Exploring the Linkages between Urbanisation and Transportation: A Study of Metropolitan Cities in India with special reference to Pune

Dissertation submitted in partial fulfilment of the requirements for the award of degree of Master of Philosophy in Applied Economics of the Jawaharlal Nehru University

Sowjanya. R. Peddi
M.Phil Programme in Applied Economics
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Centre for Development Studies
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I hereby affirm that the work for this dissertation, ***"Exploring the Linkages between Urbanisation and Transportation: A Study of Metropolitan Cities in India, with special reference to Pune"***, being submitted as part of the requirements of the M.Phil. Programme in Applied Economics of the Jawaharlal Nehru University, was carried out entirely by myself and has not formed part of any other Programme and not submitted to any other institution/University for the award of any Degree or Programme of Studies.

Sowjanya.

June 29, 2001 Sowjanya. R. Peddi

Certified that this study is the bona fide work of Sowjanya. R. Peddi, carried out under my supervision at the Centre for Development Studies.

John Kurien
Associate Fellow

Chandan Mukherjee
Director
Centre for Development Studies

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Abstract of the Dissertation

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Sowjanya. R Peddi

M.Phil. Programme in Applied Economics, Jawaharlal Nehru University

1999-2001

Centre for Development Studies

This study is aimed to analyse the 'modal mix' of the urban transport system in the Indian metropolitan cities with a closer look at the factors that bias the modal mix in favour of personal modes. We begin by locating the modal mix problem in the larger context of urban transport emphasising its importance for the developing countries. Modal mix gains significance due to the implications of various vehicular types (broadly classified into public, intermediate and personal modes) on the urban environment in terms of transport externalities. The literature review examines the range of studies in this field highlighting the dearth of work on urban transport and modal split in India.

Next we draw the theoretical links between urbanisation and transportation especially, the modal mix, providing a prelude to the cross-city analysis and the case study of Pune. We place the problem in the city size debate while discussing the reasons for studying size as an intervening variable. We also study how individual factors are expected to impact the modal mix in the system and how these are built into the very processes of urbanisation. However, our analysis is greatly modified or restricted due to severe data limitations. Thus, we catalogue the important databases relevant to us, discussing their limitations and the resulting restrictions to our analysis.

The cross-city analysis shows that the relationship between size and modal intensities is a complex one and not linear. The smaller cities show a greater variation in their transport scenario in terms of modal intensities reflecting that the transport intensities are more amenable to certain local factors as compared to the larger cities. As the size grows, the variation in the modal intensities falls simultaneously hinting at a positive relation with size. The rail-based cities remain an exception, with lower vehicular intensities, particularly two-wheelers, indicating the impact of rail systems on the urban transport scene in these cities.

The micro-level analysis of the transport environment in Pune, was useful to throw light on factors that could not be explored by the macro-level analysis. Moreover, it also helped in the study of the processes of urbanisation that occur over time as the city grows in terms of size. These processes in terms of demographic, economic and occupational changes bias the modal mix towards personal modes of transport. The urban form has evolved not through land use planning but has largely been an outcome of historical influences. The spatial distribution of residential, commercial and industrial activity is now such that it increases the trip demand between regions which when not catered to by efficient public transport systems lead to the increased dependence on personal modes. Thus, the question of mode gets inter-linked with the problem of total demand for transport in the agglomeration.

This is accompanied by the fact that the share of public transport systems has never been dominant and is falling over time. In terms of per capita availability too, they have not risen adequately to meet the needs of the growing population. This assumes further importance in the light of the fact that the travel demands of the population in terms of trip intensity are expected to grow with the growth in urbanisation. Their deficient performance, both in physical and financial terms, can be largely explained by their ambiguous institutional objective in not maximising either the service or the profit motive. The rapid growth of the intermediate mode, six-seater, comparable with the bus service in terms fares and service clearly highlights the gap that the bus systems could not fill.

The modal mix problem is both a supply as well as a demand side problem. In the context of the growing dependence on personal modes, travel demand management and road pricing assumes importance to make the private mode users pay the true costs of their mode of travel and also to achieve a more favourable modal mix. A comprehensive urban transport policy co-ordinating the various agencies involved in the system, regulating intermediate and personal modes and consciously promoting public modes seems to be the present need of the system.

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Introduction

1.1 The Problem

Urbanisation is a concomitant outcome of the process of economic development. As the economy develops, its production base and work force shifts from primary to secondary and tertiary sectors. The resultant market expansion facilitates economies of scale, which lead to rise of vertically integrated production organisations employing workers working either in a central place or in a sequential production process. This growth in manufacturing and services, especially the organised sector, in turn means concentration of economic activity and habitation. Thus emerge towns and cities. As the economic activity gets concentrated, it draws more people from outside in search of job opportunities to the cities and this growth in turn boosts the economic activity. The very process of concentration, which facilitates the production activity[1], however, gives rise to a set of problems that may be termed as 'urban problems'. One such problem is that of urban mobility in which motor vehicles and consequently the urban transport system plays a substantive role.

The phenomenon of urban mobility has to be understood at multiple levels. It is not merely quantitative in terms of more people creating more demands on the transport system, but also qualitative in terms of the decisions people make regarding the place to travel, mode of travel, choice of route and time of travel. This study is aimed at analysing the 'modal mix' in urban transport system in India. We define, for this purpose, modal mix as the combination of different modes within the transport system. The study focuses on the analysis o f modal mix across Indian metropolitan cities, exploring the factors that are expected to influence it. Further the factors that are likely to influence modal mix at the micro level and over time are examined with the help of the case study of a selected city, Pune.

1.2 Contextualising the Problem

The study of 'modal mix' assumes importance as different modes have different implications for the urban economy. There is hardly any attempt, particularly in the Indian context to examine the problem of modal mix. In a developing country like India, with

[1] Considerable work has been done on the size of the cities and the economies of scale they offer for the production process (Sukla, 1996).

rapidly growing urbanisation, the problem of urban transport gains importance. We examine the urbanisation process in India by looking into the growth and pattern of urbanisation over years and the associated problems. Such an attempt may enable us to contextualise the problem of urban transport where we place our question of modal mix.

1.2.1 The growth and pattern of urbanisation in India

Urbanisation in India has gained momentum since independence. The urban population has increased almost 3.5 times from 62.4 million in 1951 to 217.2 million in 1991, constituting 25.7 per cent of the total population (see table 1.1). We can also see that urbanisation is biased in terms of a few cities accommodating a large percentage of the population. There were 296 Class I cities in 1991 which accommodated 65.2 per cent of the population out of which 50 per cent is concentrated in the 23 metropolitan cities (see table 1.1 and 1.2). Another striking feature is that the pace of expansion of large cities is faster as compared to that of smaller ones.[2] The percentage of population in Class I cities increased significantly whereas it remained almost constant in Class II cities and registered a notable decline in all other classes over the period 1951-91.[3]

Table 1.1: Urbanisation Patterns in India

Description	1951	1961	1971	1981	1991
Number of urban areas/towns	2843	2365	2590	3378	3768
Urban population (millions)	62.4	78.9	109.1	159.5	217.2
per cent of urban population	17.3	18.0	19.9	23.3	25.7
Decennial growth rate of urban population (per cent)	41.4	26.4	38.2	46.1	36.2
Distribution of Urban population among cities (percentage)					
Class I	44.6	51.4	57.2	60.4	65.2
Class II	10	11.2	10.9	11.6	10.9
Class III	15.7	16.9	16	14.3	13.2
Class IV	13.6	12.8	10.9	9.5	7.8
Class V	13	6.9	4.5	3.6	2.6
Class VI	3.1	0.8	0.4	0.5	0.3

Note: Class I towns (called cities) have a population of 100000 and above; Class II: 50000 to 99999; Class III: 20000 to 49999; Class IV: 10000 to 19999; Class V: 5000 to 9999: and Class VI: less than 5000.
Source: Ramanathan (2000)

Table 1.2 gives the number and the size of the metropolitan cities from 1951 onwards. The number of metropolitan cities has gone up from 5 to 23 over a period of 40 years. In

[2] This impression has been contested by Visaria (1997) as formed by the census authorities practice of giving rates of growth of urban population by size class of towns without any adjustment for changes in the number of towns in different size class categories.

[3] It is to be noted here that as per the Government of India projections there will be 83 cities in the country by 2001 with a population of 0.25 million. And travel demand in these cities will be 443 billion passenger kilometre (PKM), of which nearly 80 per cent will be met by road based systems (Ramanathan,1999).

particular, there has been a spurt in the number of metropolitan cities in the last decade, 1981-91, during which it almost doubled (from 12 to 23). Also the share of metropolitan population both in total population as well as urban population has increased significantly over years.

Table 1.2: Number and Size of Metropolitan Cities in India, 1951-1991

Year	Number of Metropolitan Cities	Average population (in millions)	Share of population in	
			Total Population	Urban population
1951	5	2.35	3.25	18.81
1961	7	2.59	4.12	22.93
1971	9	3.09	5.08	25.51
1981	12	3.51	6.16	26.41
1991	23	3.07	8.37	32.54

Source: Ramanathan (2000)

Thus urbanisation is increasing rapidly in India with metropolitan cities becoming a major form of urbanisation. As is mentioned earlier, the problem of urban transport is very crucial in cities growing rapidly and hence a study of the same is of significance.

1.2.2 Urban Poor

Another important dimension of Indian urbanisation is the persistence of poverty. It is observed that 32.4 per cent of the urban population in India live below the poverty line in 1993-94 (Dev and Ranade, 1999). The percentage of slum population living in the metropolitan cities in 1991 varied from 8.7 per cent in Coimbatore to 63.5 per cent in Patna, with 12 other cities having more than 25 per cent of their population living in slums. However, it should be noted that poverty is accompanied by wide income inequalities. Transport becomes important in the context of this class segmentation in the city. Unregulated urban transport might lead to further inequalities in the sense that richer sections may have access to better mobility in terms of time and may be even cost.[4] At the same time, the poor may be worse-off as they may have to travel longer in terms of distance and time and may even have to spend more.[5]

[4] The notion of equity is also important as the poor have a higher susceptibility to urban transport externalities (transport externalities here refers to air pollution, accidents, congestion etc.) as compared to the rich. They might be unable to make preventive measures like helmets, masks etc., as they are not affordable to the them.

[5] This again gains importance in the context of developing countries. For example in Latin America the settlement pattern is different from that of the developed countries; the urban poor rather than the higher income groups are found living at the edges of the large cities (Tolley and Crihfield, 1987).

In terms of land use too, the existence of social inequities has implications. For instance, the presence of large informal sector in developing countries creates problems for urban mobility as unauthorised settlements in the form of hawkers, pavement shops, cycle, motor vehicle repair shops etc. reduce the network capacity. Similarly, unauthorised residential settlements might also increase as the rising cost of transport within the city and long working hours force the workers to live close to the place of employment (Tiwari, 1998).[6] Both these have implications for urban transport. Thus the urban poverty and the resultant inequality points to the need for a better urban transport system which makes it further important to have a study on existing urban transport system.

1.2.3 Pollution and Urban Health

One major problem of present day urban transportation is that of air pollution. Transport is fast becoming a major source of air pollution in cities all over the world. Delhi, Calcutta and Mumbai are amongst the ten most polluted cities in the world. And it is the urban transport system that generates the larger share of urban air pollution. Motor vehicles are found to be responsible for emissions of almost 90 percent of carbon monoxide, 85 per cent of hydrocarbon, 59 per cent of nitrogen oxide, 13 per cent of sulphur dioxide, and 37 per cent of suspended particulate matter in Delhi during 1987 (World Resources Report, 1996-97). The case is not different in other metropolitan cities (Patankar, 2000).[7] For example in Pune almost 60-70 per cent of the air pollution is created by road transport alone.[8]

These emissions of various air pollutants affect the health of urban population adversely. Prolonged exposure to various chemicals like carbon monoxide, suspended particulate matter, nitrogen dioxide, sulphur dioxide, lead, etc. can lead to various chronic respiratory and cardiovascular diseases.[9] There are such evidences in the case of Indian cities. It is found that while in Hyderabad every fourth child suffers from a respiratory ailment, in Delhi one person dies every hour due to problems related to air pollution. High Suspended Particulate Matter levels lead to 52,000 premature deaths every year (Sharma, 2000;

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[6] Even at the minimum cost, public transport accounts for 20 to 30 per cent of the family income of nearly 50 per cent of the city population living in unauthorised settlements in Delhi, thus a fare hike would largely affect their travel costs.

[7] It is observed that two-wheelers and cars contribute 78 per cent and 11 per cent respectively to vehicular pollution in the metropolises while three wheelers, buses and trucks contribute 5, 2 and 4 per cents respectively

[8] Discussion Papers of Pune Management Association (2000).

[9] For a detailed discussion on the pollutants, their major source and their health effects, see Subramanian, (2000).

Agarwal et al, 1999).[10] A study on Bangalore city shows that asthma is higher among children going to schools near high traffic areas as compared to those going to low traffic areas (Acharya, 2000). National Institute of Environmental Engineering (NIEE) in their recent study on air pollution estimated that 9 lakh people suffer from asthma while 2 lakh children were affected by bronchitis and approximately two crore man days were lost due to health problems in Mumbai. This has economic implications for the society as a whole; loss of health is not only a personal but also a social loss.

1.2.4 Urban Form

Most of the cities in India are not planned; rather they have evolved over years owing to historical reasons. Hence, they have grown in concentric fashion with the city origin being the nucleus, the core around which later development occurs in terms of sprawls. This made the core areas of most cities congested and unamenable for further expansion in terms of road space. In view of this it is important to plan the right mode of transport for the cities that are in conformity with the urban geography and can maximise the benefits of urban concentration. As the transport area constitutes around 10 to 50 per cent (Ramanathan, 2001) in most Indian cities the study of urban transport is important.

1.2.5 Urban Finances

Urban transport also has connotations for the municipal finances. Local bodies are entrusted with the task of providing transport infrastructure, mainly roads. Municipalities spent around 58 per cent on core municipal services out of which the per capita expenditure on municipal roads and street lighting together come up to 12.5 per cent (Ramanathan, 1999). This is an important component especially in the light of the fact that m ost urban bodies face a severe constraint on resources and have to depend heavily on state and central governments for even providing basic services.[11] It is estimated that the municipal bodies of India would require an additional investment in basic infrastructure and services of about Rs. 74000 crore if the deficiencies in the existing level of services has to be eliminated and all sections of urban population be provided basic access by 2020. In addition, approximately Rs. 18,000 crore would be needed annually to operate and maintain these

[10] From a study done by CSE (Centre for Science and Environment) in 36 Indian cities in 1995

[11] During the year 1991-92 municipal bodies were able to raise only Rs. 3900 crore on their own which was a mere 4.7 per cent and 8 per cent of the revenue raised by the central and state governments respectively. Besides most urban local bodies are becoming increasingly dependent on higher levels of govt assistance for their operation and maintenance requirements. They also accumulate large debts and face serious problems in servicing them (Mathur, 2001).

services at the barest minimum levels. At the present rate of municipal taxation, user charges, and efficiency, it is expected that only two-thirds of the total operation and maintenance requirements will be generated by the municipalities themselves (Mathur, 1999). [12] Thus, a comparative study of modal mix would help to rightly evaluate the benefits from municipal expenditure on transport infrastructure primarily promoting private modes vis-à-vis expenditure on public transport systems, which are right now relegated a second place in the municipal finances.[13]

The above discussion on urbanisation process and the allied problems clearly brings out the significance of studying the problems of urban transport system. However, the discussion also shows that the problem of urban transport is multi-dimensional and extensive. There is a fair amount of literature examining different dimensions of the problem of urban transport system. In what follows we review some of the important studies. Such a review may help us derive certain relevant hypothesis and research issues which are unaddressed or given only diminutive attention in the literature.

1.3 Studies on Urban Transport: A Brief Review

Literature on urban transport ranges over a wide variety of issues. Studies encompass descriptive analysis of transportation situations in various cities, quantification of externalities of urban transport, impact of transport policies, automobile ownership and use, energy consumption of various systems, public transportation systems, bus deregulation, investments in transport infrastructure, land use patterns and their effect on transportation etc. This section reviews some important studies on urban transportation in general, in the context of both developed and developing countries. The first part of the review discusses studies in the international context and is organised accor ding to the dimensions of the problem they address and the second part deals with Indian studies.

Studies on *transport policies* consist of assessing the impact of policies and measures adopted by the cities or nations towards managing their transport problem. For example, the national policy towards cars in Netherlands has been assessed in light of the developments in motorization after Second World War, population growth, changes in population structure, changes in the economic situation and land use (Hoorn et al, 1986). Similar

[12] This in the light of the fact that urban centres contribute 60 per cent of the country's GDP reveals that the present structure of taxes of the municipal bodies do not benefit from the economic activities that take place within their own jurisdiction.

[13] Inferred from the case study of Pune Municipal Corporation.

studies on transport policies have been undertaken for Hong Kong, (Mace, 1986), Germany, (Kunert, 1988), Greece (Giannapoulos, 1985) and Singapore[14] (Winston et al, 1994, Asher 1997). These studies emphasise on the national level policies and how they have affected the transport scenes in these countries over time. Site et al (1995) have analysed the effectiveness of optimal bus policy for dealing with fuel consumption in urban areas under different hypothesis of car pricing. They show that policies based on improving frequency, fares and bus size alone have negligible impacts unless supported by car pricing measures.

In view of growing importance of *public transport/bus system*, particularly in the developing countries, there exists a good amount of work on the public transport/bus systems across countries. It includes studies that evaluate the existing systems, specific policies and their impact on public transport system or comparing bus systems with rail systems, etc. Also there are studies that compare public transport systems in developed and developing countries. A study by Jacobs et al (1979) shows a faster growth in the number of passenger trips in public transport system in relation to population growth in developing countries primarily because of increased trip rate per head[15]. An econometric analysis by Kain and Liu (1999) shows that the transit ridership growth in Houston and San Diego regions was caused principally by large service increases and fare reductions as well as metropolitan employment and population growth. A similar study of Freiburg in Germany attributes the doubling of patronage growth for public transport to the introduction of cheap travel pass with the essential characterises of unlimited use at zero marginal cost, interpersonal transferability and wide regional validity (Fitzroy, 1998). Goodwin (1993) also supports the *prima facie* case that public transport service levels, fares or quality had a small but possibly important effect on car ownership.[16] Webster et al (1986) highlights the adverse effect of growing car ownership on public transport and the bleak future for public transport unless supported by huge subsidies. Roth (1987) argues that private provision of

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[14] Considerable work has been undertaken on Singapore's transport policies and various measures implemented in the country to restrict car use. Singapore being a country with limited land area has taken resort to strict physical controls like the Vehicle Quota System, Permits, Weekend Cars etc. Its vehicle quota system is acclaimed to have effectively controlled the demand for vehicles.

[15] The study concludes that the increase in real incomes, density of the city and the variables that describe bus operations are the major factors affecting demand for public transport. The increase in the real incomes in the developing countries leads to an increase in public transport usage, whereas in the developed countries it leads to increased car ownership, which, together with a decrease in service levels, results in a decline of the public transport usage.

[16] The results are based on six surveys carried out in South Yorkshire over 1972-1991, during which there were profound changes in public transport policy. It is observed that at the household level, especially for multiple car households, the volatility of car ownership levels provides a context within which the quality of public transport provision appears to influence both the level of car ownership and the relationship between changes in the ownership level and public transport use.

public services will be more efficient and thus desirable as public transport is unable to respond to the market needs.

The appropriateness of rail-based systems as mass transit vis-à-vis bus systems is discussed by Allport (1986) emphasising that public sector resources have a high opportunity cost which make all but the lowest cost mass transit systems difficult to justify. A number of studies have been undertaken on the issue of bus deregulation also (for example Glaister, 1985 and 1986; Rus, 1997; Gwilliam, 1989 etc.) An interesting finding in most of the studies is that bus regulation will lead to smaller size of buses, but more frequency while the fares might go up.

Gronau (2000) investigates the viability of the operation of small vehicles catering to high-value-of-time travellers along side large vehicles serving low-value-of-time travellers serving the same route. The study argues that when frequency and vehicle size are set optimally, congestion has little effect on wheth er a single mode or multiple modes should be operated, and should not affect the modal split. In a discussion on economic and environmental characteristics of public and private transport modes, Nash (1976) has reviewed the potential for modifying modal split in each of the main sectors - the private and the public- of the transport market. The study stresses the relevance of cost-benefit analysis of future infrastructure changes rather than the historic way of comparing revenue and cost in the issue of the choice of modal split.

Studies on *transportation demand management (TDM)/road pricing* has also appeared in the literature in the past few years. A recent study on the evolution and effectiveness of TDM in the U.S. concludes that measures to increase travel price for single occupant vehicle use will be most effective (Meyer, 1999).[17] Bhattacharjee et al (1997) makes an evaluation of commuters' attitudes to TDM in Bangkok. Among the suggested strategies[18] public transportation improvement was found to be the most popular and fiscal restraint to be the least desirable approach.

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[17] The paper also identifies several strategies for improving the effectiveness of TDM actions in the context of regional transportation planning, including: incorporating TDM as part of the solutions for regional transportation planning, linking TDM to land use decisions, making the costs of travel more apparent to the user and making TDM implementation more palatable to the general public. A theoretical exposition on the reasons for the unwillingness to adopt road pricing were explained in Rietveld et al (1996).

[18] Four broad strategies of suggested measures were, public transit improvement (rapid mass transit, bus lanes), ride sharing strategy (introducing school bus, staff bus, car pooling), peak period dispersion (staggered work hours, school hours) and fiscal restraint (high annual road tax, increase on street parking fees, impose parking fees on Govt. offices).

In an analysis of *automobile dependence* in various cities across the world Kenworthy et al (1999) found that US, Australian and Canadian cities respectively exhibit the most extreme dependence on automobile, while European and Asian cities are more transit-oriented with greater levels of walking and cycling. This is primarily related to land use patterns (urban form or urban density) rather than income differences across the cities.[19] A study on Asian cities (Barter, 2000) identifies the challenges and opportunities faced by these cities due to their high densities and emphasises the role of non-automobile modes of transport and policy initiatives to promote them. Another study on three cities in UK (London, Birmingham and Manchester) over 1981-91 revealed that auto dependence had increased the energy consumption due to more work trips being made by car-based modes (Frost, 1997).

There are studies that makes projections on vehicle growth in cities (Dargay et al,1999; Gallez, 1994). Attempts at *behavioural travel models* (Quarmby, 1967; Donnea de F.X, 1971) gained wide acceptance with the appearance of McFadden (1974) who gave a behavioural theory for demand forecasting practices, which helped to resolve the empirical questions on the determinants of travel demand. Similarly, models on factors influencing car demand and use have appeared in the literature (Train, 1986).

Works on *travel behaviour/attitudes* has assumed importance in recent times with shifting emphasis on the role of 'perceptions' in travel behaviour. Curtis et al (1997) while examining the attitudes of car commuters found that majority of the commuters were highly car oriented and not susceptible to change making pricing the only effective measure to reduce automobile independence (Tertoolen et al, 1998). Baldassare et al (1998) discuss the effectiveness of policies aimed at discouraging commuters from solo driving in the US metropolitan area in light of policy changes in California. The younger and lower-status solo drivers are found to be more likely to stop driving alone if there were fees or cash bonuses. In an attempt to understand how individuals perceive congestion and the range of coping strategies they adopt, Mokhtarian et al (1997) concludes that individuals are likely to adopt the low cost, travel maintaining strategies first and policies aimed at travel reduction will be slower to yield. Women were more likely than men to adopt coping strategies. The relevance of public attitudes is brought out also by Taylor et al (1997) in a study in Britain regarding the traffic calming schemes used. The study concluded that the success in calming schemes depends, not only on objective empirical measures, but also on the overwhelming

[19] Auto-dependent cities are less wealthy compared to some other more transit oriented cities.

support of the local community, which in turn depends upon the openness of the consultation process.

