form of non-motorised transport (principally walk or bicycle) or one of the many forms of public transport. The latter will be particularly important in providing for longer trip lengths. Trips to/from work and education are likely to be the majority of these non-walk trips. Work-trip movements will be largely radial, focusing on the central area of a mono-centric city. Third World cities generally exhibit less distinct travel 'peaks' possibly because of the inadequacy of transport facilities to handle demand, but also because mid-day commuting is common in some societies.

2. CITY STRUCTURE

2.1. Population

At the aggregate level, changes in population would seem to have three important effects on travel. Firstly, more bodies generate more trips. The marginal increase may not be in line with current average per capita trip rates as the increase in population is partly fuelled by immigration of itinerant workers, many of whom are in the informal sector; they may live at their place of work, but in any case are not likely to generate high travel demand. Neither would the changing age structure, implicit in population growth, have an immediate impact on travel demand. More, very young children are unlikely to have a major impact on travel demand until they feed through to secondary school level. Even so, this fundamental effect of population growth is important. Jacobs et al (1987), for example, suggested that each additional thousand population in a developing city can be associated with an additional 350-400 public transport trips per day.

The second effect of population change concerns the way in which the physical area of the city changes. Assuming no radical change in city structure or density, then more population implies expanding area and the likelihood of longer trip lengths. This has

important implications for modal choice, and it might be expected, for example, that the burden on public transport will increase with city size because travellers are unable to walk or cycle the longer distances involved.

The final major impact of population change concerns the way in which the transport system adapts to growth and the resulting impact on travel patterns. In an earlier study of differences in transport characteristics between different sized cities in Nigeria (Fouracre et al, 1990), it was suggested that as a city becomes larger so transport operators tend to concentrate their resources on servicing general patterns of movement along major corridors, rather than try to cater for all possible origin-destination choices. These changes might also be accompanied by a move away from flexible public transport services (like shared taxis) towards fixed-route bus services often employing large-size vehicles. The impact on travel characteristics would take the form of more complex journeys possibly involving interchange and lengthy waiting and walking times. To compensate, the unit cost of travel should be lower.

Population growth appears to be slowing in the mega-cities of the developing world (eg Richardson, 1989), though rates of 4 per cent per annum are still common. The trend is still towards urbanisation but, as Harris (1984) observes in India, the growth seems to be most pronounced in smaller cities, while larger cities are dispersing over a wider metropolitan area and beyond.

2.2. Urban form

A characteristic of many developing cities, even some of the very largest, is their mono-centric spatial form. Richardson (1989) believes that they have retained this structure over time (and for much longer than their developed country counterparts) partly because transportation and other infrastructure is spatially concentrated and partly because high-income residents (who might be expected to lead any move towards suburbanisation) live close to the city centre and have neither incentive nor opportunity to decentralise. In Thomson's typology of cities (Thomson, 1977) developing cities, which tend to have high population densities, are separately identified as 'low (transportation) cost'; because of very limited resources, these cities are unable or unwilling to commit large sums to transportation developments and thus have little choice but to retain a compact, radial structure, giving strong emphasis to public transport corridors in which non-residential activities are concentrated. Thomson estimated that a road-based public transport system could support a maximum central area employment of between 0.5-0.7 million jobs, and this would probably be generated by a city population of about 2.0 million. For larger cities, he expected further development to take place along the radials and as close to the centre as possible, in order to minimise transport costs.

The resulting impact on travel characteristics, particularly in medium to larger cities, has been the strong emphasis on radial movements towards the city centre and dependence on road-based public transport. In smaller cities, historical colonial development still

influences travel patterns. Banjo and Dimitriou (1983), for example, have presented a traffic development model which follows the response of travel demand to changes in settlement patterns during colonial and post-colonial times. A key characteristic of their model is the separate identity and development of the residential areas of indigenous and colonial inhabitants. This was taken to extremes in a city like Harare where vast townships were built well beyond the city limits creating major travel problems for the inhabitants and transport operators alike. In other cities, similar problems have resulted from the 'irregular' settlement of peripheral areas (often outside the scope of the municipal authorities) by new arrivals (Hall, 1983).

Some developing cities are attempting to encourage re-structuring of the city through the development of sub-centres within the city and satellite cities beyond. For example, Delhi not only has a master plan for the city which involves the development of a number of sub-centres, but it is also the subject of the National Capital Region plan which involves large portions of neighbouring states' land and the promotion of their cities into large regional satellites which will take some of the strain off the capital. Cairo is similarly developing satellite cities, but with the difference that theirs are greenfield sites. Some cities, as noted by Spencer (1989), have well established secondary centres or satellites which have in many cases been privately funded. These include Heliopolis and Nasr City in Cairo, Makati and Cubao in Manila, Petaling Jaya in Kuala Lumpur and Kebayoran Baru and Bumi Serpong Damai New City in Jakarta. The impact on travel demand of these developments has not been well documented; Noe (1991), in his analysis of Bumi Serpong Damai, a satellite some 15km south-west of Jakarta, seriously doubted whether it will contribute to decongesting the metropolis since it 'will have been enveloped in the uncontrolled sprawl of Jakarta' within a 20 year time frame. He also noted some of the difficulties in this kind of development, in particular the haphazard nature of planning and control.

3. SOCIO-ECONOMIC CHARACTERISTICS

3.1. Household structure

Households consisting of extended families are common in many developing cities. This, with a higher birth rate, means that the average size of household in the developing world is generally higher than in the developed world. Typical average household size is around 5-6 persons, though this is dependent on the degree of economic development. Household size affects the number of trips made.

A travel study of three Indian cities (Fouracre and Maunder, 1987) found that a 10 per cent increase in household size was associated with a 6 per cent increase in household trip making, and a 1 to 3 per cent reduction in per capita trip making. In his travel study of Kumasi, Takyi (1991) has also suggested that increasing family size is associated with a greater likelihood of using public transport, though, as he notes, this is probably because larger families have lower per capita incomes.

The sex, age and role structure of household members are also likely to have an important influence on travel characteristics; activity analysis carried out in the UK suggest that households have very different travel patterns at different life-cycle stages (Jones et al,1983). In their Indian study, Fouracre and Maunder found that an increase in the proportion of students and/or workers in the household had a positive effect on both household and per capita trip rates. The magnitude of these elasticity values was of the same order giving rise to a 1 to 4 per cent increase in trip making for a 10 per cent increase in either the proportion of students or workers in the household. Women have a lower participation rate than men in both work and education; Momsen (1991) notes, for example, that female employment rates in urban areas of the developing world average only 25 per cent of total employed. Because of their domestic responsibilities (child-care, household upkeep, etc), women are less likely than their western counterparts (or men in general) to travel long distances for employment. Where they do travel longer distances they are very unlikely to use a bicycle or any motorised personal vehicle, except as a passenger. In some cities they travel in reserved compartments on public transport. Many women will not travel unaccompanied on any kind of business, apart from local shopping and school (accompanying young children) trips.

Age structure is important largely in respect of children and the retired. Pre-school children are unlikely to make any significant trips except in the company of elders. While all school children make school trips their mode of travel may well be influenced by their age; young children will have only a short trip to a local school which can be accomplished on foot, while older children attending secondary school and colleges will inevitably travel further, possibly using some mechanised mode. Lida Song (1989) also noted, in Beijing, a large (over two-thirds) increase in trip making as students progress from primary to secondary education age. The same study also demonstrated the rapid drop in trip making which results from old age.

3.2. Income

From the limited evidence available, household income does not appear to play a significant part in determining household trip rates, though it is clearly a major determinant of modal choice. The study of three Indian cities (Fouracre and Maunder, 1987) indicated that income has a relatively small impact: a 10 per cent increase in either household or per capita income was associated with a 1 per cent increase in household and per capita trip making respectively. Much trip making must be a necessary part of life (to get to work or school) irrespective of income level; only households made up solely of the very poor, the unemployed or retired will not participate in these committed trips. Income is more likely to have an effect on trips associated with more leisurely pursuits, though these might account for only 20 per cent of total trip making. Even here, however, there is no strong reason to believe that higher income groups will have markedly higher activity patterns.

Income clearly affects the way in which people choose to travel. It sets the limit on

their capacity to acquire a personal vehicle and also, given that trip making is relatively inelastic to income, it sets the limit on how much of a particular mode they can 'consume' in order to achieve their desired level of travel. For example, it is quite common for low-income commuters to switch their normal mode of travel from bus to walking towards the end of their pay-period as money runs out.

Not surprisingly, personal vehicle ownership is highly correlated with high income (eg. Fouracre and Maunder, 1987). Personal car ownership is largely confined to high income groups, though as Cundill (1986) noted in Kenya, the equi-probability income (ie. the income level at which the probability of car ownership is 50 per cent) seems to be falling. This would suggest that car ownership will increase regardless of any increase in household income. Perhaps as a cheaper 'second best' to car ownership, motor-cycle ownership amongst the middle income groups has increased at a very rapid pace in many cities. Bicycle-ownership is high amongst low income groups in specific locations, notably Chinese and Indian cities. The reason for non-use of bicycles in other apparently 'fertile' locations is not clearly understood, although differences in attitude towards cycle use may be critical (Barrett, 1991).