A discussion on the problems of *political and social feasibility* of environmentally friendly transport policies in the Netherlands by Rietveld (1996) concludes that policies that are most efficient in economic terms are also those that receive little political support. Rienstra et al (1996) also explore the social and political feasibility in the Netherlands with the aid of a statistical analysis of perceptions of transport problems and support for policy measures. They observe that while safety problems are considered to be more important at individual point of view, environmental problems are perceived as a social problem, however the level of education and income has a larger effect on making people aware of environmental problems. Verhoef (2000) assesses the regulatory policy mixes directly aimed at the containment of market failures in road transport, in terms of efficiency as well as equity and social feasibility.

There are some studies analysing the *cost of externalities* related to transport; particularly on costs of motor vehicle related air pollution (McCubbin and Delucchi, 2000; Jurado and Southgate, 1999; and Bart, 1994) and valuation of cost of accidents (Jasson, 1994). Attempts at quantifying the CO_2 emissions that add to the greenhouse gases increasing global warming have also been undertaken (Maddison et at, 1996). Krupnick (1997) has made a cross-country analysis using Global Environmental Monitoring System (GEMS) data for SO_2 and SPM levels. Button and Verhoef (1998) in their analysis of Pigouvian taxes concentrated on road pricing as a possible solution for various externalities.

In the *case of India*, there has been very limited theoretical or empirical work investigating the dynamics of urban transport problem. We review some of the important works. Rao et al (1997) in a study on Vishakhapatnam have documented various characteristics of the city including geographic, demographic and economic characteristics, which have a bearing on the urban transport. Mishra (2000) discusses measures including traffic restraint policies, ring railway etc. to relieve the congestion on Delhi's roads. Reddy (2000) while analysing the trends in passenger transport in Mumbai observes that the well-developed rail and bus transport system places the city in a better position in terms of vehicle density, energy intensity and vehicular emission compared to Bangalore.[20]

[20] Reddy (1993) has undertaken a detailed study on Bangalore, but the emphasis was mainly on energy implications of urban transport.

Padam (1998) traces the history of bus transport in India. Patankar (1989) analyses the changing modal splits, declining public transport provision etc in various Indian cities and attempts to formulate policy guidelines regarding urban transportation. Patankar (1978), with the help of a case study on Bombay, shows the superiority of an effective mass transportation system as a viable and optimal alternative and recommend public transport as against private transport. Swamy et al (1993) review the existing transportation scenario in Ahmedabad city and explore alternative measures to improve the situation. With the help of a detailed modelling exercise, implications of three strategies for the bus systems have been analysed concluding enhancement of trip serviceability as the most effective option.

In two comparative studies, one contrasting two socio-economic groups (Maunder et al, 1982) and another contrasting two suburban localities (Maunder et al, 1983) in Delhi in relation to the demand of public transport, the authors have analysed the factors effecting trip rate and modal choice pinpointing the specific problems of low income households. Maunder (1985) analysed three medium sized cities, Jaipur, Vadodara and Patna with respect to the provision of public transport facilities and the demand for public transport services.

The studies by Ramanathan (1999 and 2000) across metropolitan cities in India shows that the number of vehicles in a city is likely to grow approximately along an S-shaped pattern as the city size increases.[21] Ramanathan and Parikh (1999), in their attempt to forecast the passenger traffic and freight traffic in India predict that it will grow at more than 8 per cent and 5 per cent respectively per year during 1990-2010 resulting in an equivalent increase in the energy consumption and CO_2 emissions. They also argue that modal split in favour of public transport modes (rail and public road transport) will bring about a 45 per cent reduction in energy requirements and CO_2 emissions.

Thus, as we have mentioned earlier, the problem of urban transport is a multidimensional one. And as is evident from the above review, there exist a number of studies that examine select dimensions of the problem such as transport policies, public transport system, externalities and so on. However, studies focussing on the modal combinations across cities are scarce. In

[21] As the city size increases and if the existing transport network is enough to meet the demands, the number of vehicles tends to grow slowly until the city reaches a certain critical size. Once the critical size is reached, the city witnesses a rapid rise in its vehicular population due to increasing level of income resulting from high level of economic activity in the city. The increased economic activity also demands a larger mobility of passengers and freight, and larger additions to transport infrastructure and equipment. However, the growth of vehicles tends to reduce beyond another critical level when the infrastructural bottlenecks tend to limit the economic activities and insufficient road infrastructure discourage private vehicles. Again when additional infrastructure is provided in large cities, economic activities and vehicular growth will continue to increase at a higher rate.

the context of developing countries studies, on urban transport are few and far between. It is important to look into the patterns emerging in developing country cities as they are expected to be significantly different from the developed country growth patterns. In the case of India most of the studies are case studies. There are hardly any cross-city analyses. Such a conspicuous absence makes our analysis of modal mix across cities more relevant. Therefore, as pointed out earlier we are limiting ourselves to the study of modal mix in urban transport systems. In what follows we discuss the importance of examining the modal mix.

1.4 Study of Modal mix

We define modal mix as the split between public, intermediate and private modes. As data is not available directly according to the ownership classification, we broadly classify the various vehicular types into these three different modes. We define rail and bus based systems as public modes, autos and taxis as intermediate modes and two and four-wheelers (cars, jeeps etc) as personal modes. This classification is useful because it also divides the vehicles broadly according to their mode of operation. Public modes are usually state owned and are operated in the fashion of stage carriages, intermediate modes are privately owned, used for commercial transportation purposes, usually operated in the fashion of contract carriages whereas personal modes are mostly privately owned and used for non commercial purposes.[22] This classification may thus be useful for policy implications.

The study of the modal mix in urban areas is of crucial importance. Whether the city's transportation system consists mainly of public, intermediate or private modes has consequences on not just the externalities created by transport but also on the growth and structure of the cities themselves. In this section, a comparative assessment of various modes of transport in terms of their carrying capacities, road space requirements, energy requirements, emissions etc is carried out. This may help us to understand the analysis at the macro level and the implication of the trends and patterns emerging from it.

1.4.1 Carrying Capacities

Table 1.3 gives the physical carrying capacities for various types of vehicles, that is the number of passengers each type of vehicle can carry *when* they are full. It also gives the

[22] There are of course exceptions, which make the classification according to vehicle type into the three modes inaccurate. Buses can be privately owned, some intermediate modes, e.g. six-seaters operate as stage carriages and even personal modes are sometimes used for commercial purposes (For e.g. in Goa we see that motor cycles are used as taxis). Again we are able to classify taxi separately as information is available on taxi as a separate vehicle type.

relative average occupancy rates[23] for each type of vehicle. It is seen that on an average, a bus can replace 40 two-wheelers, 20 cars and 30 autos. This may have implications in terms of congestion levels, energy consumption, pollution, accidents etc. We examine each of these individually with evidences largely from Pune city.

Table 1.3: Carrying capacities of different vehicles.

Mode	No. of Passengers
Two-wheelers	2
Private Car/Taxi	4
Autos	3
Bus	70
Surface Railway	2200
Average Occupancy: 1 Bus = 40 Scooters = 20 Cars = 30 Autos	

Source: CIRT (1988)

1.4.2 Congestion

Modal mix has implications in terms of congestion in cities. Table 1.4 gives an index of the levels of congestion that each mode produces. It is defined as the road space each mode occupies when transporting 1 million passenger kilometres (kms).[24] The congestion index shows that bus is the most efficient mode of transportation in terms of road space used, followed by autos, cars and then two-wheelers. Thus, two-wheelers are the most inefficient mode in terms of producing congestion, followed by cars. Hence we can see that different modes have diverse implications on congestion as their carrying capacities differ.

Table 1. 4: Vehicles Required for Transporting 1 Million Passenger kms

Type of Vehicle	No. of Vehicles.	PCUs Generated	Index
Buses	111	333	1
Six-seaters	1333	3199	9
Auto-rickshaws	5000	3750	11
Cars	13333	13333	40
Two-wheelers	43478	17391	130

Note: PCUs: Passenger Car Units is a measure of the car equivalent of space occupied by a vehicle while on road. The equivalences are; car = 1 PCU, bus = 3 PCU, two-wheeler = 0.5 PCU, and three-wheeler = 0.75 PCU.

Source: CIRT (1988)

1.4.3 Energy Implications

Fuel is an expensive and depleting resource, especially for a country like India, which imports to the extent of 22 thousand crore rupees annually. In the light of the above concern,

[23] This is different from the carrying capacity of the vehicle, as vehicles do not always run at full capacity.

[24] It should be noted that using passenger kms as the unit standardises the figures by the amount of passengers carried and thus is a pure number and is comparable across modes.

it becomes important to analyse the relative energy consumption of different modes. Table 1.5 gives the energy implications in terms of cost of operation of different transportation modes. In terms of total costs an auto-rickshaw and a two-wheeler are almost three times as costly while the car is ten times as costly as compared to a bus. Also in the case of energy costs a two-wheeler is found to be five times costlier than a bus. In terms of kilocalories standardised for passenger kms. too bus is the least energy consuming, followed by two-wheeler, auto and car. Thus, the private modes tend to be more inefficient as compared to public modes in terms of both costs as well as energy.

Table 1.5: Energy Implications/Cost of Operation

Mode	Total Cost/ Passenger Km (Paise)	Relative Costs	Energy Cost/Passenger Km (Paise)	Relative Costs	Kilocalories per pass. Km.
Bus	15	1	3	1	61.2
Auto	56	3.73	17	5.67	159.0
Two-wheeler	51	3.40	14	4.67	134.0
Car	162	10.80	32	10.67	306.0

Note: The energy consumption in Kilocalories in 1987 for Pune city.
Source: CIRT (1988)

1.4.4 Pollution

In the last section, we have seen that a predominant contributor of air pollution in cities is the urban transport system. Consequently, in an urban transport scene, the transport mix gains relevance in terms of how much emission each mode produces per unit of fuel used. Also, the mix of petrol and diesel vehicles may have different connotations on the composition of air pollution.[25] An overview of the mass emissions from cars, two-wheelers and buses are given in table 1.6. Though in absolute terms a bus produces more pollution than a car or two-wheeler, given its high carrying capacity it produces the least pollution per passenger carried (see pollution index). In fact, car and two-wheeler produce 7 and 6 times more pollution per passenger respectively than a bus. Especially, two-wheelers using two-stroke engines are more polluting than four stroke engines used by other vehicles.

[25] Note that the rapid increase in passenger transport leads to an increase in fuel consumption as well. For instance Delhi's petrol consumption increased by more than 5.5 times over the last decade and a similar trend is expected in other cities also.

Table 1.6: Mass Emissions from various types of Vehicles (in Grams/Km.)

Vehicle type	CO	HC	NO_X	Total	Pollution Index
Cars	24.03	3.75	1.57	29.17 * 20	583
Scooters	8.30	5.18	NA	13.48 * 40	539
Bus	NA	NA	NA	87.12 * 1	87

Note: CO - Carbon monoxide, HC - Hydrocarbons and NO_X - Nitrogen oxide.
Pollution Index is calculated multiplying the total pollutants released with their average occupancy given in table 1.3

Source: CIRT (1988)

1.4.5 Accidents

Another important issue that makes modal mix important is accidents. Table 1.7 shows the accidents in Pune Metropolitan Region during 1991-99. The figures show a rising trend and the problem assumes considerable proportions with almost one death a day. Table 1.8 gives a detailed account of the accidents in Pune for the years 1998 and 1999. Accidents are classified into fatal and serious.[26] It is seen that goods vehicles are the dominant primary vehicles causing accidents and largest number of fatalities. The next category is buses, followed by two and four-wheelers. Two-wheelers and four-wheelers, however, occupy a dominant share in the serious accidents.

Table 1.7: Accidents in Pune Metropolitan Region during 1991-99

Year	Road Accidents	Persons Killed
1991	1949	283
1992	2757	284
1993	2282	286
1994	2184	282
1995	2562	308
1996	2279	271
1997	2687	302
1998	2644	334
1999(Jan to June)	1353	156

Source: Traffic Control Department

[26] A fatal accident is one in which a death occurs while a serious accident involves a serious injury/damage but no death.

Table 1.8: Classification of Accidents on the basis of the vehicles causing the same.

Primary Vehicles	Fatal	Serious	Fatal	Serious	Secondary Party	Fatal	Serious	Fatal	Serious
	1998		1999			1998		1999	
Goods	135	63	135	45	Pedestrian	107	98	103	80
Two-wheeler	46	96	44	76	Cycle	50	42	49	34
Four-wheeler	38	50	35	60	Two-wheeler	89	114	102	117
Municipal Buses	22	19	23	8	Four-wheeler	4	6	4	8
Other Buses	39	11	4	8	Goods	12	14	9	9
Autos	9	12	2	23	Buses	5	7	9	3
Six-seaters	3	8	6	11	Auto	9	9	8	11
ST	11	3	29	7	Others	1	14	24	6
Unknown	48	50	47	26					

Note: Primary vehicles are those due to which an accident is caused and secondary vehicles are the victims in the accident.

Source: Accident Study for Pune Metropolitan Region.

As is expected the secondary vehicles involved in the accident give a different picture. Pedestrian and the two-wheelers are the most important categories in terms of fatal as well as serious accidents. The share of serious accidents is the highest for the two-wheelers in both the years, followed by cyclists. Thus, two-wheeler users constitute the vulnerable group in terms of high chance of death or serious injury when involved in an accident, whereas buses, cars and even autos seem to be relatively safer.

The above discussion clearly brings out the comparative advantages and disadvantages of each mode of transport. Two-wheelers are the most space consuming and unsafe mode while four-wheelers are the most energy consuming and polluting. Bus systems, on the other hand, are the least space consuming, least polluting, energy efficient and safest passenger modes. Thus in view of the above discussion it emerges that an analysis of modal mix in terms of its determinants and reasons is of high importance in an urban transport system. There is hardly any study in this direction in the literature, particularly in the case of India, as is evident from the review. The present study aims at this gap, making an attempt to understand the transportation situation and the modal mix differences across Indian metropolitan cities. We also make an attempt to understand the forces influencing the urban transport at micro level by evaluating the urban transport scenario of Pune over the last four decades. In this background the study is carried out with the following specific objectives.

1.5 Objectives of the Study:

The following are the specific objectives of the study:

1. To assess the modal mix across metropolitan cities in India in terms of growth and compositions.
2. To explore the determinants of private mode intensities across cities.
3. To review the evolution of Pune's transport system and examine the factors that have shaped it over years.
4. To understand the role of demand side factors in modal choice in terms of perceptions and attitudes.

1.6 Organisation of the Study

The study is organised in six chapters. The second chapter discusses the relevant theoretical concepts, which provides a prelude to the subsequent chapters. It also provides an overview of the available databases while discussing their limitations. Chapter 3 looks into the trends, compositions and determinants of vehicular population in metropolitan cities, categorised according to size. It is accomplished with the help of a cross-city analysis of selected variables that are expected to cause differentials in the personal mode intensities across cities. Chapter 4 gives a more micro picture of the problem with the help of a case study on Pune city. We investigate how certain processes in the development of urbanisation tend to bias the modal mix in favour of private modes. Chapter 5, with the help of primary data, examines the role of perceptions in determining the modal mix. We study the role of preferences and attitudes to assess their implications for public modes. The major findings of the study are summed up in Chapter 6.

1.7 Scope of the Study

As indicated in our title, this is an attempt at exploring linkages between urbanisation and transportation. Motivated by the importance of this relationship, we set out with the given limitations of data and lack of adequate research in the developing country context, to examine the contours of this linkage. By examining the macro t heoretical perspectives and juxtaposing it with a micro level example we attempt to highlight the causal relationships which merit further investigation. Our study is therefore only a modest beginning in moving towards a clearer understanding of an important relationship, which has important economic, social and ecological implications in the urban reality of today and the future.

Chapter 2

Concepts, Data and Measurement

Introduction

Urbanisation and transportation are inter-linked in a complex manner. The technology and accessibility of transportation in a place affect the urban form, economic activity and the very pace of economic development. However, in the present study, we limit our focus to one side of this inter-linkage. We examine how the processes of urbanisation expand and intensify the travel demands simultaneously impinging on the modal mix. The chapter is organised in three sections. In the first section, we discuss the framework in which we study the problem of urban transport with reference to urbanisation. This provides a prelude to the analysis in the following chapters. In the second section, we discuss the available databases on urban transport and their limitations. In the third section an attempt is made to identify the ways in which our analysis is constrained or modified because of the data limitations.

2.1 Urbanisation and Transportation: Some theoretical issues

Here, we discuss the analytical links through which we study the interaction between urbanisation and transportation. We look at the issue in the context of city size and also in relation to various factors that are supposed to have a bearing on the transportation patters.

2.1.1 Transportation: Issues around Urban Size

In the context of rapid urbanisation and especially a tendency in India towards the formation of large cities, the issue of 'optimal city size' assumes importance. There has been a contention in the literature on the relationship between urban size and its amenity effects (Kelley, 1977; Fogarty et al, 1980). This has led to the search for an 'optimal city size' which is neither too small to lose out from the net benefits of agglomeration and neither too big to suffer from the net losses of the negative externalities associated with large size (Henderson, 1987; Montgomery, 1988; Power, 1981).

We base our study in this context of urban size and dis-amenities associated with particular transport structures in terms of modal mix within the city. In the previous chapter we already discussed the specific implications of different vehicular types on transport

externalities. We also elaborated on how these vehicular types can be clubbed into another, more useful classification i.e. personal, intermediate and public modes. We saw that the benefits of private transport (personal modes) accrue largely to the individual while the negative effects have to be borne by the society as a whole in the form of externalities. These externalities of urban transport - congestion, air pollution, noise pollution, accidents, etc., contribute to the dis-amenity effect of a city. This transforms into higher costs of living in the city due to time and money spent on travelling, health related costs, and the loss of an 'amenity' value from a better environment.

In our analysis, we place the modal mix of various cities in the context of city size debate to see whether city size is a determinant of transportation patterns within the cities. Does size have any role in the emergence of a particular modal picture? Do cities of the same size share the same transport characteristics? And what is the role of various factors contributing to the present transport scenario in a typical Indian city? These are some of the questions we address in this study.

City size has been studied as an intervening variable in urban studies for studying its influence on many urban phenomena. For example, it has been studied in context of crime, air pollution, congestion etc. Conventionally these problems are considered to be typical or severe for cities, their magnitude increasing at an increasing rate with the size of the city[1] (Tolley and Crihfield, 1987). But, some economists have argued against, this doubting the empirical evidence available for establishing city size as an intervening variable. They consider that most of these problems that are considered to be urban or city size problems actually arise from the spatial concentration in cities that makes these problems look accentuated (Kelley, 1977; Richardson, 1973). Thus, the concept of an optimal city size is debated and policy to control the size of the cities is scorned, especially in the context of the fact that poorer economies are expected to suffer greater income losses if urban growth is restricted (Shukla, 1996). Thus, many of the economists hold the view that the positive

[1] However, Shukla et al (1996) show that the city size is not monotonically related to the air pollution levels, but the relation is of an inverted U shape as pollution incidence first rises and then falls with increasing city size.

effects from spatial agglomeration[2] far outweigh the negative effects (if any) from such an agglomeration.

Thus, examining the problem with size as a reference point provides an important policy variable. If transport diseconomies grow beyond a point, where the marginal social costs exceed the marginal social benefits of particular modal patterns beyond a certain size then, this would call for policies trying to either limit the size of the city or for certain interventions to control the modal mix in relation to city size. Transport systems have never been placed in the context of city size and this might be important in the context of current debate about policies aimed at limiting spatial agglomeration.

City size becomes a meaningful lever to study the modal mix also because it is expected to be related to certain other geographic and economic phenomena. Studies show a negative relationship between urban density and city size (Mera, 1970), positive relationship with income level[3] (Losch, 1954; Richardson 1973) especially, with wage levels (Rosen, 1979), and a negative relationship with income inequality (Richardson, 1973). Size may be also related to the extent and structure of industrial activity in the city, which is linked to the locational advantages and disadvantages, themselves related to city size (Smith, 1971). Especially, the availability of external economies like communication economies, access to information resources, specialist expertise in commerce and finance, etc., lead to specialisation in service sector in large cities (Richardson, 1973).

However, these phenomena assume greater complexity in our study where we are dealing with only the metropolitan cities in a developing country. For example, income inequality is expected to decrease as city size increases (Richardson, 1973), the most marked and dramatic fall in the incidence of poverty taking place for the million plus cities (Ornati, 1970). But, this relationship is not so clear within the million plus cities themselves (Murray, 1969) and also becomes debatable in the developing country context, where political factors play an important role causing skewed income distribution (Cutright, 1970). Therefore, investigating the relationships between each variable with the modal mix becomes important.

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[2] For a detailed discussion on the agglomeration effects and a review of some empirical studies proving positive agglomeration effects, see Montgomery (1988).

[3] Infact, many of the problems of urban concentration might stem from "the sheer growth and affluence of the society" Rothenberg (1970).

2.1.2 Transportation: Issues around city-specific factors

Here, we discuss some of the variables that are expected to impact the modal mi: hypothesising on the possible direction of their relation to private mode intensities. W broadly divide the factors into geographical, economic, occupational, demographic transportation and infrastructural factors.

2.1.2.1 Geographical Factors

We look at three elements under the geographical factors that may impact the modal mix. Urban sprawl, sub urbanisation and the growth in satellite towns is an indispensable phenomenon of urbanisation in all countries. Size may affect the modal mix as larger city sizes mean longer journeys to work unless jobs decentralise as fast as homes, and this also implies longer travel times (Voorhees, 1966). Also, travel time increases with city size faster than travel distance due to the congestion resulting from a higher concentration of vehicles using the limited road network. The modal mix might be affected, as geographically compact cities are more amenable to private transport because of shorter trip distances. On the other hand, investments in new and improved systems having greater capacity with lower congestion costs like rail-based systems become economically viable in larger cities (Richardson, 1973). However, the shift might not happen necessarily in favour of public systems, if first of all, these systems are inefficient[4] or secondly, the growth in incomes leads to a shift within the personal modes itself to four-wheelers, which reduce the inconvenience of long distance journeys.

An important aspect of growth in size is not only the increase in the geographical spread but also the location of economic activity vis-à-vis that of commercial and residential within the larger urban space. Industrialisation concentrates activity in specific locations creating a large demand for work trips. Inappropriate land use planning will lead to increased trips across the various zones. Unless appropriate public transport systems are made available to suit these specialised trips this will lead to a mushrooming in the growth of personal modes.

The next important factor is the growth rate of cities. Fast growing cities mean rapidly increasing travel demands. However, in a situation where public and intermediate modes

Y,33;7:7&X,4.443531 N9 P1

[4] For instance, rail-based systems may be more efficient in terms of larger savings in time for covering long distances as compared to bus systems.

cannot increase as rapidly, excess demand is satisfied by the increased reliance on private modes of transport. The proportion of migrant population in the city might also be of especial importance as it gets attracted to the city in search of employment, business or educational reasons and thus might have greater travel needs.