Access to a personal vehicle seems to confer on households a marginally higher trip rate (per capita and per household). Again, the Indian study of Fouracre and Maunder (1987) suggests that motor-vehicle owning households make ten per cent more trips than bicycle-owning households, who in turn make ten per cent more trips than non-vehicle-owning households. The same study also noted that higher trip rates were associated with access to cheap public transport: a family living in Vadodara, where average total public transport cost was estimated to be 21 paise per passenger km., was making 15 per cent more trips than a similar family in Patna, where comparative costs were 30 paise (ie. one third as much).

3.3. Location

A sizeable proportion of work trips in most developing cities are focused on the city centre with its commercial, service, government and retailing activities. Some light industry may also be centrally located, though main industrial sites are likely to be in the suburbs.

Most people in a city live in a location which affords reasonable access, by one way or another, to both their work place and other activities. As a result, location, like income, probably has little effect on trip rate and has more influence on mode choice and travel time. Maunder (1984) established some differences in income elasticities between communities living close to and long distance from the centre of Delhi, but he was unable to show the extent to which different levels of vehicle ownership and access to public transport may have been influencing his findings. However, it is possible that there may be some small attenuation in non-essential trip making as distances from city centre (or sub-centre) increase and that this attenuation is more marked in low-income groups. It is also the case, as already indicated, that women (who are less able to travel long distances to work) will be more affected, than men, by location.

Locational aspects are very important in mode choice. Maunder's work in Delhi, for example, showed how commuters come to rely on public transport for journeys in excess of about 10km. This characteristic is particularly marked in low-income groups who have little other travel option. (It is one of the ironies of development in Third World cities that, as already noted, it tends to be the low-income groups who live furthest from the city centre.) Where high income commuters do travel long distances, they usually have access to modes faster than public transport and will accomplish their journeys speedily.

4. TRANSPORT CHARACTERISTICS

4.1. Infrastructure

There is little understanding of the impact of infrastructure provision on travel demand in developing cities. There can be little doubt that new infrastructure will generate new demand, but the scale of the impact is unknown. A recent study of metro investment in developing cities (Allport and Thomson, 1989) made some estimates of likely generation effects for a number of cities; these estimates ranged from little more than 5 per cent of total demand to as much as two thirds. New infrastructure (and equipment) may also enable concentration of peak travel, a possibly unwelcome outcome!

One likely major impact of a large-scale investment, like a metro, is that it will emphasise and encourage existing travel patterns. This is because the investment is put in place to meet an existing high demand which is expected to grow. Metro lines constructed along main radial corridors will have the potential to feed many more commuters into a city centre than an existing road-based system (Allport and Thomson, 1989). This has implications for the development of the city structure; a radial metro may well sustain mono-centric city development. Some cities have advocated these large transport investments in a planned attempt to re-structure the city, but there are few examples of the successful exploitation of transport in this way. As Cherry (1983) has wryly observed 'it is impossible for urban growth to be managed in this way except for short periods by the most authoritarian political regimes'.

It is generally believed that the level of infrastructure provision is lower than in a counterpart industrialised city, but the evidence to substantiate this is largely anecdotal. Limited data from some African cities (Barrett, 1988) suggests that the level of roads provision (km per capita) is perhaps one tenth that of some Australian cities for which comparable data are available. This undoubtedly reflects much lower car ownership levels and higher population densities in the African cities. Another measure of road provision, the ratio of road area to city area, is also probably lower in developing cities (see, for example, Gardner et al, 1989).

4.2. Transport modes

4.2.1. Walk

Walking, as a mode of transport, is limited in range by both its speed and energy requirement. Few trips of more than 5km are made regularly. Even so, walking is a major mode of travel and can account for between 20 to 40 per cent of trips (Fouracre and Maunder, 1989), and even more if very short trips are included (travel surveys often exclude very short trips). Neither do these figures take account of walking associated with the use of other modes (ie access to and from public transport, etc.). The impact of walking on travel demand derives from the numbers of the population who are dependent on it; this group not only includes most housewives and children, but also anyone who has to walk to access another mode. The limitations of walking are therefore very powerful in the planning of the spatial location of local amenities, as well as the transport network.

Little encouragement is given to the walk mode and it is often the case that the road itself is the only useable footpath, which creates conflict with motorised traffic. It is also the case that walking as a means of access to other modes is often ill-considered, to the detriment of the mode being serviced. There is evidence, for example, of metro patronage being adversely affected by the poor positioning of stations with respect to activity centres (Allport and Thomson, 1989).

4.2.2. Bicycle

In cities where bicycles are widely owned, their use is impressive; for example, in medium size Indian cities, cycles typically account for between 35 to 50 per cent of traffic on major corridors and 10 to 30 per cent of all trips (CRRI, 1986). However, as already noted, the bicycle is not in universal use in developing cities and even where it is used it may be barred, through social norm or male priority, to women riders (though not to women passengers).