The density of the city is another important geographical factor expected to have impact on modal mix. High density may result in traffic congestion in the city to the extent that it may act as a disincentive to go by a private mode. Further, public transport systems tend to become more viable in cities with greater densities, thus improving the overall returns to public transport (Kenworthy et al., 1999). Thus one may expect a negative relationship between the density of the city and its vehicular intensity. Another dimension is the spatial distribution of density. Uneven density within the cities with core areas having higher densities as compared to other regions again has implications for the modal mix through the provision of public transport.

2.1.2.2 Economic Factors

Income is expected to be an important variable in the vehicular ownership and use especially in developing countries (Dargay et al, 1999). The per capita incomes in urban areas are greater and also tend to rise faster. Higher levels of income imply greater affordability to own private automobiles as it represents the symbol for perfect mobility.[5] Nevertheless, it is not income alone, but also distribution of income within a city that influences vehicular ownership. A more skewed income distribution might lead to a more biased modal mix towards private automobiles rather than marginal increases in the overall income level in the city. Hence the personal mode intensities may have a positive association with the level of city's income[6] and income inequality. Another such facilitator for the increase in private modes is credit availability. Better-developed banking and credit facilities leading to accessibility of easy credit in terms of soft loans can become another major factor in the private vehicular growth.

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[5] Kenworthy et al. 1999, however, in a cross country study shown that income (Gross Regional Product) is not the most important determinant in deciding the transport structure of cities.

[6] However, a study noted that an increase in the real incomes in the developing countries leads to an increase in public transport usage, whereas in the developed countries a substantial increase in real incomes led to increased car ownership and a decrease in public transport usage (Jacobs et al, 1979).

2.1.2.3 Occupational Factors

Most of the modern economic activity[7] involves greater proportion of people in the secondary and tertiary activities that involve work away from home as different from primary activities. Thus, occupational structure of the population has implications for travel intensity of the population, which means the requirements of such a population in terms of trips per person are higher. Another implication of the composition of economic activity arises from the fact that some sectors involve more travel on job (business travel) as compared to others. Thus, a growth in the service sector for example, may lead to a growth in the travel intensity with a bias to personal modes as a high value of time is attached to business travel. Also, occupational status over and above the income related effects do exist in commuting propensities and residential preferences (Cubukgil et al., 1982). These again tend to bias travel towards the personal modes.

The spatial dimension of economic activity i.e. employment concentration is another important factor. Apart from the fact that urban areas are structurally different from rural areas, what makes the problem more acute is the concentration of certain characteristics which involve more travel. The density of employment in a certain area means an increased demand of transportation services, which, in the absence of substitutable alternative modes will be satisfied by private modes. Therefore, the occupational and economic structure of a city can have multiple implications for urban travel.

2.1.2.4 Demographic Characteristics

Age composition of the urban population might also have implications on travel intensity and the preference for private modes. The adult population in active age groups are expected to be more mobile as compared to the children and the aged population. In terms of modal mix too, this might have implications as certain age groups (like the college-goers or the aged) might have a preference for using private modes of transport rather than public modes. Another added dimension is that over time, the population becomes more automobile dependent. For example, if the dependence on private modes is high for a certain group of

[7] There is a fall in the primary industries between non-metropolitan and metropolitan areas and up the urban hierarchy (Richardson, 1973).

population in their youth, then the chances are that they will continue to prefer this mode over public modes even in their later ages (Hoorn et al, 1986).

2.1.2.5 Transport Characteristics

The availability of the public and intermediate modes determines the personal mode intensities to a great extent. Public and private modes can be considered substitutes to each other at least over a certain range of income. A good public transport system can thwart the growth of private vehicles (Goodwin, 1993)[8]. The existence of efficient public modes (rail or bus systems) or intermediate modes can obviate the need for automobile dependence. The operation of the public transport assumes a major significance at the local level where the dependence on private vehicles tends to be highly sensitive to the changes in fares and service levels of public transport.

2.1.2.6 Infrastructure Factors

The provision of better transport infrastructure in terms of road space is expected to increase the dependence on personal modes of transport. This is known as the 'magic circle' or induced traffic where travel and dependence on private modes increases as an outcome of better transportation facilities in the form of more road space and other infrastructure (Dupuy, 1993; Venables[9], 1999). Thus, one would expect a positive relationship between road availability and vehicular intensity.

In the light of the above theoretical concepts, the present study tries to understand the transport system of a developing country like India. We begin with the available data across Indian metropolitan cities to examine the relationship between urban size and its transport systems. But, since this is only a static snapshot of the transport scenario, we then move on to a more dynamic and explicit study of a particular city, Pune. We study the growth of its transport structure in an evolutionary light over the last four decades. Here we document the historical processes, which have impacted the urbanisation within the city and also its transport structures. We also discuss the more pervasive processes, like changes in some

[8] However, this has been questioned by Kenworthy, 1999.

[9] Venables have shown that road improvement can reduce welfare if road improvement leads to further traffic creation and consequent congestion. He argues that congestion effects may be quite far-reaching, extending to travellers who do not directly benefit from the improvement. Then there is a possiblity that road improvement reduces welfare.

socio-economic and demographic variables contrasting the city with its hinterland, to delineate the effects of urban concentration. We then look at some specific local level determinants like public transport, transport policies and political forces that have impacted the transportation scene.

2.2 A Discussion on Database

Urban transport is a relatively under-researched problem especially in India. The first and foremost difficulty faced by the researcher is the lack of vital statistics and scattered data on some of the important variables. Urban problems belong to a specific class of problems, which are crucially determined by the prevailing local factors within the city itself. Unless data is collected at the urban agglomeration (henceforth UA) level, published and disseminated, research in this area will prove to be difficult. In this section we briefly discuss the available data sources that are relevant for our purposes discussed in the previous section and highlight the crucial data that is presently unavailable.

2.2.1 Data on vehicular populations

The Motor Transport Statistics of India is the primary source of official statistics for reference on all the important aspects of road transport in India. This provides statistics on the number of registered motor vehicles in the metropolitan cities along with more explicit details for states. Data is provided under the physical categories of vehicles, that is two-wheelers, four-wheelers, cars, jeeps, taxis, buses, trucks, tractors, trailers and others. The limitation of this database is that data is available only for metropolitan cities and not for other class towns and cities. Secondly, these figures are merely impressionistic estimates derived from the vehicles registered with the particular Road Transport Offices (RTOs) and are to that extent mere approximations.[10] Another drawback is that data is not maintained at the metropolitan level according to ownership classification of public or private vehicles. State level Motor Transport Statistics (Maharashtra) also gives information on the various parameters like motor vehicle population, registration, licences, revenue, road accidents and road statistics. It gives the vehicular population for important cities in the particular state.

[10] For example, Pune District has two RTOs. Many of the vehicles that are registered with the RTO ply only in rural areas and the exact share of these vehicles is unknown. It might help to collect and classify data on the basis of the residential address of the owners.

2.2.2 Data on public transport

There are no databases on the provision of public transport within the cities. Data is available only for those Municipal Undertakings that are registered with the Association of State Road Transport Units. Most of these municipal undertaking are from Maharashtra, Punjab, and Gujrat. Detailed information is available here on the fleet size, capital structure, financial performance, physical performance, operational information and staff details of these units. However, for the other cities, it is not possible to even know the fleet size of the public transport units. No information is available on the private bus services within the cities.

2.2.3 Data on intermediate transport

Information on autorickshaws and taxis registered with the RTO are given by the Motor Transport Statistics. However, the exact number of vehicles plying within the city is not available. For instance, there are 3000 taxis registered in Pune city, however, these taxis ply only inter-city/district and don't ply within the city limits. Secondly, no information is available on the variety of intermediate systems that exist across cities like jeeps, matadors, six-seaters and other non-motorised transport which carries a vast amount of traffic within the cities.

2.2.4 Data on urban roads

The Basic Road Statistics of India gives information on National Highways and state highways, other PWD roads, zilla parishad roads, village panchayat roads, community development blocks/ panchayat samiti roads etc. The total and surfaced length of urban roads and municipal roads in India is available at the state level, but disaggregation for cities is not available. The Statistical Abstract of the states gives district level data regarding road lengths. Although, the Town Directory from the District Statistical Abstract of the Census of India gives information on the lengths of roads in respective towns and urban agglomerations, this information is scattered in individual town directories of separate states. The All India Town Directory pools information on certain physical characteristics at the town level, but again here information is available only at the town level and not the UA level, and since an UA contains many towns, it is tedious to sum up these for various UAs.

No information is available on the urban road areas, which might be a more accurate measure for estimating the road space available in the cities.

2.2.5 Data on urban rail systems

Statistics relating to the rail transport are mainly available in the Monthly Railway Statistics, Indian Railways Yearbook and Indian Railways Annual Report and Accounts. Aggregate data on the operation of urban and suburban rail transit is available in the Railway Yearbook, CMIE Infrastructure Report and in the Railway Annual Reports. However, to the best of our knowledge a break up for the cities (Mumbai, Kolkatta and Chennai) is not available.[11] Data on the operation of these systems is crucial as the rail systems play a major role in the urban transport of these cities. It would be crucial to estimate the impact of these systems on the modal mix.

2.2.6 Data at the household level

No published travel survey databases are available across cities. The NSSO, 54th round has investigated commuting patterns by workers and students and the NSSO, 50th round in a survey on the use of durable goods by Indian households has information on the vehicular ownership across different income groups. However, these studies give estimates at the State level, with urban and rural distinction, which might not be an accurate estimate for the town or metropolitan region. Similarly, no information is available on the income levels across cities, or a city over time. Income being a crucial variable in determining the pattern of travel and also varying considerably from the state level income is an important gap in databases on cities. However, the 'Working Class Family Income and Expenditure Survey, 1981-82' gives information on the family income and expenditure across 76 important industrial cities of India. It also has information on the expenditure on transport and communications and also a disaggregation of expenditure on various modes by the families across these cities.

[11] We were able to get some data separately for these three mega cities in 'A Review of the Performance of the Indian Railways' and 'Supplement to Indian Railways Report and Accounts' both published by the Ministry of Railways, Govt. of India in the seventies and eighties respectively. But, we were unable to determine whether these publications were available for recent years.

2.2.7 Other statistics

Investments on transport infrastructure in the city is fundamentally at the municipal level and data at this level is available only with the respective corporations. Expenditure on roads is at two levels, revenue expenditure and capital expenditure. Data on annual revenue expenditure is published in the annual reports but data on capital expenditure are more difficult to find. Capital expenditure is made out of a grant made by the State government, which is a lump sum every three years (as inferred from the case of Pune). Other databases that might be interesting are the Pocket Book on Transport Statistics in India, which gives information on all modes of transport. Facts & Figures, by Automobile Component Manufacturers Association gives information on vehicle production, vehicle sale and other details regarding the automobile industry. The production and sales of various firms, their imports, exports of automobiles and various components etc are listed. Motor Transport Statistics in India gives a the number of people killed and injured in motor vehicle accidents state level and for metropolitan cities. But, a detailed composition of the primary and secondary vehicles involved in the accident is available only with the particular traffic branch. Data on air pollution is available for 290 stations, covering 92 cities and towns in 28 states and union territories under the National Ambient Air Quality Monitoring (NAAQM) programme jointly by the Central Pollution Control Board and NEERI. However, data from 1987 to 1995 is available only for 87 cities in 23 states and union territories.

2.3 Limitations of the analysis due to data constraints

The data limitations prevent us from examining some of the theoretical concepts discussed in the previous section of this chapter. Therefore, wherever relevant we have been forced to use crude proxies for certain crucial variables. Here, we discuss some of these issues.

Our analysis of the relationship between modal mix and city size is restricted to only the metropolitan cities as data is not available for cities of smaller size. Thus, we are unable to investigate the impact of city size on the transport patterns over a larger range of cities, as our study is limited only to the upper rung of the city size ladder.

We have used the bus populations registered in the metropolitan cities to substitute for the lack of data on public buses in the cities. However, this introduces inaccuracies as this data is inclusive of school and company buses and buses catering to mofussil services. The proportion between public and private buses may vary across cities constraining us from

understanding the effect of public transport provision on private mode intensities. For estimates of infrastructure provision across cities we have used the CMIE[i] infrastructure index at the district level which is again not an accurate indicator for infrastructural provision across cities.

Data is not available at the city level for us to examine the changes over time in the vehicular populations in relation to changes in the city level factors over time. Thus, our discussion in the case study is based mainly on data at the district level. This non-availability of data also prevents us from testing the nature of relationships between certain variables over time that could have been important in explaining the changes in the growth over time.

No indicator on the differences in urban wealth across cities is available. An indicator at the city level equivalent to the State Domestic Product at the state level would have been useful to know the economic status of the cities. In the absence of this, we have substituted the town level expenditures and incomes.[12] Another important indicator is the household income or expenditure estimates collected through sample surveys similar to the NSSO Consumer Expenditure Surveys. However, to the best of our knowledge no such indicator was available for the time period relevant for our analysis. In the absence of which, we have used the results of the Working Class Family Income and Expenditure Survey, 1981-82.[13] This too has limitations, as firstly, the surveyed class is only the working class and secondly, it introduces inaccuracies with respect to the lapsed time period. In our case study of Pune, too the lack of an appropriate income variable prevents us from determining the changes in the income levels in Pune city. The only estimates of changes in income were the State Domestic Income for Maharashtra from the National Accounts Statistics. However, the incomes at the city level are expected to be higher and have grown at a higher rate as compared to the state level. Again no indicator was available as an indictor of income inequalities across cities or over time. We have used the percentage of slum population across cities as a proxy.

[12] Since the incomes and expenditures at the UA level were difficult to obtain, we have used the town income and expenditure figures.

[13] This is under the assumption that the relative levels of incomes across cities have not varied significantly from 1981-1991.

Summary

The above section delineates some of the data gaps while discussing the available data for work on urban transport in a country like India. Densely populated, land scarce economies need to have a more focussed policy orientation towards sustainable transport systems and this would mean constant research input for perceptive decision making. Appropriate collection of data could thus be one of the crucial first steps to make in this direction.

This chapter laid out some concepts, which aid our analysis and discussion in the next two chapters. We discussed various dimensions of urbanisation and the resulting implications for urban transport. This chapter also looked into the available databases relevant for work on urban transport stating their limitations.

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[i] CMIE, Profiles of Districts (2000) calculates the Infrastructure Index on four major infrastructural facilities- energy, transport, irrigation and finance along with communications, education and health. It is a composite measure of infrastructural development. Using a base period, the growth of infrastructural facilities and their relative levels among states has been measured.
The weights use are listed below:

Sector	Weight(%)
Transport Facilities	26
Energy	24
Irrigation Facilities	20
Banking Facilities	12
Communication Infrastructure	6
Educational Institutes	6
Health Facilities	6
Total	100

Chapter 3

Vehicular Population in Metropolitan Cities: Trends, Composition and Determinants

Introduction

This chapter analyses the trends and composition of vehicular populations in the metropolitan cities of India. It also attempts to explore their relationship with selected variables which literature suggests to be important in determining the transport structure of cities. The chapter is organised in four sections. Section one gives a brief profile of Indian metropolitan cities. Section two examines the transport situation across these cities in relation to city size by looking at their average vehicular population, intensities, composition and growth. Section three makes an attempt to explore the determinants of private vehicular intensities. Section four sums up the major findings of the analysis.

3.1 Profile of the cities

The importance of considering size of the city as a reference point to understand the pattern of transport systems across cities is pointed out in the previous chapter. Accordingly, here, we classify the 23 Indian metropolitan cities[1] according to their size, measured in terms of population, for the purpose of our analysis. A 'metropolitan' city is defined to have a population of more than one million. Thus all the cities in our sample have a high population. Hence our categorisation of cities, according to size measured in terms of population, is to be considered only as contextual. It should, however, be noted here that there is considerable variation among these cities in terms of population. While the smallest population in the sample is1.01 million (Ludhiana) the largest is 12.57 million (Mumbai) in 1991. The picture is clearer from figure 3.1, which depicts the distribution of population across the Indian metropolitan cities in 1991. As is expected it is seen that the level of population is very high in mega cities, Mumbai, Kolkatta, Chennai and Delhi. These are followed by the cities Ahemedabad, Hyderabad and Bangalore.

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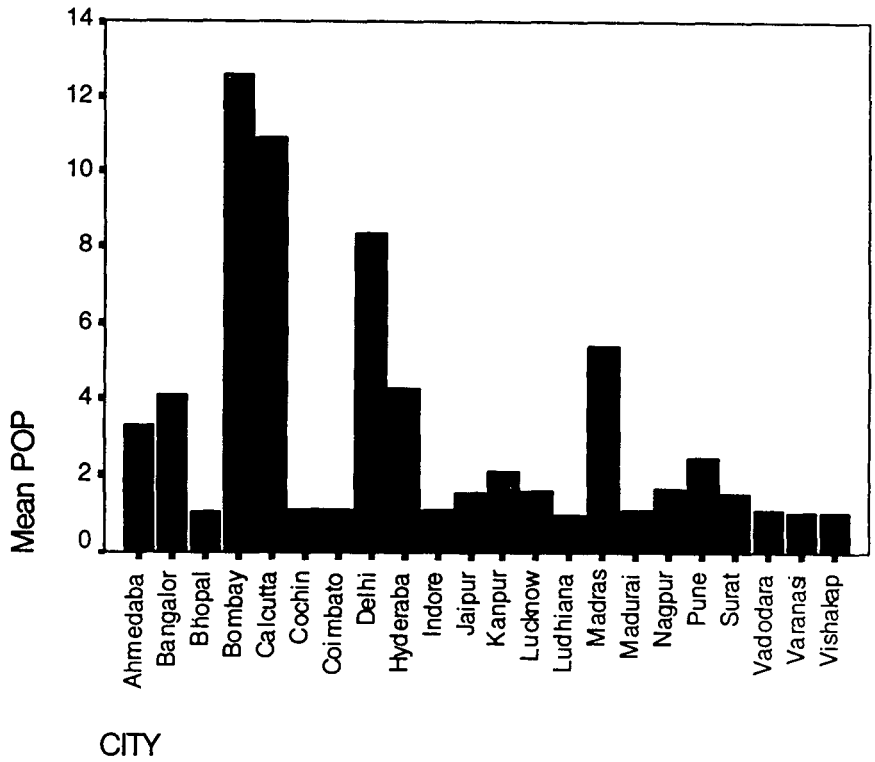
[1] The study is confined only to the metropolitan cities, largely due to the non-availability of relevant data pertaining to other cities. Patna has been excluded from the analysis, as no data is available on the vehicular populations in the city.

Fig. 3.1: Population of Metropolitan cities.



Source: Motor Transport Statistics of India.

Table 3A.1 in the appendix to this chapter gives the profiles of metropolitan cities in terms of their populations, area, density and population growth rate over the decade 1981-91. Reading from the graph and table we may classify cities according to their population into four, viz. the mega cities, the large cities, the medium cities and the small cities (see table 3.1). As is seen from the bar diagram, Mumbai, Kolkatta, Chennai and Delhi obviously have very huge populations, above 5 million, as compared to other metropolitan cities. They may, therefore, be grouped separately as 'mega cities'. The existence of urban rail systems in Mumbai, Kolkatta and Chennai, however, again makes it difficult to include Delhi in this classification. Therefore, Delhi is considered separately. Cities with a population below 5 million are classified as 'Large cities'. This includes Bangalore, Hyderabad and Ahmedabad. Next, Pune, Surat, Nagpur, Kanpur, Jaipur and Lucknow, with a population of less than 2.5 million have been classified as 'Medium' cities, while all other cities with a population below 1.5 million have been grouped under the category 'Small'.[2]

[2] Incidentally, all the cities coming under 'small' category with the exception of Surat have acquired their metropolitan status in 1991.

Table 3.1: Categorisation of Metropolitan Cities

Group	Description		Number
Small	Population between 1 to 1.5 million.		9
Medium	Population between 1.5 to 2.5 million.		6
Large	Population between 2.5 to 5 million.		3
Mega	Population above 5 million.		4
	Rail-based	*Mega cities with rail systems.*	3
	Delhi	*Mega city without rail systems.*	1

Thus the entire sample is re-classified into four categories - small, medium, large and mega. It is worth mentioning that the number of cities in each category varies widely (see table 3.1). While 58 per cent of our sample is constituted by small and medium cities, 42 per cent of the sample comprises of large and mega cities.

3.2 City size and vehicular modal mix

We examine the relationship between city size and average passenger vehicular populations in cities by the classification of personal modes sub-divided into two and four-wheelers, intermediate and public modes.[3] Figure 3A.1 in the appendix gives the vehicular populations of different cities as on 31st March 1997. Delhi has an enormous vehicular population compared to any other city. In fact, it is equivalent to the other three mega cities put together i.e. Chennai, Mumbai and Kolkatta, indicating a possible negative relationship between availability of good public transport systems such as urban rail transport and vehicular populations. The size of the vehicular population grows along with the increase in population in almost all the cities except Mumbai and Kolkatta. The top eight big cities in terms of population are also therefore, the largest in terms of vehicular populations.

Table 3.2 gives the maximum, minimum and sum of the total vehicular population, personal modes, intermediate modes, public modes and goods vehicles over the different city categories. Incidentally, we can see from the table that, in terms of the absolute numbers the totals of various categories are almost comparable.[4]

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[3] Intermediate modes consist of autos plus taxis. We have not analysed them separately since they form a small percentage of the total vehicular population. Secondly, as data is available only for the physical category of 'buses' we use this as a proxy for public modes and use the word interchangeably in this chapter. Finally, though we do not discuss goods vehicles as such, we have provided for that category in our tables.

[4] That is the total vehicular population in nine small cities is only a little higher than the total vehicular population of six medium sized cities, and equivalent to that in three large and three rail-based cities. However, in terms of absolute numbers, Delhi has more vehicles than nine other metropolitan cities.

Table 3.2: Vehicular Populations in 1997

City		Minimum	Maximum	Sum	Average	Co. Var
Small	***All Vehicles***	***122165***	***360549***	***2288470***	***254274***	***0.32***
	Two-wheelers	94560	309808	1741760	193529	0.36
	Four-wheelers	9079	38754	248975	27664	0.43
	Personal Modes	103639	339113	1990735	221193	0.35
	Intermediate Modes	3277	20954	89299	9922	0.65
	Public Modes	1125	6679	25810	2868	0.62
	Goods/Others	9166	38951	182626	20292	0.45
Medium	***All Vehicles***	***238576***	***476372***	***1856164***	***371233***	***0.26***
	Two-wheelers	187219	351538	1441465	288293	0.23
	Four-wheelers	19667	52630	188439	37688	0.35
	Personal Modes	206886	399977		325981	0.24
	Intermediate Modes	9577	35061	82528	16506	0.65
	Public Modes	594	12386	24547	4909	0.98
	Goods/Others	5943	41079	119185	23837	0.59
Large	***All Vehicles***	***631019***	***972375***	***2372795***	***790932***	***0.22***
	Two-wheelers	488547	707863	1865084	621695	0.19
	Four-wheelers	23919	145981	241673	80558	0.76
	Personal Modes	560320	853844	2106757	702252	0.21
	Intermediate Modes	37676	53980	130688	43563	0.21
	Public Modes	2342	14640	30561	10187	0.67
	Goods/Others	17027	50972	104789	34930	0.49
Rail-based	***All Vehicles***	***587576***	***889819***	***2274308***	***758103***	***0.2***
	Two-wheelers	261325	652990	1243255	414418	0.51
	Four-wheelers	162966	279613	659962	219987	0.27
	Personal Modes	478708	815956	1903217	634406	0.27
	Intermediate Modes	29868	120653	189536	63179	0.79
	Public Modes	5198	12809	25091	8364	0.47
	Goods/Others	38797	62769	156464	52155	0.23
Delhi	***All Vehicles***				***2847695***	
	Two-wheelers				1876053	
	Four-wheelers				705923	
	Personal Modes				2581976	
	Intermediate Modes				95225	
	Public Modes				29572	
	Goods/Others				140922	

Note: Co. Var: Coefficient of Variation
Source: Calculated from Motor Transport Statistics of India, 1999.

3.2.1 Average Vehicular Populations

The mean vehicular populations across cities and their coefficient of variation (Co. Var) are also given in table 3.2. The mean vehicular population is seen to increase with the size of cities, except for mega-cities with rail transport systems[5], where it is even lower than that for

[5] This is primarily because of low vehicular populations in Kolkatta and Mumbai.

'Large' cities. Delhi, however, has an exceptionally high population of more than 28 lakh vehicles. A similar trend exists for two-wheelers as well. However, there seems to be a more consistent relation between size and average four-wheeler populations. This seems to suggest that the presence of rail systems within the city might affect two-wheeler populations rather than four-wheeler populations. There is more variability in the average bus population within and across city sizes. Again the existence of rail systems seems to affect the provision of bus population, as the average bus population in these cities are lower.[6] The average population of intermediate modes rises with city sizes.[7]

3.2.2 Changes in Vehicular Composition over the years

Table 3.3 shows the changing composition of vehicular populations over 1985-1997. It is seen that for all groups of cities personal modes constitute 80-90 per cent of the total vehicular population. Though there is not much variation across groups in general, in the mega cities the proportion of four-wheelers is much higher. This may be attributed to the likely concentration of wealth in certain groups in these cities given that ownership of four-wheelers is considered as an important indicator of their socio-economic status. The intermediate modes form an average of 4 to 7 per cent of total vehicular population in all the groups, however the rail-based cities show a slightly higher share. The proportion of two-wheeler population has risen from 1985 onwards in all the groups except Delhi. In the case of Delhi, the two-wheeler population has came down by almost three per cent, but, the share of personal modes as a whole has increased due to the rise in the share of four-wheelers. This is in contrast to other cities where there has been a fall in the proportion of four-wheelers over years. In the category of rail-based cities, four-wheelers occupied a dominant share in 1985 (44 per cent), which has however come down (to 30 per cent) in 1997. However, the proportion of personal modes has gone up due to the rise in the proportion of two-wheelers from 31 to 55 per cent. The bus populations has generally constituted a very small percentage (less than 2 per cent) of the total vehicular population in the cities and has in fact fallen over the years.

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[6] This might be a conscious policy decision, or the presence of rail systems acting as a competitor to bus systems and thus making them unprofitable.

[7] The population of intermediate modes in Chennai and Kolkatta are lower when compared to their size and the population of four-wheelers and buses in Hyderabad is also exceptionally lower.

Table 3.3: Vehicular Compositions (in percent)

City	Two-wheelers	Four-wheelers	Personal Modes	Intermediate Modes	Public Modes	Goods
			1985			
Small	NA	NA	NA	NA	NA	NA
Medium	69.62	12.13	81.75	4.05	1.88	12.32
Large	73.19	14.99	88.18	7.06	1.45	4.97
Rail-based	35.76	41.22	76.98	8.88	1.66	12.48
Delhi	68.84	18.75	87.59	4.58	1.61	6.23
			1991			
Small	70.37	12.28	82.66	5.04	1.69	10.61
Medium	78.80	9.25	88.06	3.76	1.19	6.99
Large	77.82	11.58	89.40	5.02	1.28	4.31
Rail-based	49.99	34.37	84.36	5.78	1.76	8.10
Delhi	67.33	21.98	89.31	4.04	1.04	5.62
			1997			
Small	76.11	10.88	79.56	3.90	1.13	7.98
Medium	77.66	10.15	87.81	4.45	1.32	6.42
Large	78.60	10.19	88.79	5.51	1.29	4.42
Rail-based	54.67	29.02	83.68	8.33	1.10	6.88
Delhi	65.88	24.79	90.67	3.34	1.04	4.95

Note: NA - Not available as these cities attained metropolitan status only in the year 1991.
Source: Computed from Motor Transport Statistics of India.

3.2.3 Growth of Vehicular population

A comparative picture of the growth of vehicular population during 1985-91 and 1991-97 is provided in table 3.4, which gives the annual growth rates of different components over the various groups of cities. It is important to note here that the Indian economy has witnessed significant shift in its industrial policy in 1991 and the new liberalisation policies are expected to have impact on the automobile industry. Therefore, it is interesting to have a comparative picture of the growth rates in the two periods-the pre reform and the post reform periods.

We can see that for all the categories the growth rates of total vehicular population has come down in the second period as compared to the first. Across cities the growth rate is highest in the second period for the new entrants as metropolitan cities i.e. the small cities which is comparable to the other categories in the first period. The two-wheelers generally have a higher growth rate as compared to the other categories in the first period. This dominance has come down in the second period for all the other categories except for small cities. The growth rate of four-wheelers has also fallen in the second period for all the categories but, is high for the small cities and Delhi. Another feature that is interesting from the table is that for the medium cities and Delhi there has been a fall in the growth rate of intermediate modes and a rise in the growth rate of public modes while just the opposite is true for large

and rail-based cities. The rail-based cities have seen a negative growth rate in the bus populations.

The point that emerges from the discussion is that liberalisation as such does not seem to have affected the growth rates of the vehicular population. Infact, the growth rates for all the categories have declined in the second period. However, the growth rates seem to be more connected to the size of the cities. As the cities grow larger in size, the growth in their vehicular population has slowed while the small cities have growth rates equivalent to that of the medium and large cities in the previous decade. Thus, the small cities seem to be the major group poised for growth.

Table 3.4: Growth Rate for all cities from 1991-97

Year	Two Wheelers	Four-wheelers	Personal Modes	Intermediate Modes	Public Modes	Goods	Total
Small							
85-91	NA	NA	NA	NA	NA	NA	NA
91-97	14.03	10.30	13.51	7.86	5.19	7.33	12.37
Medium							
85-91	14.63	7.97	13.76	10.85	6.10	4.01	12.52
91-97	4.81	7.19	5.08	8.46	8.75	5.02	5.27
Large							
85-91	14.02	8.11	13.12	6.60	10.55	17.92	12.42
91-97	7.74	5.29	7.44	9.25	7.70	8.01	7.56
Rail-based							
85-91	17.93	8.19	13.24	3.47	12.57	3.76	11.52
91-97	7.10	2.58	5.38	12.15	-2.35	2.68	5.52
Delhi							
85-91	13.23	16.70	14.02	11.28	5.70	11.72	13.65
91-97	7.43	10.00	8.09	4.49	7.79	5.56	7.82

Note: *Surat is excluded from the analysis.
Source: Computed from Motor Transport Statistics of India.

However, growth rates vary widely in the second period in the smaller cities and tend to fall over larger city sizes. This pattern persists for all the above mode categories analysed. (See table 3A.2 in appendix)

3.2.4 Vehicular Intensities and city size

The above analysis on average vehicular population helps us to get an idea of the expected number of vehicles in a city of a particular size. However, a more accurate picture is given by the vehicular intensity, defined as vehicles per unit population. Table 3.5 gives the vehicular intensities of various modes across cities. The high coefficient of variation values

show that there is no direct relationship between city size and vehicular intensity. Thus our classification of cities by size is not directly useful in studying the average vehicular populations across cites.

Table 3.5: Vehicular Intensity in 1991[8] (per million populations)

CITY	Small	Co. Var	Medium	Co. Var	Large	Co. Var	Rail-based	Co. Var	Delhi
Two-wheelers	92430	0.60	90653	0.23	100930	0.14	36414	0.85	145661
Four-wheelers	15864	0.40	10748	0.52	15040	0.33	19863	0.12	47551
Personal Modes	108294	0.54	101401	0.26	115970	0.15	56277	0.58	193212
Intermediate Modes	6448	0.63	4071	0.57	6817	0.41	3031	0.47	8731
Public Modes	2167	0.64	1433	1.46	1774	0.63	1099	0.38	2250
Goods/Others	13810	0.74	7999	0.73	5511	0.30	4589	0.09	12151
Total	130719	0.50	114911	0.30	130072	0.11	64996	0.49	216345

Source: Computed from Motor Transport Statistics of India.

This can be seen more clearly from figures 3.2 to 3.6. There is a wide variation within size classes. For instance, the 'small' category contains both very high intensity cities as well as very low intensities. However, a striking feature that is captured by this classification is the variation over the size classes. We can see that the variation is much more in the small cities and decreases over medium and large cities. The range of this variation has fallen with increase in size of the cities and stabilises for the larger cities.

We can see from figure 3.2 that Delhi has the largest vehicular intensity at 21 lakh vehicles followed closely by Bhopal, Ludhiana and Indore, all three small cities. The vehicular intensity for the rail-based cities is low at 43,000 vehicles in Kolkatta, 45,000 in Mumbai and 1,00,000 vehicles in Chennai. There is a huge amount of variation in the two-wheeler populations with Ludhiana having the highest vehicular intensity among all the metropolitan cities at 1,72,000 two-wheelers per million and Madurai having a low of 21,600 two-wheelers per million. The range of variation falls over the medium cities with Kanpur having the lowest in the category with 69,000 and Jaipur with 1,26,000. We can also see that the two rail-based mega cities ie. Mumbai and Kolkatta have the lowest two-wheeler intensity among the cities and even Chennai has a relatively low two-wheeler intensity compared to the other cities, while Delhi has a high two-wheeler intensity at 1,45,600.

[8] The intensities are calculated for 1991 because the population data are available for that year.

This variation over size classes is retained for the four-wheeler intensities as well (see figure 3.4). Delhi has the highest four-wheeler intensity at 47,500 followed by Jaipur, Bangalore, Mumbai, Chennai, Cochin and Bhopal all having a vehicular intensity ranging between 20,000-25,000. Similarly, for bus and intermediate vehicles we can see that the range is the highest for the small cities, with Vishakapatna and Surat having the highest bus intensities (over 5000 buses per million population, while most larger cities have intensities less than 2000 per million). Cochin and Vadodara have the highest intermediate mode intensities (over 10,000 vehicles per million). The figures 3.5 and 3.6 show evidence of considerable variation among the other city classes as well.

Thus, we can see that no direct relationship can be deduced between city size and its vehicular intensity. However, a sketchy positive relationship seems to emerge for cities having a population over two million.[9] The intensity of total vehicular population and the intensity of personal modes increase sharply with city size while this pattern is less sharp for public and intermediate modes. However, Mumbai and Kolkatta remain important exceptions.

The above observation coupled with the fact that the variation in the intensities stabilises over larger city sizes helps us to draw some important inferences. Firstly, certain local level factors seem to play an important role in the determination of vehicular intensities in the smaller cities. With the size of the city, the impact of these factors declines and the vehicular intensities stabilise in association with city size, increasing with the size of the city. Thus, for the larger cities we can expect a certain level of intensity for various categories unless they are provided with systems like rail-based ones which have a dominant impact on other modes.[10]

[9] However, this has to be interpreted with caution as there are very few cities in our sample above two million.

[10] Considerable differences between the city of Chennai and the other two rail-based cities, Mumbai and Kolkatta can be explained in terms of the relatively lower number of passengers that the Chennai metro carries as opposed to the other two. In the year 1985-86, 1550 million suburban passengers originated from Mumbai, 378 million from Kolkatta while only 172 million from the city of Chennai.

Fig. 3.2 : Total Vehicular Intensity and city size.

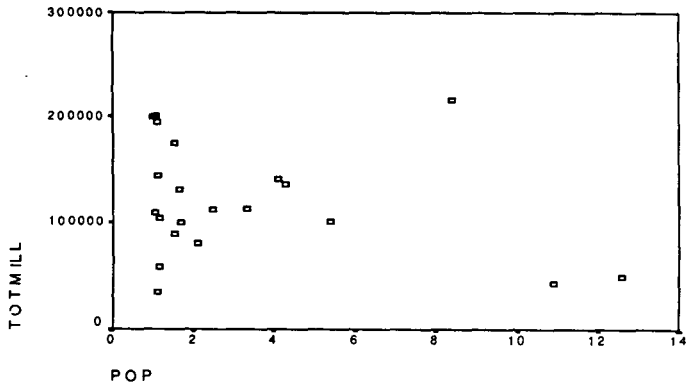


Fig 3.3: Two-wheeler intensity and city size.

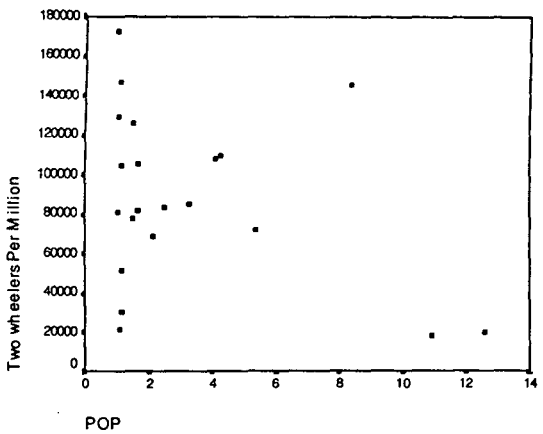


Fig 3.5 Public Modes and city size

Fig 3.4: Four-wheeler intensity and city size.

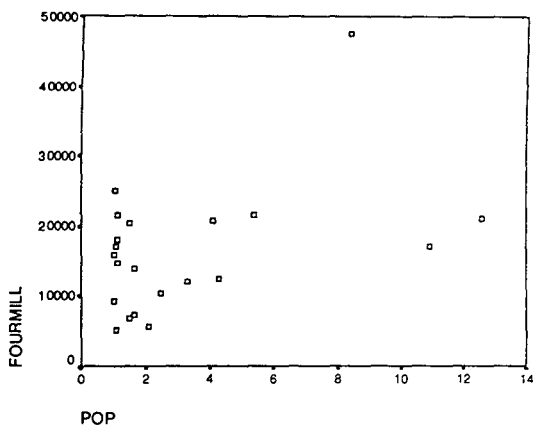
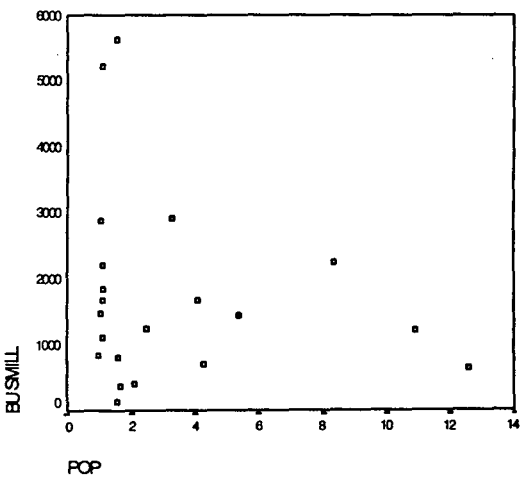
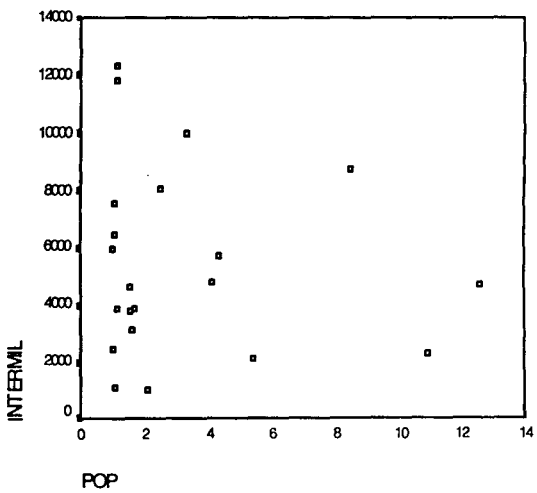


Fig 3.6: Intermediate Modes and city size.





3.2.5 Vehicle Densities and city size

We examine congestion across cities by taking vehicles per km of road length and sq. km of land area as indicators.[11] Since the vehicular compositions do not vary widely over cities we use data on total vehicles in a city.[12] Land congestion (vehicles per sq. km of the metropolitan area) increases over the size of cities indicating that vehicular populations increase at a much faster rate as compared to the size of the city. Here too, we can see that smaller cities have a higher variation showing that there is no linear relation between size of the city and land congestion (See figures 3.7 and 3.8). Some of the smaller cities have a high density of vehicles, but again as the size increases, this variation decreases and the average increases. In the case of road[13] congestion (vehicles per km of road length) too, we see that small and medium cities have a wide variability, however the large cities have relatively high vehicular densities while the mega cities (except Mumbai[14]) have relatively low vehicular densities on road. Delhi has the highest congestion in terms of land congestion, while it has a low road congestion.[15] The rail-based cities are better off as compared to the large cities in terms of both road as well as land congestion. The table 3.6 also shows another infrastructural indicator i.e. light points per km of road length. We examine this as indicators of the provision of infrastructural facilities. There seems to be no apparent relationship with city size in terms of this parameter.

Thus, we can conclude that the vehicular densities in terms of land seem to show the same pattern we noticed in the previous section in relation to the vehicular intensities. However, the relationship between road congestion and city size is much more random implying at a similar process in the policy of road provision across cities.

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[11] However, a more appropriate measure is the congestion index which shows the congestion created for one lakh passenger kms carried correcting for the carrying capacity, average occupancy and size of the vehicle. (Chapter 1, section 1.4)

[12] This is so except for the three rail-based ones where the proportion of four-wheelers is higher as compared to the two-wheelers, hence our index will actually underestimate the congestion in terms of physical space taken by the vehicles.

[13] The exact road length of the UAs sub divided into kuccha and pukka roads is given in appendix table 3A.3. We use only the pukka road length for our analysis.

[14] Mumbai has a high road congestion in conformity with its size with a vehicular density of around 400 vehicles per km of road length.

[15] The capital city has expanded its road network, spanning about 20,000 kms to suit the requirements of its huge vehicular population.

Table 3.6: Vehicular Densities

City Size	Land Congestion	Road Congestion	Light Points per Km
Small	687.83	141.67	27.19
Co. Var	0.80	0.80	.34
Medium	763.34	177.78	40.73
Co. Var	0.34	0.47	.98
Large	1293.79	288.16	74.75
Co. Var		0.15	.97
Rail-based	820.10	210.07	32.69
Co. Var	0.32	0.78	.35
Delhi	2904.09	91.55	16.38

Source: Computed from Motor Transport Statistics of India.

Fig 3.7: Vehicular Density of Land

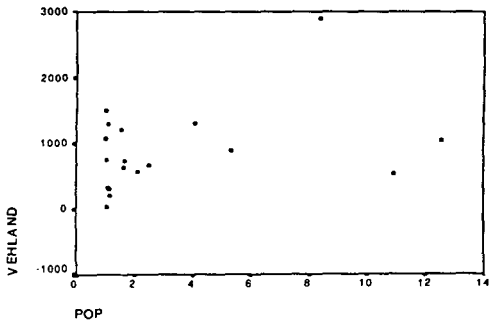
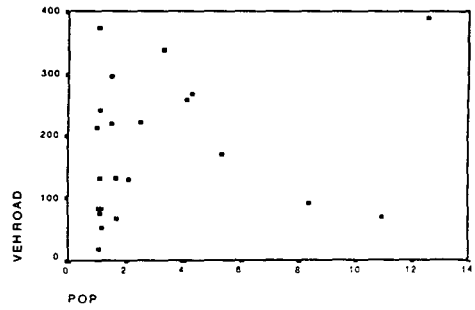


Fig 3.8: Vehicular Density of Road.



Relationship between vehicular intensities and vehicular densities

Here we briefly digress to investigate the relationship between vehicular intensities and densities (Table 3.7). There is a positive association between them indicating that the cities that have a higher vehicular intensity are the ones that have a higher road and land congestion.

Table 3.7: Relationship of vehicular intensities and densities

Vehicular Densities		Vehicular Intensities		
		Low	High	Total
Land Congestion	Low	6	2	8
	High	3	6	9
	Total	*9*	*8*	*17*
Road Congestion	Low	7	3	10
	High	3	8	11
	Total	*10*	*11*	*21*

3.3 City Size and its Implications

No direct relationship between city size and its transport pattern in terms of vehicular intensities and densities (henceforth, jointly referred to as vehicular concentrations) is evident. There is a high variability among cities of the same size, particularly so for the smaller cities. But the relationship between vehicular intensities and city size seems to stabilise for cities over two million into a positive relationship. Similar is the case with vehicular densities in relation to the land area while in relation to road it is irregular.

Now we try to provide some possible explanations on why there does not emerge any direct relationship between vehicular concentrations and city size. Analysing the factors that are expected to be related to city size (See chapter 2) we see that similar to the patterns observed in context of vehicular concentrations, these factors too do not have a one to one relationship with city size. This is evident from the scatters in figure 3A.2 in the appendix. Only area and to a certain extent density show a positive association with city size. Infact, these patterns are similar to the ones observed while analysing the vehicular patterns with a higher range of variation for smaller cities, with this variation stabilising for larger city sizes and a sketchy pattern emerging as the city size becomes larger. The scatter is wide and narrows down for income variables (both per capita income and per capita town incomes), the income inequality parameter (percentage of slum population), employment variables (percentage of working population and percentage of population in industry and services), transport variables (buses and intermediate modes per million, road length per million) and even for the growth rate of cities. The other variables related to road (road length per sq. km of area and light points per road length) show no relationship with size at all. The income variables, the employment variables and percentage of slum population seem to show an association with city size for larger cities in the sample.

Thus, the particular relationships that we expected in chapter two in relation to selected socio-economic characters with city size don't seem to be valid for our sample of cities. This could be because of two reasons. One, our sample consists of only the metropolitan cities, which are the largest cities in the city size ladder. Thus, in spite of the fact that such a relationship exists over a larger range of sizes it might not be exactly so within the same class i.e. metropolitan cities. Another consideration is that the relationships that were

discussed in chapter two were mostly verified in the context of developed countries and may not hold in the context of developing countries because of their distinct institutional characteristics.

Thus, the foregoing analysis opens up further questions regarding the determinants of vehicular concentrations within cities. These patterns seem to be much more related to specific factors within the cities rather than with city size. This is especially true for the smaller cities which seem relatively more sensitive to local factors. These could be related to the city's transport system including fleet size, bus fares and service levels or to geographic factors like urban form or to specific economic factors etc. This calls for a separate disaggregated analysis, which can pin down the effect of individual factors on the vehicular intensities. We are unable to analyse all these in their specificity due to severe data constraints. However, in the next section we attempt a disaggregated analysis of the determinants of personal mode intensities, both two and four-wheelers with the available data. Further, some of these factors can only be studied at a micro level with the help of a detailed case study, which we take up in the subsequent chapter.