Where bicycle ownership is high the cost of acquisition is found to be modest; in India the capital cost of a bicycle is less than the average monthly wage (Fouracre and Maunder, 1989). In these circumstances it is hardly surprising that high ownership levels span a broad range of income levels; in three Indian cities even very poor households had a 30 per cent likelihood of access to a bicycle (Fouracre and Maunder, 1987). In Tanzania, the average cyclist was found to earn 50 per cent more than the average monthly wage and bicycle trips made up less than 10 per cent of all urban trips (Kipke, 1991).

The bicycle extends the possible range of travel beyond the limits of the walking to typically 10km. Range is again constrained by speed and energy requirement. Furthermore, as with walking, few cities actively encourage cycling and its safety record is poor. Where the bicycle is common it clearly has an impact on travel patterns; principally it allows low-income male workers to commute from longer distances at very low marginal cost. In doing so, it frees these commuters from the more rigid radial patterns of movement which are often imposed by public transport networks.

4.2.3. Public transport

Public transport is characterised in developing cities by the wide range of vehicle types in use and services on offer. Despite the variety of vehicle types it is clear that most are employed in one of two main ways: either providing a bus-like service with fixed routes and fares (for given trips) or a taxi-like service where the route is determined by the hirer of the vehicle and the charge for the hire is metered or bargained. One important variation common in many cities is the shared taxi in which the first occupant determines the destination and other passengers, heading in the same general direction, are picked up 'en route' - each passenger paying a fixed fare. Most public transport is road-based and is likely to remain so in the future (Fouracre and Gardner, 1992).

It has been noted earlier why public transport is likely to be important in any developing city and why its importance is likely to increase with city size. It has also been noted how the development of public transport may influence city development; in particular the radial metro permits the city centre to develop. Continued dependence on more traditional, usually expensive, public transport (like cycle-rickshaws) may also have some impact, just as will the provision of cheap subsidised buses to low income settlements at the city edge (see, for example, Fouracre and Maunder, 1986).

Because of its importance, public transport does receive a good deal of attention from local government. This usually takes the form of strong regulatory controls, particularly in respect of fare levels and subsidies to public-sector operators. While some authorities have also invested vast sums on metro systems, few have introduced priority traffic measures for the main carrier; road-based public transport. Except on newer metro systems, service quality on all forms of public transport is generally poor, partly because fare levels (even in the private sector) are insufficient to meet investment needs.

4.2.4. Personal vehicles

While ownership levels are typically one tenth of ownership levels in the industrialised world, growth in motor vehicle numbers is high and congestion in large city centres is as bad as in any developed city. Cars are mainly owned and operated by higher income groups, though there is undoubtedly a substantial fleet of company and government vehicles in use. The burgeoning middle-income groups are also acquiring cars or motor-cycles in increasing numbers.

The impact of the private vehicle on the transport system seems to be immense, despite the fact that its share in modal choice is usually quite small. Most major urban transport infrastructure projects are designed to ease the flow of road traffic, a large proportion of which is made up of personal motor-vehicles.

Access to a motor-vehicle confers a high degree of flexibility and range in travel. In some cities the high costs of operating a car may restrict its use to non-regular trips. However, without controls in its use, the growth in vehicle ownership must have an increasingly important impact on city development, possibly encouraging trends towards decentralisation.

5. CONCLUSIONS

This paper has presented a review of travel demand in developing cities. The main determinants of travel behaviour, at both the macro and micro levels, have been discussed. Quite evidently, it has been difficult to draw general conclusions from the assembled observations; partly this is because the survey material is still thin on the ground and partly it is because the field of study is perhaps more diverse than previously credited. Third World cities present a range of development characteristics, dynamic growth patterns, transport infrastructure and operations, and social customs which defy all but the broadest generalisations. Even so, as was said at the outset, it is important to try to understand the processes and interactions which drive transport demand if transport planners are to contribute positively to the general debate about urban development.

From the traveller's viewpoint the main concerns are reasonable access to activities in reasonable time and comfort, and at affordable cost. Even in the short term transport planners and operators are struggling to achieve some semblance of satisfying these needs - and that at mounting cost as central area access and congestion problems worsen with increasing city size.

Further research on travel demand is required on a broad front, with perhaps some emphasis on the issues which concern employment (because of its fundamental bearing on the economic well-being of the city) and how it interacts with transport needs. Studies which follow the progress of satellite cities and city sub-centres could strongly influence future thinking about urban development. Transport planners cannot control urban development, but if they can understand what urban planners are trying to achieve they should be in a position to influence positively the way in which transport adapts to meet development needs in the most effective manner.

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