3.4 Factors affecting Personal Mode Intensities

The analysis in the previous section was useful to discuss the trends and compositions of vehicular populations across city sizes. However, we saw that no definite association between vehicular concentrations emerged with city size as the intervening variable. This section, in a disaggregate analysis, tries to explore the relationship between the intensity of personal modes and selected factors, which have been identified as influential in the second chapter. The aim is to investigate the relationship between the specific macro economic variables and vehicular intensities. We concentrate only on private modes intensities as the variations in the intensities of public and intermediate modes are primarily influenced by government policies and thus the macro economic variables may not have much bearing on them. Infact, in our later analysis we take intensities of public and intermediate modes as possible determinants of personal mode intensities in the cities. The factors examined and the variables used to conduct the analysis have been specifically discussed in the second chapter. Broadly, these factors fall under four broad categories, viz. geographical, economic, infrastructural and occupational factors.

Table 3A.4 in appendix shows the correlation between the factors and two and four-wheeler intensities. Population growth rate, per capita income and percentage of migrant population are the variables significantly correlated with two-wheeler intensities. Whereas in the case of four-wheeler intensities, size of the city (both in terms of area and population), infrastructural factors (road length), income (in terms of per capita income and also the state domestic product), and percentage of service population are all positively significantly correlated. Another interesting point is that vehicular intensities of different modes are positively correlated. The two-wheeler[16] intensities are highly correlated with the four-wheeler intensities, while the four-wheeler intensities are again significantly correlated with intermediate and public modes. There is a strong correlation between public and private vehicles. (See table 3A.5)

Further, we have used a multiple regression analysis for understanding the effect of individual characteristics on vehicular intensities while controlling for the effect of other variables. OLS models are used in the regression analysis. All the variables were transformed to their log values. Various specifications were tried out using the relevant variables interchangeably. In table 3.8 and 3.9 we shows the results of those models which were found to have the best fit. While analysing the two-wheeler intensities, we have excluded the three cities having rail-based systems, as the presence of rail system has considerable impact on the two-wheeler populations (see section 3.2). Thus, the number of observations in the model explaining two-wheeler intensities is 17 while the model explaining four-wheeler intensities has 21 observations.[17] Population growth rate was not included in the second model, as it is not expected to have any a priori relationship with the four-wheeler intensity.[18] Two variables are used to capture the effect of city size: area and population. These were tried out in the different models interchangeably and only significant coefficients are shown in the results. Two measures of road availability were used, road length per million population and road length per acre.

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[16] Rail-based cities have not been considered.

[17] Hyderabad was not included in both the models because of non-availability of data on area. Data on area of the UA was not available for the cities of Ahemadabad, Surat and Vadodara. But, we have arrived at an approximate measure by using the density data available for the Municipal Corporation area for these cities and assuming the same density for the whole of UA.

[18] A four-wheeler is basically a luxury good, while a two-wheeler can become a necessity if the public transport system is not adequate.

Table 3. 8: Determinants of two-wheeler intensity: Regression Results

	Coefficient	t-ratio	P-value
Constant	9.391	2.432	0.032
Road length/Area (Sq. kms.)	0.167	1.009	0.333
Per Capita Income	-0.094	-0.117	0.909
Population Growth Rate	1.028	3.286	0.007
Size of the city (Area in Sq.kms)	-0.063	-0.262	0.798
% of population in service sector	0.745	0.702	0.496
R-square	0.572		
R-bar square	0.393		
DW Statistic	2.191		

We see that the most important factor determining two-wheeler intensities is the rate of population growth in cities. It is the only significant variable and has the highest coefficient. The regression coefficient is positive and significant indicating that high growing cities have high two-wheeler intensities.[19] This suggests that the cities that have been growing at a fast pace show a higher propensity to own two-wheelers. This is a very plausible result. The travel demands of fast growing city increase rapidly while the supply of transport facilities in terms of public transport provision or intermediate transport does not adjust simultaneously. This supply side lag in adjustment can be attributed to the lack of proper planning and other institutional ambiguities that prevent the municipal transport to respond immediately. The obstruction of the free interplay of market forces also prevent intermediate transport from responding promptly to these increasing travel demands. Therefore we see a supply side lag in the transport systems which provides a further push to the dependence on private transport. [20] In such a situation, the people are forced to fend for themselves and since transportation is an important service to maintain the current levels of economic activity they invest in personal modes of transport.

[19] The correlation coefficient is also highly significant at the one per cent level.

[20] Infact, as the cities grow in size the *intensity* of public modes has to also go up in consideration of the increased travel demands. A study done by CIRT (1988) recommends that cities with a population between 0.5 to 1 million should have at least 30 buses per lakh population, cities between 1 to 3 million cities should at least have 50 buses per lakh of population, whereas for cities over 3 million the recommended bus population per lakh is 75. Similarly the recommended modal split in terms of percentage of trips made by public, intermediate and personal transport varies with city sizes. The cities with a population between 0.5 to 1 million are expected to have modal split of 70-15-15 split between public, intermediate and personal modes. For 1 to 3 million the split is 80-8-12 and for cities over three million, 85-5-10. Thus we can see that the modal split should increasingly shift in favour of public transport with the increase in city size. (Patankar, 1989)

Table 3.9: Determinants of four-wheeler intensity: Regression Results

	Coefficient	t-ratio	P-value
Constant	6.365	0.725	0.479
Road Length per Pop	0.302	1.835	0.086
% of Slum Population	-0.100	-0.364	0.721
Size of the city (Pop)	0.303	2.280	0.038
Per Capita Income	1.957	2.983	0.009
Percentage of population in service sector	0.623	1.015	0.326
R-square	0.575		
R-bar square	0.433		
DW Statistic	1.548		

The table 3.9 shows the determinants of four-wheeler intensity. Road availability, income, and the size of the city have significant positive coefficients. We can see that the factors determining two and four-wheeler intensities are not the same. This analysis throws some important implications for policy.

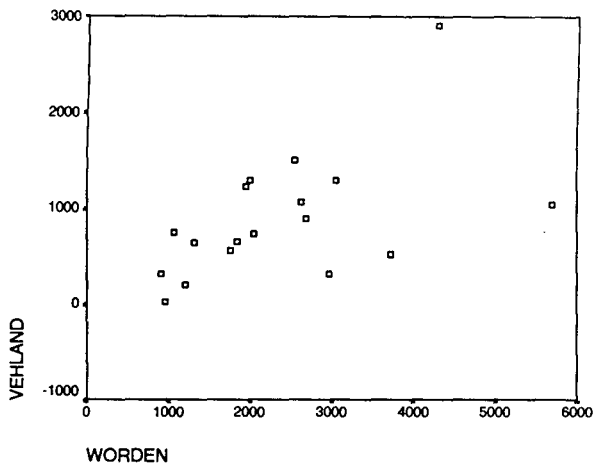
Travel demands of fast growing cities increase rapidly and such cities will have to focus on increasing the provision of public transport simultaneously, to avoid excessive dependence of the population on two-wheelers. The four-wheeler intensities are highly sensitive to the increase in income. In this scenario, the role of road pricing and taxes becomes important. Simultaneously, as the city grows in size it will have to adopt other physical controls like parking controls and entry barriers to restrict the size of its four-wheeler population. This assumes special importance in the Indian context where we see a tendency for cities to grow denser as they grow larger. Thus, larger cities cannot sustain high four-wheeler intensities. Our results also seem to support the theory of 'induced traffic' where the provision of additional infrastructure encourages automobile ownership. This questions the current policy of local bodies which is to increase the road space in the city as the solution to the congestion problems and highlights the importance of implementing demand management measures to control the growth of vehicles.

3.5 Factors affecting vehicular densities

Here, we briefly digress to discuss the spatial dimension of urbanisation in terms of personal mode densities. The figure 3.9 shows the relation between vehicular density and employment density defined as worker per sq. km of land. As we can see there is a strong positive association between the two variables (except for rail-based cities) even though

percentage employed did not show any significant association with vehicular intensities. This is relevant in the context that more employment concentration in a small area would mean higher transportation requirements in that area and taking the bus service as given, it would result in higher ownership of private vehicles in that area. Here, it is important to stress this aspect of urbanisation, which also pushes the vehicular modal mix in favour of personal modes. The next chapter allows us to see at a micro level how the modal intensities may get affected because of the distribution of geographical concentrations which make special demands on the public transport system which if unmet, result in higher automobile dependence.

Fig.3.9: Relationship between vehicular and employment density



Summary

We started our analysis with an examination of the transportation patterns with reference to the composition and growth of the vehicular population in context of city size. The impact of rail-based systems on the two-wheeler populations was obvious in that the average two-wheeler populations of rail-based cities were lower than the category of 'large' cities. As compared to the other categories where the share of four-wheelers is around 10 per cent in the vehicular population, in the mega cities it is above 25 per cent. But, over time the share of four-wheelers is falling in the rail-based cities compensated by a rise in the share of two-wheelers but, in Delhi, the share of four-wheelers is increasing over time. It has gone up from 19 per cent in 1985 to 25 per cent in 1997. An examination of the growth rates showed that liberalisation as such does not seem to have impacted the growth of vehicular populations (infact the growth rates are much lower in the post liberalisation period). The category of smaller cities has a higher growth rate indicating their emergence as the next

rung of cities which will experience rapid vehicular growth. However, there is a wide variability in growth rates in relation to the city size. Smaller cities show a higher variation while the growth stabilises into comparatively lower rates for the larger cities.

Then we investigated the relationship between vehicular intensities and densities with city size. Size does not emerge as an intervening variable in the determination of vehicular concentrations. However, our categorisation proved useful in capturing the changing variability of these measures over city sizes. The small cities show the largest variation while variation falls over larger city sizes. Over city sizes with a population above two million, the vehicular populations stabilise into a sketchy positive relationship with size itself. Finally, the disaggregate analysis conducted to ascertain the determinants of two and four-wheeler intensities, proved that in the case of two-wheelers, the growth rate of the cities is a major determinant, while in the case of four-wheelers, income, road availability and city size emerge as important factors.

However due to data problems and small sample size the inferences that we can draw from such an analysis are limited. The foregoing analysis clearly indicates that macro-level explanations are no sufficient to adequately explain the patterns in urban transport. This is because the spatio-temporal specificities of different cities might probably influence the underlying patterns. It is possible to analyse the importance of certain other determining factors only at a micro level taking a particular city as a case study which is carried out in the next chapter.

APPENDIX

Table 3A.1: Profile of the Metropolitan Cities

City	Population in Millions	Area in Sq. Kms	Density	Growth Rate 81-91
Ludhiana	1.01	134.67	7500	66.72
Varanasi	1.03	104.82	9826	28.77
Vishakaptnam	1.05	318.16	3300	74.3
Bhopal	1.06	284.9	3721	58.51
Madurai	1.09	115.48	9439	20.49
Indore	1.1	165.17	6660	33.13
Vadodara	1.12		*10409*	49.7
Cochin	1.14	373.27	3054	38.14
Coimbatore	1.14	317.23	3594	23.38
Small	**1.08**	**226.71**	**6389**	**43.68**
Jaipur	1.52	218.26	6964	49.18
Surat	1.52		*13665*	66
Lucknow	1.64	337.5	4859	62.97
Nagpur	1.66	228.81	7255	36.24
Kanpur	2.11	298.97	7058	28.81
Pune	2.49	423.42	5881	47.38
Medium	**1.82**	**301.39**	**7613**	**48.43**
Ahmedabad	3.3		*17733*	29.4
Bangalore	4.09	445.91	9172	39.9
Hyderabad	4.28			67
Large	**3.89**	**445.91**	**13452**	**45.43**
Chennai	5.36	612.11	8757	24.99
Kolkatta	10.92	897.41	12168	18.73
Mumbai	12.57	603	20846	33.43
Rail-based Metros	**9.62**	**704.17**	**13923**	**25.72**
Delhi	**8.38**	**624.28**	**13423**	**46.18**

Note:

1. Population Figures in Millions.
2. Area for Ahmedabad, Surat, Vadodara and Hyderabad are not available. For these cities except Hyderabad, where area has not been available density figures have been substituted for the Urban Agglomeration figures from CMIE (2000).
3. Town Per Capita Expenditure and Town Per Capita Incomes of the Town Municipalities for the year 1988-89. Source: All-India Town Directory, Census of India,1991.

Fig 3A.1: Vehicular Populations across cities.

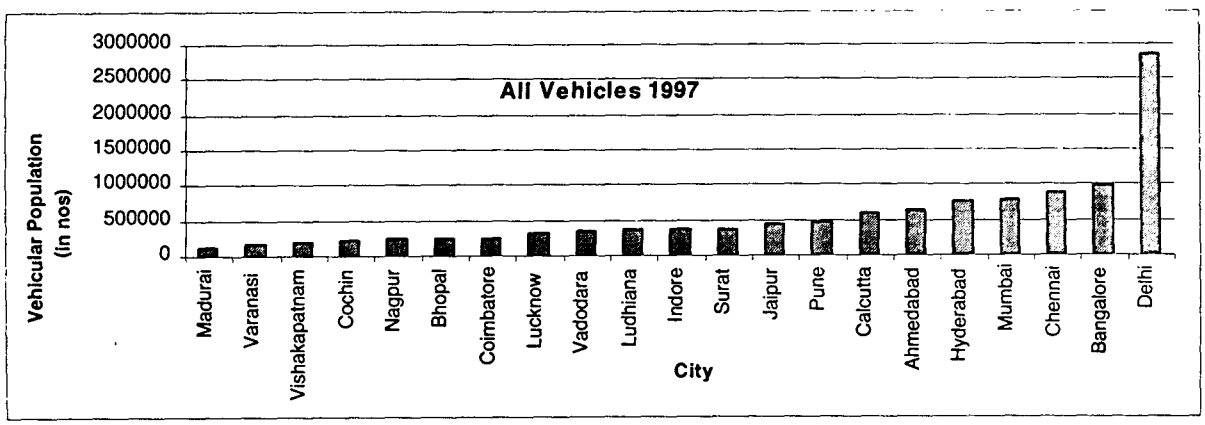


Table 3A.2: Growth Rates (percentage increases) from 1985-1991 and 1991 to 1997

	Two-wheelers		Four-wheelers		Total Private		Intermediate		Buses		Goods/Others		Total	
	85-91	91-97	85-91	91-97	85-91	91-97	85-91	91-97	85-91	91-97	85-91	91-97	85-91	91-97
Ahmedabad	133	75	69	81	123	76	48	19	218	51	40	38	111	69
Bangalore	133	60	60	72	117	62	35	177	11	98	50	116	107	69
Bhopal		26		19		25		26		43		-38		14
Mumbai	76	36	46	6	59	20	0	105	29	61	14	0	46	27
Kolkatta	126	34	38	17	72	26	111	56	135	-46	15	13	66	24
Cochin		131		49		107		50		-37		85		90
Coimbatore		445		120		339		26		11		147		285
Delhi	111	54	153	77	120	59	90	30	39	57	94	38	116	57
Hyderabad	102	42	52	-55	95	32	56	54	98	-23	55	22	92	32
Indore		64		105		68		23		174		78		69
Jaipur	143	73	77	70	131	72	63	60	40	45	40	47	110	68
Kanpur	112		45		105		35		238		-15		90	
Lucknow	184	52	104	61	172	53	153	102	63	33	85	42	163	53
Ludhiana		78		82		78		77		31		71		78
Chennai	369	69	214	42	321	63	65	163	221	-33	122	67	292	64
Madurai		302		63		256		171		-7		139		222
Nagpur	132	37	12	63	113	39	296	50	-26	368	8	64	102	43
Pune	90	69	45	86	84	71	61	75	47	120	23	50	75	70
Surat		161		200		164		183		205		220		166
Vadodara		117		92		113		52		58		73		105
Varanasi		71		54		69		10		56		48		64

Table 3A.3: Road lengths (in kms) of the UAs

City	Pukka Road	Kuccha Road	Total Road	Road Lighting Points
Ludhiana	946		946	142
Varanasi			1337.86	26052
Vishakaptnam	585.84	127.74	713.58	17887
Bhopal	567.2	183.75	750.95	22164
Madurai	505.8	2.85	508.65	18562
Indore	882.5	74.25	956.75	28310
Vadodara	1231.19	265.68	1496.87	24888
Cochin	2269.51	1023.7	3288.21	26613
Coimbatore	797.76	115.18	912.94	22097
Jaipur	900	151	1051	107510
Surat	619.17	158.35	777.52	10389
Lucknow			3203.77	51458
Nagpur	1264	225	1489	26258
Kanpur	1303.24	105.72	1408.72	53937
Pune	1262.6	132.99	1395.59	37746
Ahmedabad	1103.3	281.2	1384.5	173450
Bangalore	2239.9	475	2714.9	49191
Hyderabad	2170.16	818.96	2989.12	97816
Chennai	3205.84	688.94	3894.78	103638
Kolkatta	6818.67	1154.33	7973	145131
Mumbai	1608		1608	71494
Delhi	19803		19803	324322

Table 3A.4: Correlation of two and four-wheeler intensities with the relevant factors

Pearson Correlation	Two-wheelers	Four-wheelers
Geographical Factors		
Population	0.06	0.44*
Area	-0.16	0.47*
Density	-0.03	0.11
Growth rate	0.62**	0.11
Infrastructural factors		
Road length per population@	0.17	0.51*
Light points per km of road	-0.03	-0.08
Road length per acre	0.33	0.66**
Infrastructure Index	-0.04	0.75
Economic factors		
Monthly per capita income@	0.73**	0.41^
Town income per million population	0.05	0.01
Per capita SDP, 1991	0.11	0.50*
Percentage of slum population	0.30	0.14
Percentage of migrant population	0.44^	0.38
Other transport factors		
Public transport (Buses per million)	0.01	0.37
Intermediate transport (per million)	0.08	0.37
Occupational factors		
Percentage of working population	-0.13	0.22
Percentage involved in manufacturing and services	0.06	0.21
Percentage involved in services	0.06	0.55**
Density of workers per sq. km of land	0.28	0.34

Note: @- Outliers have been deleted, ^- Significant at 10 per cent, *- significant at 5 per cent, ** - significant at 1 per cent. The variable Infrastructure Index was deleted from later analysis as the scatter showed that it is biased by one point i.e. Delhi.

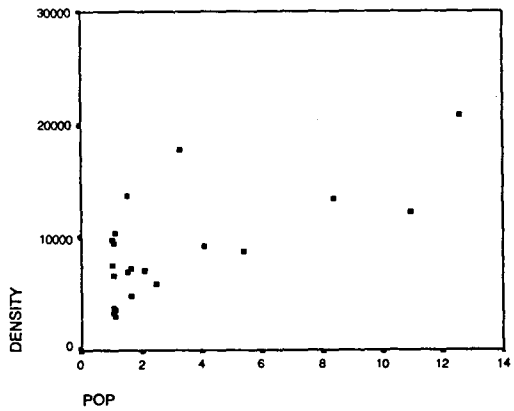
Table 3A.5: Correlation between various modes

Rank Correlation	Four-wheeler intensity	Intermediate mode intensity	Public mode intensity
Two-wheeler intensity	.600**	.216	.166
	.009	.390	.510
Four-wheeler intensity		.560*	.600**
		.016	.009
Intermediate mode intensity			.515*
			.029
	Public mode intensity		
Private mode intensity	.442*		
	.045		
	21		

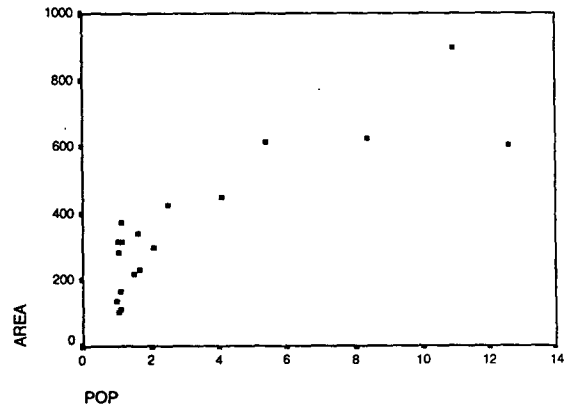
Note: *- significant at 5 per cent, ** - significant at 1 per cent.

Figure 3A.2 City size and socio- economic variables

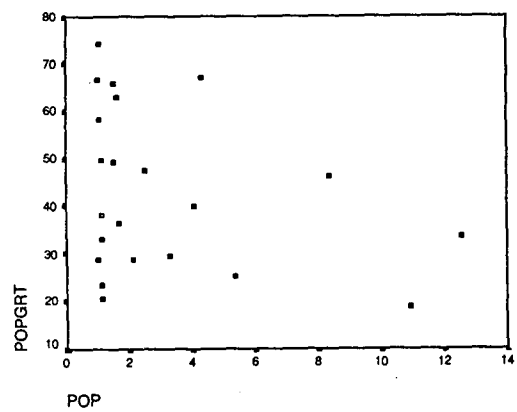
Density across city sizes



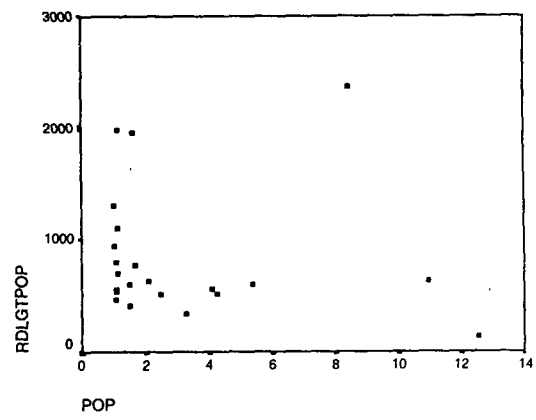
Area across city sizes



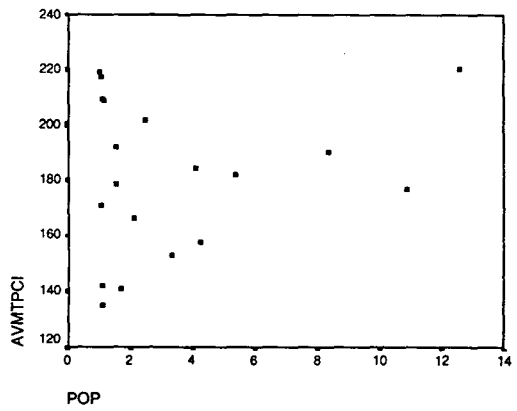
Population Growth across city sizes



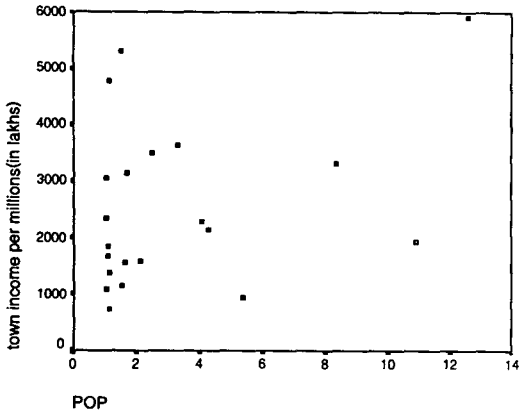
Road availability across city sizes



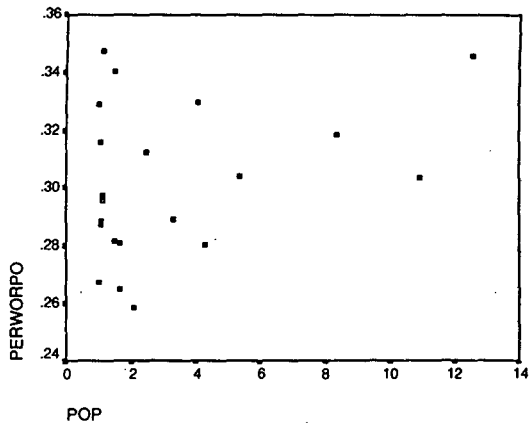
Per capita Income across city sizes



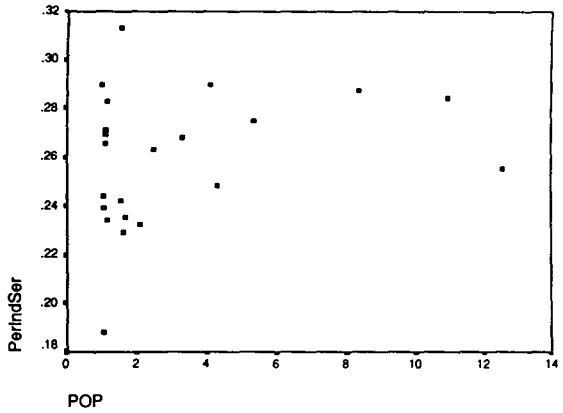
Town income (per million) across city sizes.



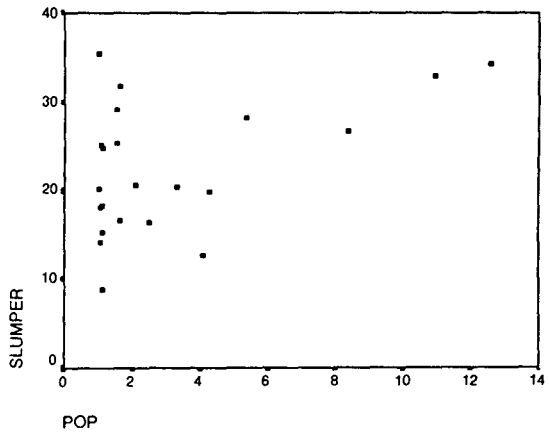
Percentage of working population and



Percentage in industry and services across city size



Percentage of slum population across city size.



Chapter 4

Urbanisation and Modal Mix: A Case Study of Pune

Introduction

In the previous chapter we looked at the urban transport scenario across cities, and explored some of the factors that impinge on transport structure. In this chapter, we attempt to understand the relationship between urbanisation processes and development of transport system over time with the help of a case study on Pune. The chapter contains five sections. The first section gives a profile of Pune city. In the second section we analyse the urban transport scenario in terms of its evolution and growth. In the third section we look at the processes of urbanisation, which are expected to be relevant in determining the transport structure of the city, over the past four decades. In section four we discuss the specific problems of public and intermediate modes in the city. In the last section we look into the policy failure regarding public transport.

4.1 Pune as a case study

Pune is an important regional centre in the most urbanised state in India, Maharashtra, and is situated 177 kms south-east of Mumbai to which it is well linked by National Highway No.4 and a broad gauge electrified railway. Geographically, it is situated at a latitude of 18° 37' N and a longitude of 73° 51'E on a raised plateau (570 Metres above mean sea level), on the banks of two rivers, the Mula and Mutha, and is surrounded by Sahyadri range of hills. During the pre-independence days, it was well known as an important administrative, commercial, educational and military centre. In the post-independence period it has witnessed rapid industrialisation and thereby emerged as one of the most important industrial cities of the country. It is the divisional headquarters of Pune Division, which comprises the districts of Pune, Satara, Sholapur, Sangli and Kolhapur and the district headquarters of Pune District.

Pune has a vehicular population of over 5 lakhs with a two-wheeler population of 3.5 lakhs (sixth largest in the country), highest in the state of Maharashtra[1] (1999). The city acquired metropolitan status in 1971. It is the eighth most populous city in India and is growing rapidly at a rate of 4.7 per cent per annum as compared to the national average of 2.21 per cent. (1981-1991). Pune is therefore considered an ideal city for our case study.

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[1] Incidentally, Maharashtra has the highest vehicular population in India.

4.2 Pune's Transport Scenario

In this section we discuss the evolution of different forms in the transport scenario and analyse the vehicular composition and growth in Pune district[2] over the period 1961-2000.

4.2.1 Evolution of various forms

The most popular form of public transport in the 19th century was the public tonga, drawn by one horse. Various types of these with differential fares were available. Later in the 1920s and 1930s, the bicycle became the most popular form of transport and the city came to be known as the Bicycle City. Though the first car in Pune city was seen around 1905, automobiles gained prominence only in the 1950s with spectacular growth occurring in the two-wheelers after 1975. Bus service in Pune is primarily run by the two municipal transport authorities. Pune Municipal Transport (PMT) was established in 1950 after the Corporation took over the city bus service owned by a private company viz. Silver Jubilee Motors Pvt. Ltd. Pimpri-Chinchwad Municipal Transport (PCMT) commenced operation in 1974. Another significant development for transport was the introduction of auto rickshaws in 1948.[3] For the compact urban areas with their major economic activities clustered in the central districts of the town, where roads were narrow and acutely winding, this mode was highly suitable. In a short span of time they replaced the horse driven tongas and the limited number of taxis that were plying. Presently around 3000 taxis cater only to inter city traffic. The introduction of six-seaters in November 1994 is the other significant development in the urban transport scene in the nineties.

4.2.2 Composition

Goods and passenger vehicles formed equal shares in the vehicular population in 1961 but passenger vehicles have grown rapidly and steadily to form more than 90 per cent of total vehicular population[4] (Table 4.1). Among the passenger transport modes, another way of

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[2] Data at the city level is available only from the late eighties and so, we forced are to look at the district level figures to get an idea about vehicular populations.

[3] Before this rickshaws pulled by the use of human labour were operating in the city as public service vehicles, but they were banned as public carriers in 1949, on humanitarian grounds (Patankar, 1962).

[4] The data being used is the number of vehicles registered with the RTO. Note that as goods vehicles have a wider spread, it is probable that the actual share of goods vehicles on road is greater than those registered with the RTO of the district.

classification is based on the nature of use of vehicles, i.e. whether they are used for commercial (public and intermediate modes) purposes or for non-commercial (personal modes) purposes.[5] The share of non-commercial modes in transport has always been very high as compared to commercial ones and this has also been growing over the years. Non-commercial vehicles, which occupied a considerable share of 87 per cent, have increased to almost 93 per cent while the share of commercial vehicles has fallen from 13 per cent to 7 per cent in the period 1961-91.

Table 4.1 shows the changes in percentage shares of different categories of vehicles from 1961 to 1991. Passenger vehicles have grown to dominate the scene and also that almost all of this growth has come from the growth in the personal modes of transport, while the share of public modes has declined. As a percentage *within* the passenger vehicles, personal modes have grown from 86.42 per cent to 92.26 per cent. The share of two-wheelers has increased from 36 per cent to 81 per cent while the share of four-wheelers has fallen from 51 per cent to 11 per cent, though in terms of actual numbers there has been a 15 times increase since 1961. Intermediate modes have increased from 2 per cent to 5.86 per cent while public modes have fallen sharply from 7.8 per cent to a mere 0.77 per cent. Personal modes thus constitute 85 per cent of the total vehicles on road with two-wheelers forming almost 75 per cent of the total reflecting their complete dominance in the transport scenario of the city.

Within the two-wheeler population, data disaggregated into motorcycles, scooters and mopeds are available from 1984 onwards. It is seen that scooters have dominated the two-wheeler scene generally with their percentage share going up from 34 in 1984 to 43 in 2000 while the share of motorcycles has gone up to 37 per cent from 26 per cent in the same period. Mopeds have not retained the popularity that they seem to have had in the late 1980s; their share has fallen from 33 per cent to 20 per cent. Similarly, the proportion of cars has been increasing as compared to jeeps.

[5] This classification is suitable in view of the specificity of Pune. For example, in Pune taxis cater only to inter city traffic. Thus, they don't impinge significantly on the urban scene. Also, the public modes include vehicles registered with the RTO but which actually ply inter city, district or state, like mofussil buses etc. But, as the exact segregation is not available we take the figures to represent the public modes therefore these figures may be slightly inflated. Public modes here include stage and contract carriages.

Table 4.1: Percentage Shares of Different Modes

Modes/Year	1961	1971	1981	1991	2000
Personal Modes	11039 (40)	36840 (65)	102520 (76)	393564 (85)	887075 (85)
Two-wheelers	4574 (17)	22268 (39)	81831 (62)	352032 (75)	774095 (74)
Four-wheelers	6465 (24)	14572 (26)	20689 (13)	41532 (9)	112980 (10)
Intermediate Modes Auto rickshaws	295 (1)	1962 (3)	8798 (7)	25573 (5)	53891 (5)
Public Modes	992 (4)	3670 (6)	3539 (2)	1712 (0.4)	6964 (1)
Contract Carriages			18 (0.01)	169 (0.04)	1747 (0.2)
Stage Carriages	992 (4)	3670 (6)	3521 (2)	1544 (0.4)	5217 (0.5)
Others	461 (2)	863 (2)	1259 (1)	4245 (1)	2623 (1)
Passenger Vehicles	12787 (47)	43335 (76)	116115 (86)	425094 (91)	950553 (91)
Goods Vehicles	14628 (53)	13726 (24)	25311 (14)	39988 (9)	85311 (9)
Total	**27414**	**57061**	**141426**	**465081**	**1035864**

Note: Figures in brackets are percentages of total.
Source: Compiled from the Motor Transport Statistics, Maharashtra.

4.2.3 Growth Rates

Here, we review the growth of the different components of vehicular population over time in Pune district. Table 4.2 shows the growth rates of different components of passenger vehicles. Stage carriages show a negative growth rate in 1970s and more so in the 1980s. The growth rate of two-wheelers has come down in the 1990s after three decades of rapid growth, while the growth rate of four-wheelers has picked up.[6] This might reflect on the saturation of the market for two-wheelers and a rising demand for four-wheelers. Personal modes have registered their highest growth in the decade 1981-91 while this decade has registered a negative growth rate in public modes. This decade interestingly coincides with a period of economic liberalisation in the Indian economy that witnessed reduction of trade barriers and promotion of competition. This process, in turn, allowed the introduction of a number of new models of two and four-wheelers into the market, which appears to have definitely influenced the pattern of growth. The growth rate of intermediate modes has been falling consistently. Similar to the patterns we observed across cities, the growth rate of the total vehicular population has fallen in the post liberalisation period i.e. the 1990s.

[6] The fall in the year 1981-82 might be due to problems related to the data. Till 1981 data is available for Pune region as a whole which included Sholapur region, so we have deducted 15 per cent from it to arrive at the district figures for Pune for the period before 1981.

Table 4.2: Annual Compound Growth Rates of Different Categories of Vehicles

Modes/Period	1961-71	1971-81	1981-91	1991-00
Personal Modes	12.81	10.78	14.40	8.47
Two-wheelers	17.15	13.90	15.71	8.20
Four-wheelers	8.47	3.57	7.22	10.53
Intermediate Modes Auto rickshaws	20.86	16.19	11.26	7.74
Public Modes	13.98	-0.36	-7.00	15.06
Contract Carriages			25.17	26.35
Stage Carriages	13.98	-0.42	-7.92	12.95
Others	6.47	3.85	12.93	-4.70
Passenger Vehicles	12.98	10.36	13.86	8.38
Goods Vehicles	-0.63	6.31	4.68	7.87
Total	**7.61**	**9.50**	**12.64**	**8.34**

Source: Computed from Motor Transport Statistics, Maharashtra.

4.2.4 Vehicular Intensities

The analysis has an added significance when we take into account the accompanying population change and growth. Table 4.3 shows the vehicles per thousand population for different categories and their growth rates over the period 1961-1991. This gives us comparable changes in the vehicular population over time and also the availability of vehicles of each category relative to the population. The table shows that two-wheeler intensity has grown by 35 times, four-wheeler intensity by almost 3 times as compared to that in 1961. Meanwhile the intensity of public modes grew but again fell to an all time low in 1991 to just 30 vehicles per lakh population (0.31 per thousand) in 1991. This indicates that though the absolute numbers of carriages have increased over time, they have not risen adequately to cater to the rising population.

Table 4.3: Vehicular intensities (per 1000 populations) for different modes

Mode	1961	1971	1981	1991
Population in '000	*2467*	*3172*	*4164*	*5532*
Personal Modes	4.47	11.61	24.62	71.14
Two-wheelers	1.85	7.02	19.65	63.64
Four-wheelers	2.62	4.59	4.97	7.51
Intermediate Modes Auto rickshaws	0.12	0.62	2.11	4.62
Public Modes	0.40	1.16	0.85	0.31
Contract Carriages				0.03
Stage Carriages	0.40	1.16	0.85	0.28
Others	0.19	0.27	0.30	0.77
Total	**5.18**	**13.66**	**27.89**	**76.84**

Source: Computed from the Motor Transport Statistics.

This decline in transportation facilities partly explains why people fall back on personal modes of transport for their needs. With growing urbanisation, the travel needs of the people increase and this is reflected in the increase in the personal mode intensity from 4.47 to 71.14 vehicles. This increase in personal modes falls into place when juxtaposed against negative growtn rates of public modes during the decades 1971-91.

4.2.5 Comparison with city level

At the UA level data is available for some years since1985. These data are generated by the Road Transport Office (RTO) of the Pune city based on estimates from the vehicles registered with the RTO. Thus they are mere estimates and there is no way of knowing the exact number and composition of vehicles that ply within the city. However, given the lack of a better data source, we make an attempt to understand Pune's vehicular patterns from the available data, and examine whether it differs from the district patterns that we noted in the above section.

The Pune UA in 1999 contained almost 70 per cent of all vehicles in the district, with 71 per cent of two-wheelers, 65 per cent of four-wheelers and 80 per cent of the auto rickshaws.[7] And within that the Pimpri-Chinchwad[8] area contains 20 per cent of all the vehicles, 20 per cent two-wheelers, 16 per cent of four-wheelers, 8 per cent of the auto rickshaws, 5 per cent of stage carriages, 28 per cent of contract carriages and 22 per cent of goods vehicles. The share of Pimpri-Chinchwad area has been rising over years. In the case of total vehicles it has increased from 13 per cent in 1987 to almost 20 per cent in 2000.

Table 4A.4 (in the appendix to this chapter) compares the public mode intensity and intermediate modes (stage carriages/buses and autos per thousand) at the district level as compared to the UA. It is found that the availability of public modes has been higher in the District from 1961 to 1981.[9] Over time the public mode intensity (carriages per thousand) has risen but again fallen to 0.28 in 1991 at the district level whereas at the city level it has not registered an increase up to 1981, but then shows a slight rise to 0.34 in 1991. The recommended level of buses for cities between 1 to 3 million is 50 buses per lakh population

[7] At the city level buses are given as physical category while at the district level data are available in the form of stage carriages, contract carriages etc.

[8] The PMR consists of two corporations: The Pune Municipal Corporation (PMC) and the Pimpri-Chinchwad Municipal Corporation (PCMC).

[9] However, the population of stage carriages has been fluctuating widely over the years at the district level.

(CIRT, 1988). We see that the UA has never reached this recommended level of bus population. In 1991, the vehicular population in the UA is higher for all categories as compared to the district. The availability of intermediate transport is also higher for the UA as compared to the district level. Over time the availability of intermediate modes has risen consistently to 4.62 per thousand population.

The increase in the personal modes evident from the above description may be understood further with the help of a discussion on the process of urbanisation in terms of its spread and specific characteristics that have necessitated the dominance of personal mode.

4.3 Processes of Urbanisation

In this section, we look at the processes of urbanisation in Pune both at the district as well as the agglomeration level, focussing on the latter, from 1961 onwards in an attempt to understand the role of urbanisation in boosting the demand for urban transportation services. We study these processes in terms of historical, geographical, demographic, occupational and economic characteristics.

4.3.1 Historical factors shaping urban form

Pune remained under the Muslim rule from 13th century to the early 17th century. By 1630 it became the nucleus of a major Maratha Kingdom but remained in a state of continuous political turmoil up to 1765 when the Peshwas finally recaptured it. The next hundred years could be described as the golden age of Pune's past when the Peshwas made it their capital city when it was politically the most influential city in India, the de facto capital of the country. The old core of the city took shape during this period with dense habitation stratified into different 'peths' or wards with different social, political and occupational patterns.[10] Pune of the eighteen peths or wadas was the creation of the Peshwas. The town began to grow rapidly around the original fortification towards the east, west and south, developing as it grew more wards in a concentric fashion. This inner core of the city with its congested and narrow streets now proves extremely difficult for the operation of the public transport modes.

[10] There was no strict segmentation between commercial and residential zones. Usually, shops used to occupy the ground floor of the building that housed the owners in the upper floors.

The advent of the British brought a dichotomy to the urban form with the establishment of the Cantonment areas.[11] These were well laid out with better roads and infrastructure.[12] From 1840, the British made Pune the seat of their Government during the monsoon months and provided a rail link in 1856 connecting it with Bombay, which further enhanced its administrative and commercial importance.

In the early decades of the 20th century, adverse economic circumstances caused by epidemics[13] and drought in the surrounding region led to a number of shanty settlements around the core of the town. However, rapid development and industrial growth started to take place from 1940 onwards. After 1947, a number of major technical, educational, research, training and cultural institutions were set up, besides some textile and chemical industries.

In the year 1950 the status of the Pune Municipal Council (formed in 1857) was elevated to that of a Municipal Corporation. The 1960s were landmark years in the urban growth of Pune. A serious flood in 1961 accelerated the growth of housing and shanty settlements away from the old city showing the first signs of urban sprawl.[14] The area covered under the Corporation was enhanced in 1962 from 41.42 sq. kms to 138.85 sq. kms. Moreover, rapid industrial development occurred from this period onwards as a ban was imposed on Mumbai's further industrial growth and Pune attracted a large number of industries aided by the development efforts by the Maharashtra Industrial Development Corporation (MIDC). The process of immigration of people from different parts of the country as well as from the neighbouring areas also continued because of employment opportunities created by rapid

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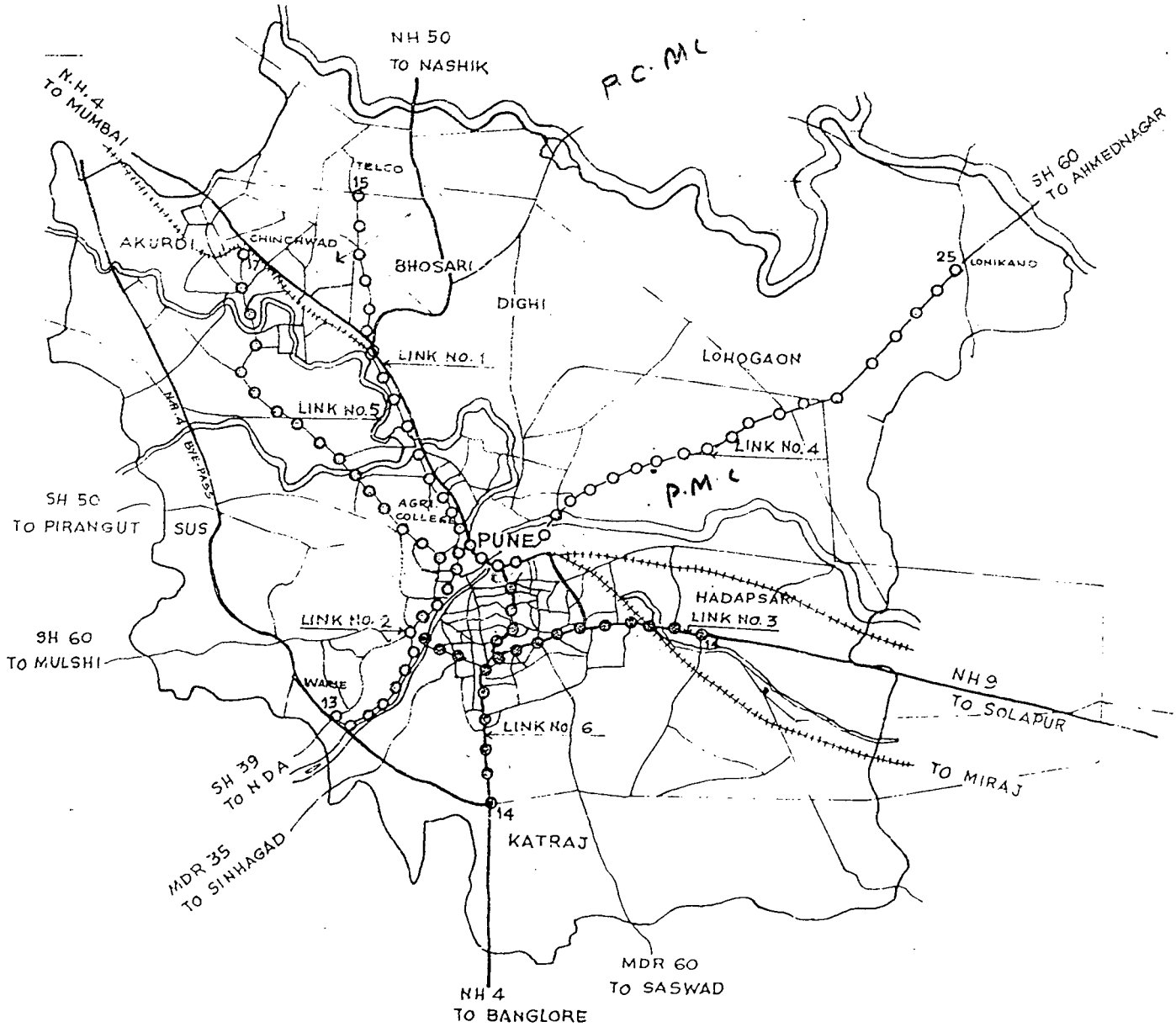
[11] The Pune cantonment was set up in 1817 on the eastern side of the city, Kirkee Cantonment was established in 1870 to the north of the city along the Mula river and Dehu Road Cantonment was set up further north on the Pune-Bombay road in the early twentieth century.

[12] How the urban form of this area differs from the old core city known as kasba Pune is well captured by this quote, "With the establishment of the military cantonment alongside the native city, a dual identity and image was forged. A dichotomous urban form developed. The native city of Pune whose heart was encased in its peths was, with a few exceptions, a confusing medley of narrow winding lanes, clusters of houses and huts dotted with gardens, shops and numerous temples and shrines of every description, while British Poona or Camp, as the Cantonment and Civil Lines area was called, was a well-laid-out garden suburb with bungalow complexes, barracks, parade grounds, clubs, imposing public buildings and a neat grid pattern layout." (Diddee and Gupta, 2000)

[13] The bubonic plague of 1896 lasted for 14 years.

[14] The breach of Panshet and Khadakawasla dams on the upstream of river Mutha accelerated the growth of housing and shanty settlements away from the old city towards the Parvati Hills area and towards Shivaji Nagar, Erandavana etc. towards the west of river Mutha.

PUNE METROPOLITAN AREA



industrialisation. Thus, overnight, suburban neighbourhoods grew into large sprawls that created fresh challenges for transport planning.[15] It also resulted in an acute housing shortage and an increase in slum settlements now containing over 40 per cent of the city's population.

Pimpri Camp came into being around 1948 and was basically a centre for refugees from West Pakistan. In 1970, the Pimpri-Chinchwad new township municipal council was constituted and in 1972 the Pimpri Chincwad new town development authority was established by the State Government.[16] In 1982, an independent Corporation was constituted viz. The Pimpri-Chinchwad Municipal Corporation (PCMC). With the limits of the PCMC extending over an area of 104 sq.km., the MIDC has acquired and developed 1215 hectares of land for industrial purpose.

Infact, PCMC is one of the richest corporations in Asia. The Pimpri-Chinchwad township is today the most significantly developed industrial belt in the State of Maharashtra. It accommodates most highly reputable companies and industries such as Telco, SKF, Bajaj Auto, Garware Nylon, Phillips, Bajaj Tempo etc. In the transport world, this part of the Pune Metropolis gives it a place of the 'Auto-Nagar' of India or 'Detroit' of the country. Infact, the vehicle manufacturers Tatas, Bajaj Auto, Mahindras and Kinetic Engineering together employ over fifty thousand workers.

Role of Planning

Now, we take a look at the planning process that have impinged on the transportation in Pune. On the face of it Pune seems to have developed like an unplanned city. But, planned development as such made its advent 8 decades ago. Town Planning Schemes of the 1930s and 1940s, the Master Plan of 1952, the Development Plan (DP) of 1966 and the revised Draft Development Plan for PMC, 1987 are some of the important plans in the history of

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[15] "Almost as an afterthought, the urban planners set out to reorganise the city with bits of grafted connections all along the major transport axes. This led to a ribbon form of development in the urban periphery, bringing on the chaotic commuting and traffic bottlenecks which Pune is now experiencing. With greatly increased demand for living space, the old core began experiencing urban involution." (Diddee and Gupta, 2000)

[16] The concentration of industrial activity in this area set the main function of the municipal council and the town development authority. While the main function of the municipal council was to look into the development of the core of the city, the town development authority looked into the provision of housing accommodation to the industrial workers in the Pimpri-Chinchwad area and was also entrusted with the development of a new town covering an area of 4324 hectares.

Pune. The 1966 plan did deal with the problems of the old city - its traffic conditions, the need for widening of its roads, and the creation of open spaces to serve as green lungs for the congested core. But, the plan could not be successfully implemented due to a paucity of funds. Only 18 per cent of this DP was implemented in a 20 year period and the percentage of implementation for transport facilities is expected to have been lower[17]. However, the rate of implementation for transport facilities for the revised plan is about 15 per cent as compared to only 8 to 10 per cent for the other DP schemes.[18] The percentage of implementation is higher at 40 per cent for the Pimpri-Chinchwad Municipal Council development plan of 1978.

A comprehensive plan, 'Traffic and Transportation Plan for Pune Metropolitan Area' was prepared in 1984 by the Traffic and Transportation cell of the Town Planning and Valuation department. The plan ascertained the existing travel patterns of the city during that period through various studies.[19] The plan cites the ownership and use of private modes as major determinants in the increasing congestion and deterioration of the overall network efficiency.[20] However, not many of the proposals suggested by the plan have been implemented to date.[21]

4.3.2 Geographical Factors

4.3.2.1 Growth in size and density and its internal distribution

At the district level, the area has remained stable while the density, number of houses, households and population have more than doubled from 1961. But, the increases are sharper in the UA, area has increased by 2.5 times, houses and population by 3.5 times and

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[17] The expected period of the plan implementation is ten years.

[18] This higher percentage of traffic amenities is attributed to the National Games that were held in the early nineties reflecting on the randomness of the process.

[19] Studies included the daily trips undertaken for various purposes, the modes used for the trips, the vulnerability of different traffic units in accidents, traffic composition, capacity of the existing road networks, public transport system etc.

[20] Walk, cycle and two-wheeler accounted for 80 per cent of the total trips and 75 per cent of fatalities and serious injuries. The proportion of cycles exceeded 60 per cent of all vehicles in the traffic composition on any part of the road network during any part of the day while the public transport accounted for merely 13.5 per cent of all trips.

[21] Some of the proposals included development of an independent cycle network, development of a high capacity mass transportation route, a rail corridor, development of necessary infrastructural facilities for according priority to bus transport systems etc.

density by 1.7 times (See table 4A.1 in the appendix). The percentage of population in the UA to the total population in the district has increased from 29 per cent in 1961 to 45 per cent in 1991 while area has increased from 1 to 2.7 per cent. The density in the UA is 16.64 times than in the district showing the concentration of population and extent of urbanisation in this area. Thus, we can see an *expansion* in urbanisation not only in terms of increase in the percentage of area and population of the UA but also in term of its *deepening* with the concentrations in the UA increasing over time.

However, our case study helps us to focus on the internal distribution of population in the PMR region. The table 4.4 gives a detailed break up of growth in the PMR and it can be seen that the increase in population growth has not occurred uniformly over the whole region. In fact, the core region of PMC constitutes 62 per cent of the population while PCMC constitutes another 22 per cent. Thus, 84 per cent of the population is squeezed into 30 per cent of the total land area of PMR. The density of PMR is 5890 people per sq. km. while that of the PMC region is much higher at 11286 people per sq. km. Further, we can see that the population is increasing rapidly in the PCMC area and to a lesser extent in the PMC area. In a short span of 20 years, Pimpri-Chinchwad area has emerged to constitute 20.7 per cent of the population from a mere 7.3 per cent in 1971. In contrast, the Cantonment areas have registered a negative growth. This imbalance indicates that the travel needs of different areas will be different and calls for more comprehensive planning on the part of public transport services. In the absence of which there will be a growth in the intensity of private modes.

Table 4.4: Population Growth in Various Segments of PMR

Areas	Area in sq kms	Percentage of households	Population (in lakhs)					Persons per sq.km. (in '000)
			1961	1971	1981	1991	2001*	
PMC	138.85	61.56	5.98	8.56 (43.14)	12.03 (40.54)	15.67 (30.26)	20.47	11.2
Pune Cant.	13.99	2.93	0.66	0.78 (18.18)	0.86 (10.26)	0.82 (-4.65)	1.06	5.9
Khadki Cant.	13.21	2.73	0.58	0.65 (12.07)	0.8 (23.08)	0.78 (-2.50)	1.02	5.9
PCMC	104.37	22.06	0.30	0.96 (220)	2.44 (154.17)	5.44 (122.95)	7.06	4.9
66 Villages	538.65	10.72	1.05	1.33 (26.67)	2.25 (69.17)	2.69 (19.56)	3.5	0.5
PMR	809.07	100	8.57	12.28 (43.29)	18.38 (49.67)	25.4 (38.19)	33.11	3.1

Note: Figures in brackets are percentage increases. * -Estimated
Source: Primary Census Abstracts.

4.3.2.2 Land Use

Another geographical dimension that is important is the zoning of land for different purposes and especially for industrial cities like Pune. Barring a few major industries that have been set up on the eastern and western sides of Pune city, most industries developed along the Pune-Bombay highway, north of Kirkee Cantonoment in the vicinity of Pimpri-Chinchwad.

Looking at the geographical distribution of industrial units we can see that 40 per cent of the industrial units are located in the PCMC area while 8 per cent are located in the Lohogaon and Hadapsar areas, all major industrial belts. Thus, 50 per cent of the industrial units are located in peripheral areas while 62 per cent of the population of the PMR resides in its core area, the PMC. This creates tremendous demand for commuter travel to work. The industrial pattern with the manufacturing belt running linearly, with the centre along the Mumbai-Pune rail and roadway creates peculiar commuting patterns. The Pimpri-Chinchwad area has large industrial cores with residential areas located around it. But, most of the remaining population commutes from the core of Pune city to the peripheries.

Similarly, the location of commercial activity is concentrated in the PMC area. It is seen that 82 per cent of the shops and 88 per cent of all commercial establishments are located in the PMC area (see table 4.5). Once again, such a pattern of geographical dispersion would create demand for trips from PCMC area to PMC area for commercial purposes. The geographical location of industrial and commercial activity vis-à-vis residential location therefore appear to play a critical role in increasing need for more trips across PMC and PCMC area (See map).

Table 4.5: Number of Establishments in PMR

Type of Establishments	**PMC**				**PCMC**		
Year	**1973**	**1977**	**1985**	**1994**	**1983**	**1985**	**1994**
Shops	24507	31429 (28.24)	36280 (15.43)	56440 (55.57)	2365	6220 (163.00)	12043 (93.62)
Commercial Establishments.	6310	7679 (21.70)	14301 (86.24)	33071 (131.25)	1183	2556 (116.06)	4663 (82.43)
Hotels	2173	2289 (5.34)	2845 (24.29)	3818 (34.20)	334	410 (22.75)	918 (123.90)
Theatres		36	55 (52.78)	55 (0)	5	5 (0)	4 (-20)
Total		41433	53481 (29.08)	93344 (74.54)	3887	9191 (136.45)	17628 (91.80)
Employment (Estimated)			67300	139000 (106.54)		15000	25000 (66.67)

Note: Figures in brackets are percentage increases. Source: Industrial and Commercial Directory of Pune.

Table 4.6 shows the growth and distribution of social infrastructure within the UA. The increase in various parameters like infrastructure in terms of road length and lighting points and also various institutions which indicate the increase in trip demand for purposes other than commuting. The distribution of these factors in both the regions again highlights the fact that most of the social infrastructure has developed in the PMC area further stressing the imbalanced growth between both regions.

Table 4.6: Growth and distribution of amenities in PMR

	Civic and other amenities			Institutions						
				Medical	Recreational	Educational			Credit	
PUA	Road length in kms		Road lighting points	Hospitals (Beds)		Colleges	Schools	Others	Banking	Others
Year	Pukka road	Kuccha road								
1971	486.5			1292	62	14	661	118	99	219
1981	637.36	48.46	14545	1342	110	22	778	190	272	490
1991 (PMR)	1262.6	132.99	37746	2683 (7558)	147	43	1116	218	350	750
1991 (PMC)	767.4	59	18125	1490 (6755)	78	36	694	135	240	577
1991 (PCMC)	270.32	28.89	11464	27 (170)	14	4	193	55	52	132

Source: Town Directories, District Statistical Abstracts.

4.3.2.3 Road Infrastructure

The table 4.7 shows the road length in the different areas of PMR and also gives the road availability in terms of road length per sq. kms. and road length per lakh population. As compared to the PCMC area we can see that the PMC area's road availability is less for both the parameters. Comparing the road length per lakh population figures across different regions we can see that the Cantonment areas have much better road availability. This also gives us a picture of the congestion levels in the different areas.[22]

In terms of expenditure on roads the burden on the municipality has been rising steadily. The average annual capital expenditure on roads for the PMC in the first half of the 1990s was around 34 million rupees, whereas in the second period this has doubled to almost 74

[22] This apart, the roads in the central parts of the city in PMC, some of which are almost 300 years old, are narrow and congested and have limited scope for further widening because of residential and commercial establishments crowding alongside. Widening through land acquisitions has been almost impossible and a painfully slow process (CIRT, 1996). The roads in the central business district in the city follow a rather zigzag pattern emerging from a ribbon development. A few of these roads have become major links in the road network; but are grossly inadequate for the present traffic load (Traffic and Transportation Plan, 1984).

million. The revenue expenditure on roads has increased from from 3 million rupees in 1960-61 to 135 million rupees in 1997-98 while the revenue from roads has increased from 70 thousand to 38 million rupees in the same period. However, in 1960-61, road revenue covered almost 50 per cent of the expenditure and this figure has steadily fallen to less than 5 per cent in the nineties (PMC's annual reports).[23]

Table 4.7: Road Network in Pune Metropolitan Region (PMR)

Area	Road Length (km)	Road Length per sq.km.	Road length per lakh population
Pune Municipal Corporation	767.4	2.83	48.97
Pune Cantonment	45	1.17	54.88
Khadki Cantonment	60.78	2.61	77.92
Pimpri-Chinchwad Municipal Corporation	270.32	4.78	49.69
Rest of PMR	119.1	0.91	44.28
Total	1262.6	2.43	49.71

Source: Computed from Town Directories, District Statistical Abstracts.

Thus, the pattern of dispersion and concentration of productive and consumptive activities at the disaggregated level of the UA has important linkages to the differential demand for travel leading to variation in modal distribution. The next section focuses on the changes in the population characteristics analysing the implications for travel demand.

4.3.3 Population Characteristics

The NSSO (54th round) survey on travel patterns shows that for the urban areas in India, travel demand is highest in the age groups 15-59 for workers whereas it is the highest between 5-14 for students. Among workers, age groups 30-44 have the highest percentage commuting to work (740 per 1000 males) followed by the group 45-59 (697 per 1000 males) and 428 per 1000 males in age group 15-29 as compared to only 335 per 1000 males in all the other age groups. Again differences also exist in terms of gender characteristics of the population. Women constitute about 15 per cent of the total commuting workers. Among students, the highest percentage of students commuting is in the age group 15 -29 is at 188 per 1000 students. Thus, we can predict that an increase in the proportion of these age groups will lead to an increase in the demand for commuting for work and educational purposes. Moreover, an increase in the concentration of these groups in the population may

[23] Road revenue includes vehicle tax, land rents and other receipts while the road expenditure includes repairs of roads, road lighting, loan instalments and interest payments etc. Capital expenditure is the expenditure to construct new roads.

have implications for the modal mix. The point here is that a simple growth in terms of public modes per capita loses significance as we can see that travel needs themselves vary across age groups. In case of Pune, we observe that the percentage of population in the age groups 15-34 and 35-39 together constitute almost 60 per cent of the population. The proportion of population in the age group 0-14 has declined over the years from 42 per cent (1961) to 32 per cent in 1991 while the percentage of population in active age groups 15-59 has gone up from 53 per cent to 62 per cent (see Table 4.8). In the UA also we can see that the younger age group of 15-34 constitutes 38 per cent of the total population in 1991. Further, the population of college goers gets included in the category of 15-34 and this group may have a bias towards using private modes of transport rather than depending on the public transport services. Pune is known as an important educational centre. In 1970-71, there were 17 colleges, whereas today, there are more than 50 colleges, with the student population going up from around 2 lakhs to 4 lakhs during the same period.

Table 4.8: Population Composition for the District and UA.

Age Groups/Year	1961	1971	1981	1991	1991
	District				UA
0-14	1032550 (41.86)	1313658 (41.34)	1568118 (37.65)	1885698 (34.08)	802175 (32.16)
15-34	797854 (32.34)	1011375 (31.82)	1402719 (33.68)	1942689 (42.02)	954674 (38.28)
35-59	509645 (20.66)	672959 (21.18)	924729 (22.21)	1296699 (16.53)	578958 (23.21)
60+	126831 (5.14)	180037 (5.67)	268904 (6.46)	407446 (7.36)	158180 (6.34)

Note: The figures in brackets are percentages to total.
Source: Socio-Cultural Tables, Census.

A better-educated workforce is expected to be employed in higher status jobs and hence, earn more income, which is expected to be positively related to use of private modes of transport. Here, we use change in educational qualifications as an indicator of changing work status. Table 4.9 gives the distribution of population according to their educational levels. We find that apart from a growing literacy, a greater percentage of the population has gone for higher education. The percentage of population in the category 'Matriculation and above' has increased from a mere 4 per cent in 1961 to 18 per cent in 1991 and this percentage is 27.5 per cent in the UA. The percentage of population in the category 'Graduate and above' has also increased to form 5 per cent of the population in the district and 7 per cent of the population in the UA.

Table 4.9: Changes in the Educational Qualifications of the Population

Educational Qualifications	1961	1971	1981	1991	1991
	District				UA
Illiterate	1620480	1760022	1914556	2237304	776847
Literate without schooling	394658	400154	21849	28620	12740
Below primary, primary and middle	352126	799690	1657791	2245837	988768
Matriculation	99616	166604	318960	541286	350397
Matriculation and above	**99616**	**218163**	**570273**	**1020781**	**700000**
Higher secondary/intermediate/pre-univ/senior secondary			98856	156200	109570
Non technical diploma		899	209	1510	800
Technical diploma		10398	32453	52162	43092
Graduate and above		**40262**	**119795**	**269623**	**169733**

Source: Socio-Cultural Tables, Census.

Thus, over time there has been an increase in the skill accumulation of the population and there has been an increase in the percentage of population in the 'working' age groups. Comparing the district and the UA, we also see a greater skill accumulation in the UA as compared to the district, which may also be related to higher vehicular intensities in the UA.

4.3.4 Occupational Characteristics

The population of workers has almost doubled for the district as a whole and more than tripled for the UA. (see 4A.2 and 4A.3) Again we can see that there is a concentration of economic activity in the UA and this has been increasing over time. The UA contained 21 per cent of the total main workers in 1961 which has gone up to 38 per cent in 1991, while it contained 61 per cent of workers involved in secondary and service activities in 1961 which has increased to 70 per cent over the same period. In terms of sectoral composition, almost 70 per cent of manufacturing other than household industry, construction, trade and commerce and 63 per cent of transport, storage and communications is concentrated in the UA and all these have increased over time, especially so for construction. As is to be expected in the process of urbanisation, the share of secondary and tertiary sectors is much higher for the UA as compared to the district. The secondary and the tertiary sectors together employ 53 per cent of the total population at the district level while they employ 97 per cent in the UA. The share of secondary and tertiary activities has increased to 53 per cent in 1991 from 36 per cent in 1961 for the district. Surprisingly, for the UA the share of secondary activities has increased from 31 to 43 per cent while that of services has fallen from 65 to 54 per cent.

Within the UA, 62 per cent of the workers reside in the PMC area and 21 per cent in the PCMC area. However, 33 per cent of the workers in the manufacturing sector are in the PCMC area. PMC has a far higher share of population involved in services i.e. 69 per cent as against 27 per cent in manufacturing while PCMC has an equal share i.e. 46 per cent and 49 per cent involved in services and manufacturing respectively. (Table 4.10)

Table 4.10: Workers In The Pune Metropolitan Region (Figures in lakhs)

Census Year	Workers engaged in				
	Agriculture & Allied Services	Manufacturing	Services	*Manufacture + Services*	Total Workers
Pune Municipal Corporation					
1961	0.007 (3.9)	0.53 (29.3)	1.21 (66.9)	*1.74 (96.1)*	1.81
1971	0.1 (4.0)	0.81 (32.7)	1.57 (63.3)	*2.38 (96.0)*	2.48
1981	0.06 (1.6)			*3.5 (95.6)*	3.66
1991	0.1 (1.98)	1.33 (26.74)	3.41 (68.68)	*4.73(95.42)*	4.96
Pimpri-Chinchwad Municipal Corporation					
1961	0.02 (20.0)	0.04 (40.0)	0.04 (40.0)	*0.08 (80.0)*	0.1
1971	0.01 (3.8)	0.16 (61.5)	0.09 (34.7)	*0.25 (96.2)*	0.26
1981	0.02 (2.7)			*0.69 (94.5)*	0.73
1991	0.057 (3.34)	0.827 (48.5)	0.785 (46.04)	*1.611 (94.49)*	1.705
Other Areas of PMR					
1961	0.66 (46.5)	0.19 (13.4)	0.57 (40.1)	*0.76 (53.5)*	1.42
1971	0.51 (34.5)	0.31 (20.9)	0.66 (44.6)	*0.97 (65.5)*	1.48
1981	0.66 (27.8)			*1.56 (65.8)*	2.37
1991	0.08 (5.91)	0.37 (27.80)	0.84 (63.94)	*1.21 (91.82)*	1.32
Total PMR					
1961	0.75 (22.5)	0.76 (22.8)	1.82 (54.7)	*2.58 (77.5)*	3.33
1971	0.62 (14.7)	1.28 (30.3)	2.32 (55.0)	*3.6 (85.3)*	4.22
1981	0.74 (10.9)			*5.75 (85.1)*	6.76
1991	0.23 (2.92)	2.52 (31.56)	5.04 (63.06)	*7.56 (94.63)*	7.98

Note: Total workers in 1981,1991 include marginal workers. Figures in brackets are percentages to total.
Source: District Census Handbook for Pune District.

It is interesting to see from table 4.11 that though total work participation ratio as such has remained constant over time at around 30 per cent in the UA, employment has got more concentrated in the UA as compared to the district. We can see that the employment density (employment per sq. km) in the UA has increased over time to 1886 workers per sq. km in 1991 from 1319 in 1961 while the district has a density of 143 workers per sq. km in 1991. This means that the commuter demands of this area as a whole has gone up tremendously and the failure of the public modes to meet this increase will push up the private mode intensities.

Table 4.11: Employment Density and Intensity

Year	Employment Density (Total Workers per acre of land area)	Employment Intensity (Work Participation Ratio)
District		
1961	67.40	42.69
1971	66.27	32.61
1981	102.55	38.52
1991	142.60	40.32
U A		
1961	1318.63	30.40
1971	1038.44	29.70
1981	1531.13	31.25
1991	1885.53	32.01

Note: The area of the UA was increased in 1971.
Source: Computed from the Primary Census Abstract.

4.3.5 Economic Factors

Information on the increases in the income levels in the UA or the district is not available. But, at the state level we can see that absolute income levels have increased in the process of urbanisation simultaneously with increase in two and four-wheeler intensities. (Figures 4A.1 and 4A.2 in the Appendix). However, it is more important to understand how its distribution would affect vehicular ownership. Higher income inequality in the society might also determine the vehicular intensity, as the higher income groups will increase their expenditure on private transport. Consumption pattern in vehicular ownership has very obvious impact on the development of particular modes of transport.[24] Here, we use results from the NSS 50th round for Maharashtra to look into vehicular ownership over income levels. We can see from table 4.12 that the probability of owning a vehicle is (except for bicycle) higher for higher income classes. This probability is much higher for the urban areas and the vehicular intensity is also higher for the urban areas, indicating that larger incomes and income inequality in the urban areas play a more vital role than in rural area.

[24] In Delhi, income distribution, with a larger proportion of middle and upper middle families, is attributed as one reason for such a high two-wheeler intensity, adding to the lack of a rail based public transport system. See Marwah et al. (2001).

Table 4.12: Distribution of vehicle owning households across the Income Classes

Vehicle Type	Urban /Rural	Income Classes											Average no per 1000 houses.
		I	II	III	IV	V	VI	VII	VIII	IX	X	ALL	
Bicycle	U	204	315	394	408	407	337	273	271	206	187	291	336
	R	58	108	135	196	197	252	293	307	303	383	234s	251
Motor-cycle, Scooter	U	1	22	30	52	69	99	117	152	167	251	110	122
	R	7	0	0	9	13	5	17	41	52	108	29	30
Car, Jeep	U	0	2	0	0	0	0	3	14	20	95	18	19
	R	0	0	0	0	3	0	0	0	1	2	1	1

Note: The above table is for Maharashtra. It is to be noted that the ranges for the decile groups for urban and rural areas is not the same. For e.g. The X decile in rural areas does not have the same range as the X decile in the urban areas.

Source: NSS 50th round.

4.4 A discussion on the alternate modes of transport

4.4.1 Public Transport in Pune

We study the performance of the public transport in terms of selected parameters and also analyse the institutional factors that are crucial in determining the performance.

4.4.1.1 Performance Evaluation

Table 4.13 gives selected parameters through which we evaluate the performance of public transport system. The PMT's fleet has increased from 148 buses in 1961 to about 800 buses in 1998, while the PCMT's stands a little over 200 buses. However, as seen in section 4.2.5, this growth is not spectacular in terms of per capita availability. In terms of the total effective kilometres run and the total passengers carried too the rise has not been spectacular in comparison to the personal modes. Moreover, in the 1990s there has been a fall in most of these indicators. The average number of vehicles held has fallen from 817 vehicles in 1995-96 to 791 vehicles in 1998-99, the total effective kilometers operated has declined from a high of 633 lakhs to 612 lakhs, the total number of passengers carried has declined from 2286 lakhs to 1719 lakhs and the total passenger kilometers carried has fallen from 24613 to 22210 in 1998-99 (for PMT) in the same period. The total passengers carried per bus per day has declined from 1139 in 1990-91 to a mere 695 in 1998-99. The trend is similar is the case for PCMT also.

Table 4.13: Selected statistics on the performance of public transport

Physical Parameters	PMT					PCMT			
Year	74-75	78-79	80-81	90-91	98-99	78-79	81-82	90-91	98-99
Average no. of vehicles held	315	368	371	561	791	48	73	277	228
% Fleet utilisation	83.49	82.33	81.7	88.1		48			61.4
Total effective kms operated (lakhs)	209.22	240.16	238.95	398.7	612.24	29.78	47.58	143.1	148.96
Total no of passengers carried (lakhs)			1605	2053	1719		280	875	292
Total passengers carried per bus per day	*1437*	1465	1451	1139	695	1042	1534	1845	573
Total Seat kms per lakhs		10151	11997	17817	27722	1369	4614	8013	8937
Total Passenger kms lakhs			8957#	15035	22210		2298@	5080	4117
Profit/loss (in paise per km.)	-7.78	-17.3	-33.76	-69.6	-250.1	-9.4	-83.28	-32.1*	-301.7

Note: #- Figures are for the years 1981-82, @ - figures are for the years 1983-84, *-Figures are for the years 1989-90.

Source: Performance Statistics of the State Transport Units, CIRT.

Losses too have assumed massive proportions from the mid-1990s. This fall in the physical and financial performance is attributed to the introduction of the six-seaters into the PMR which provide a high frequency and flexibility at a comparable cost. Further more strategies adopted by public transport like catering to long distance passengers[25] and a high fare policy[26] have proved counter productive shifting the patronage to the six-seaters. Another recent measure adopted by the public transport authority to counteract the competition from the six-seaters has been the introduction of the Janata bus service,[27] which has further aggravated the urban transport chaos.

[25] In October 1991, the Home Department encouraged PMT to start services beyond PMC limits up to 20 kms. All new buses were deployed on such routes since 1992. Though it initially helped in giving better crew and vehicle utilisation, later it led to losses due to deterioration in the bus condition due to higher utilisation, ghat and bad roads.

[26] Compared to most other city services, PMT/PCMT charge a relatively high fare. If a norm is developed on the fare charged for city buses, it will be around Rs.4.50 for 10 kms, but for Pune it is Rs.6 (CIRT, 1999). The issue of fares also becomes important in the context of petrol prices. Given the current petrol prices, the running cost of a two-wheeler almost equal that of a bus fare for a single trip apart from the fact that it offers the flexibility to carry a pillion rider at no extra cost, convenience and time savings. Thus, it can be seen that except for the initial investment in owning a two-wheeler, there are no extra operating costs for a two-wheeler user but only added benefits. And in the present scenario of the provision of soft loans for buying two and four-wheelers, the initial lump sum investment becomes easy.

[27] A Janata bus differs from an ordinary bus service in that it's fares are lower and it can be stopped and boarded anywhere in its route.

4.4.1.2 PMT's Ambiguous Institutional Role

Though PMT was constituted under the PMC[28], transport provision was not considered as an obligatory function by the Municipality unlike other public utilities such as provision of water and sanitation services. Under Section 63, the Municipal Corporation has to provide funds on a priority basis to meet its obligatory functions, while under Section 66, provision of transport services is a discretionary function and the municipal corporation may or may not provide funds. However, since transport is an important 'service', the transport authority is expected to maintain a certain level of service providing subsidies for certain sections of the society, maintain service on certain unprofitable routes etc.

The PMC and PMT are linked through the intermediation of the Transport committee. Inadequacy of funds, levying of taxes to supplement the fare box or providing subsidy[29] for transport services are all addressed through the committee. The PMT is expected to meet its own expenses except in the case of exceptional years, during which it can approach the PMC for loans repayable at an interest. However, PMC is unable to provide even the seed capital to PMT.[30] The state government decides the fares while the service level i.e. the routes operated, frequencies and other decisions have to be taken by the PMT itself.

The free play of market forces is restricted by the state's policies and thus private buses are not allowed to ply within the city while public provision remains inadequate. As the above analysis shows, growth in the performance parameters has been sluggish up to the end of eighties and has again been affected in the nineties after the competition from six-seaters. Financially, it has always been tough for the bus service to earn surpluses with losses reaching a peak in the late nineties. Moreover strategies like a high fare policy and extending service outside PMR prove counter productive in the long run with PMT losing

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[28] Under the Mumbai Provincial Municipal Corporation (BPMC) Act, 1949.

[29] Amendments - Section 95 (A) of the BPMC ACT, 1949 provides provision for subsidising the transport services since it is considered as an important function. The transport manager of the transport organisation has to prepare a budget proposal for the approval of the transport committee. If it is a deficit budget after providing depreciation and other liabilities, a report in this regard will be submitted to the transport committee for providing subsidy for the losses incurred by the municipal transport. This amendment indirectly states that bus transport is like any other public utility for PMC.

[30] It is difficult to secure financial assistance from the state government as PMT is neither a government company nor a corporation under the Road Transport Corporation Act, 1950 (CIRT, 1996). However, due to the revenue received from the rich industrial estates in its jurisdiction the PCMC is able to provide the required assistance to PCMT.

its user patronage. In the next section we take a look at the intermediate transport within the city, focussing on the recent introduction of the six-seaters.

4.4.2 Intermediate Transport

Until the introduction of six-seaters, auto rickshaws were the only dominant intermediate transport in Pune city. There were around 40,000 of them in the PMR in 1998. However, the fare charged by an auto rickshaw is relatively higher as compared to bus and thus, it is not a complete alternative for bus systems. The six-seaters combine the advantages of both the bus and auto for the traveller. They run on fixed routes, charge fares equivalent to the bus systems, can be stopped anywhere (in the route) and are available every two to three minutes (compared to an average of 15-30 minutes for the bus service).[31] There are about 4000 of them operating within the metropolitan region. In a short span of time, due to public patronage, the six-seaters have become major competitors to the three seater auto rickshaws and public transport operators like PMT and PCMT, despite the fact that they cause pollution and congestion (Rao and Rajeev, 2000). Table 4.14 shows the comparison between six-seaters and buses on some important parameters. It is clear that six-seaters have more share of traffic on the major traffic corridors to the tune of 58 per cent and offer very stiff competition to the bus service.[32] They overcome the basic disadvantage of bus operation i.e. demand is dis-aggregated while supply is more aggregated.

Table 4.14: Comparison of public and intermediate modes

Parameter	Six-Seater autos	Bus
Vehicle Utilisation (kms/day)	150	200
Number of vehicles per route	60	4
Seating Capacity	6	50
Number of seat kms offered	54000	40000
Percentage share	58	42

Source: Rao and Rajeev (2000)

The State Transport Authority (STA) issued new guidelines to RTA, in the month of January 1999 to ban the six-seater auto rickshaws within the old PMC and Pune Jurisdiction. The six-seater operators, however, approached the High Court and the case is

[31] At the time of introduction they were introduced as contract carriages, but now their operating pattern is very similar to stage carriages i.e. they ply on fixed routes picking up passengers for a fixed fare.

[32] The present operating pattern is that from about 5-6 hub centres, six-seaters spread out to about 8 to 10 routes and on the average, there are about 60 to 70 six-seaters on each route catering high frequency services to about 50-60 destinations

pending with the Court. We thus see the emergence of a dominant pressure group on the urban transport scene. The success of this mode was possible only because of the existing deficiencies in the previous system and lack of planning for urban transport on the part of local authorities. The point here to be pondered is that whether it is the most efficient mode to fill up the crucial supply gap in the transport system. The role of the six-seater might lie in plying as feeder vehicles for major corridors rather than plying as the major carriers within the corridors itself thus becoming a supplement to the public modes effectively reducing congestion.

4.5 Lack of a co-ordinated policy

The most important and interesting fact about policy regarding urban transport is the lack of it. Urban transport is regarded primarily as the concern of local authorities and there are no policy initiatives or guidelines for the local governments guiding them to a particular course of action once the city reaches certain benchmarks in terms of size or density. The effect is clear in terms of most cities planning randomly in terms of mass transit provision, bus systems, road infrastructure and most cities finding themselves confronted with the massive problems of traffic chaos and congestion. There are conflicts arising out of a lack of proper co-ordination or policy.[33]

In our case study of Pune, we see that at the local level apart from the Municipal Corporation there is the RTO, Traffic Department, Town Planning and Valuation department and the municipal transport along with other departments at the state level that are involved in monitoring the transport system of the city. However, each of them work at their individual objectives without aiming at a co-ordinated effort for arriving at a comprehensive solution to the urban transport problem.

The Regional Transport Office (RTO) is concerned with registering the new vehicles that enter the transport system. Under the Motor Vehicles Act, 1988, the RTA can only control

[33] The protest by six-seaters owners in Pune is such a typical case. Similar instances are found in other cities too. For example, in Mumbai, where after endorsing the engine change from four cylinder to three cylinder for taxis, the RTO has now decided to follow the India 2000 norms and notified a ban on them to which the taxi unions are now protesting. The recent case of protest against the banning of buses without CNG engines in Delhi is also on similar lines.

transport vehicles but not passenger vehicles.[34] As part of economic liberalisation the Government announced a new, automobile policy in June 1993, which allowed free entry to foreign companies. This national policy promoting unrestricted growth of the automobile industry is in conflict with any local level decision to limit the annual increment in the number of registered automobiles with the RTO by the use of quotas and licenses. The provision of road and town planning lies with the PMC to a great extent and also with the Town Planning department. The PMC is involved with planning for the road and transport infrastructure in its development plans and its 'traffic planner' is involved with the provision of public parking.[35] The traffic police department is concerned with the management of vehicular traffic on the city roads. Thus we can see that each department has its own objectives and judges its performance in the urban transport management to the extent of fulfilling its own objectives.

Thus, there is a need for a centralised agency concerned with co-ordinating the major forces that impact on the urban transport scene in the city. Cities that reach a particular size or at least metropolitan cities need to have independent bodies, like the Urban Development Authority (in Delhi, Hyderabad etc.) and the Urban Transport Authority. However, it is interesting to note that the Eighth Plan has some urban development schemes related specifically to urban transport. With the objective of developing a National Urban Transport Policy, the Ministry of Urban Development, the nodal agency for urban transport, has undertaken a study of 21 cities. Developments in this area will prove beneficial for urban transport (Mathur, 1999).

Summary

In this chapter we looked at various factors that are expected to influence the transport patterns in a city. We have seen that over time the vehicular populations have shifted largely in favour of private passenger vehicles, largely two-wheelers. We also found that over time as the city grows larger, changes happen in the urban economy which not only increase the

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[34] After the revisions of the Act in 1988, the state government can control only the contract carriages particularly those that are called cabs.

[35] This becomes important in the context that over 30 per cent of Pune's road space is used up for vehicles parking alone while 11 per cent of its land is used for transportation (Discussion Papers of Pune Management Association, 2000).

travel needs of the population, but also shift the modal mix in favour of private modes of transport. There has been no systematic land use planning in Pune and the urban form is more an outcome of historical processes. Moreover, the process of urbanisation itself increases the travel demands of the population in terms of increasing employment, changing occupational status, population structure and other changes. This, coupled with the inadequate performance of public transport systems, has provided the conditions for the rapid growth in the ownership of private vehicles. An important point seems to be the lack of an urban transport policy to impact modal mix. Thus, we see that the performance of public transport is non-optimal and the major cause for this lies in its ambiguous institutional identity. In other words, government failures in a sector where market failures are bound to occur would have important ramifications for urban welfare.

APPENDIX

Table 4A. 1: Growth of the district and city

Year	Area in Sq. kms	Density (persons per sq.km)	No.of occupied residential houses	No. of households	Total Population
District					
1961	15626	158	432463	455099	2466880
1971	15640	203	471968	572885	3178029
1981	15642	266	740820	767495	4164470
1991	15643	354	1064879	1079140	5532532
Pune UA					
1961	170.03 (1.09)	3409 (27.45)	138475	152078 (33.42)	737426 (29.89)
1971	324.6 (2.08)	3496 (17.22)	160190	221313 (38.63)	1135034 (35.72)
1981	344.18 (2.20)	4898 (18.41)	311028	322998 (42.08)	1686109 (40.49)
1991	423.42 (2.71)	5890 (16.64)	504912	513944 (47.63)	2493987 (45.08)

Note: Total population includes institutional and houseless population. The figures in brackets are for the UA as a per cent of the district and density is given as a proportion for that of the district.

Source: District Census Handbook.

Table 4A.2: Sectoral Composition of the workforce

Distric	I	II	III	IV	V	VI	VII	Total from I to VII	Marginal Workers	Total Main Workers	Non-Workers
District											
1961	670521	41566	83186	29922	51654	34827	141467	341056		1053143	1413737
1971	561238	22484	145207	25714	75611	42652	163516	452700		1036422	2141607
1981	694260	31764						729436	148705	1455460	2560305
1991	967446	30779	334811	112179	201224	98278	306962	1053454	179076	2051679	3301777
Pune U A											
1961	8206 (1)	8554 (21)	52313 (63)	8788 (29)	34185 (66)	22997 (66)	89164 (63)	207447 (61)		224207 (21)	513219 (36)
1971	12904 (2)	5387 (24)	105125 (72)	14172 (55)	51847 (69)	29377 (69)	118266 (72)	318787 (70)		337078 (33)	797956 (37)
1981	11378 (2)	11959 (38)						488564 (67)	15084 (10)	511901 (35)	1159124 (45)
1991	23296 (2)	13227 (43)	238754 (71)	86283 (77)	142581 (71)	61499 (63)	213164 (69)	742281 (70)	19569 (11)	778804 (38)	1695614 (51)

Note: The Roman numerals denote employment in various activities. I – Primary activity, II – Manufacturing in Household Industry, III – Manufacturing in Other than household industry, IV – Construction, V – Trade and Commerce, VI – Transport, Storage and Communication, VII – Other services, VIII – Total of manufacture and services.

Source: Primary Census Abstracts, Census.

Table 4A. 3: Share of workers in various economic activity in the District and UA

Year	Primary	Manufacturing		Construction	Secondary	Trade and Commerce	Transport, Storage and Communication	Other Services	Tertiary	Manufacture and Services
		In House hold	Other							
District										
1961	63.67	3.95	7.90	2.84	14.69	4.90	3.31	13.43	21.64	36.33
1971	54.15	2.17	14.01	2.48	18.66	7.30	4.12	15.78	27.19	45.85
1981	47.70	2.18								52.30
1991	47.15	1.50	16.32	5.47	23.29	9.81	4.79	14.96	29.56	52.85
Pune U A										
1961	3.66	3.82	23.33	3.92	31.07	15.25	10.26	39.77	65.27	96.34
1971	3.83	1.60	31.19	4.20	36.99	15.38	8.72	35.09	59.18	96.17
1981	2.22	2.34								97.78
1991	2.99	1.70	30.66	11.08	43.43	18.31	7.90	27.37	53.57	97.01

Source: Computed from Primary Census Abstracts, Census.

Table 4A.4 Selected Indicators of Vehicular Populations and Socio-Economic Characteristics

	District				UA			
Year	**1961**	**1971**	**1981**	**1991**	**1961**	**1971**	**1981**	**1991**
Vehicles (per thousand population)								
Vehicular Intensity	11.11	18.02	34.00	84.26				122.52
Two-wheeler Intensity	1.85	7.02	19.65	63.64				92.81
Four-wheeler Intensity	2.62	4.59	4.97	7.51				10.82
Private Vehicle Intensity	4.47	11.61	24.62	71.14				103.63
Size (persons per sq.km)								
Density	157.87	203.20	266.24	353.67	4337.03	3496.72	4898.92	5890.10
Transport								
Road Length (kms per thousand population)						.15	.15	.22
Public Transport Modes (Per thousand population)	0.40	1.16	0.85	0.28	0.20	0.26	0.26	0.34
Intermediate Transport (Per thousand population)	0.12	0.62	2.11	4.62				6.95
Economic Activity								
Employment (WPR)	42.69	32.61	38.52	40.32	30.4	29.7	31.25	32.01
Employment in industry & services (per cent)	36.33	45.85	52.3	52.85	96.34	96.17	97.78	97.01
Population Characteristics								
Per Cent of pop. in active age groups	53.00	53.00	55.89	59				62
Per cent of pop. with matriculation and above	4.04	6.86	19.47	18.45				
Income								
Per Capita SDP	1689.10	1783.33	2435	3483				

Figure 4A.1: SDP and two-wheeler ownership

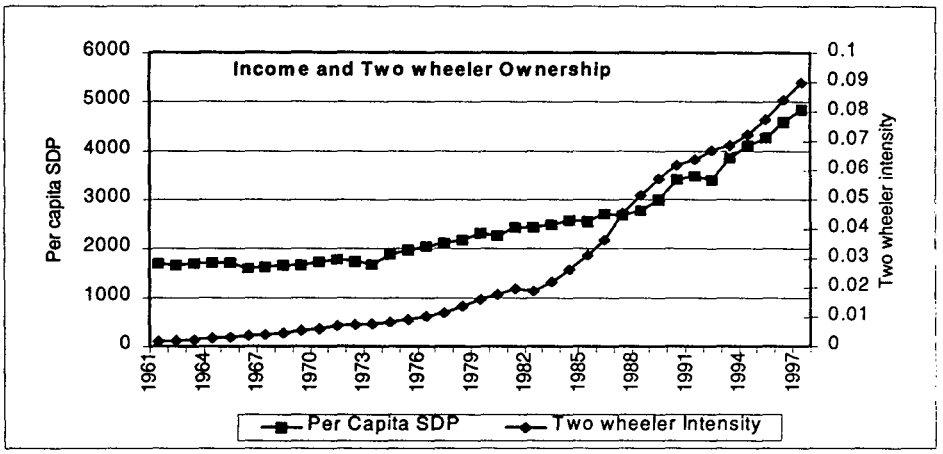
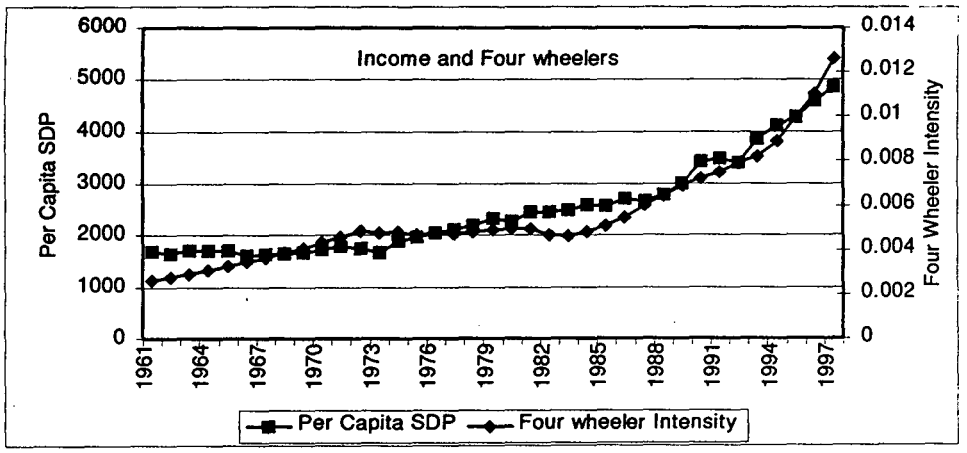


Figure 4A.2: SDP and four-wheeler ownership



Chapter 5

Role of Preferences and Attitudes in Determining Modal Mix

Introduction

Given the cost structure of the choices available, the issue of planning at the macro-level for public transport can be delineated broadly in terms of problems of satisfying the travel demand of consumers. This again affects the returns to investment made in public transport and therefore the scope for further investment. In other words, problems in allocation at the disaggregated level affect the returns to investment in public transport and therefore allocation at the aggregate level. Further, given cost-structure of choices at the micro-level, the choice in a particular context will be governed by preferences of the individual. Cost effectiveness of the choice and preferences may be complementary to each other, may move in the opposite direction or may be independent of each other. Such varieties of choices in which preferences have their role to play make the outcome at the macro-level uncertain. Thus the micro-level choices are complexly linked to the macro-level outcomes.

In the previous chapter, we looked at the supply side of the transport system. We saw the tremendous growth of private passenger vehicles over the decades, the circumstances under which the public transport is constrained to operate and the role of the intermediate transport. Thus, we got a supply side perspective of the transport system. Here, through a primary survey, we focus on the role of perceptions as an important demand side variable, which impacts the modal mix.

Travel surveys are primarily used for behavioural travel demand modelling which has been an important tool to forecast and plan for the demands of a community. The choice of how particular modal choices are made has been studied by a number of authors (McFadden, Train, Goett, Ben-Akiva). The two methods commonly used are the revealed preference techniques and the stated preference techniques but, historically, the former has been given more importance over the latter. The emphasis has been on locating the factors influencing a particular choice, examining determinants like income, household size, occupation, status in the household, distance of workplace and such other variables, which are crucial in the modal choice. The role of perceptions, attitudes and preferences are however, elicited with a method called the stated preference (SP) approach.

The role of perceptions and attitudes in modal choice is well recognised in literature[1]. They assume importance when one decision-making task is viewed as a lifelong sequence, with earlier information and choices operating through experience and memory to provide context for the current decision problem, and the results of this choice feeding forward to influence future decision problems (McFadden, 2000). For instance the improvement in the bus service might not immediately lead to a shift in behaviour, as there is a general pessimism towards public services. The SP approach, by asking a set of well-formulated questions, may enable one to elicit the consumer's preference, perceptions and attitudes that determine his/her behaviour. But, the role of perceptions has been relegated a second place in most analyses. Apart from measurement problems, the validity of stated preference is questioned for its own sake. However, recent emphasis has been on integrating the two approaches rather than seeing them as conflicting or exclusive methods to determine modal choice (Wardman, 1988)

The emphasis on perceptions may allow us to assess whether the urban transport problem in Pune is merely a supply side problem or is also reinforced by demand side factors that favour the modal mix in favour of private vehicles. Therefore, this chapter allows us to fill in certain gaps that could not be filled in by our previous analysis. We have chosen those people who travel to work by a two-wheeler. As already seen in the previous chapter, there has been a tremendous growth in the two-wheeler population over the last few decades. Moreover as work trips comprise a dominant percentage of total trips in any city this group becomes an important one for further study. Their attitudes and perceptions about their daily work trip and willingness to change to alternative mode, willingness to pay for better transport facilities etc have been assessed in this chapter.

5.1 Sampling procedure and sample profile

Here, we briefly discuss the method of sampling and also a depict a profile of the sample in terms of occupational characteristics, age, gender, income and expenditure levels, vehicular ownership etc.

[1] For a detailed discussion on the importance of preferences in choice theory, see McFadden (2000).

5.1.1 Sampling Procedure

The sample consists of 160 people who drive their two-wheeler to work and were interviewed at their work place.[2] We have used non-probability convenience sampling method. Since our emphasis was on investigating the preferences of various groups and not on estimating or proving any hypothesis we have not gone in for a probability sample.[3] Care was taken to bring in as much variability into the sample as possible by giving adequate quota representation to people from both the core and the periphery areas of the city and also from separate institutions like banks, government offices, private offices, an industry and an educational institution. Within the workplace itself we have tried to take people from different categories of employment like clerks, officers, managers etc. The questionnaire consists of three sections, socio-economic details, trip details and finally, the section on perceptions (See Appendix A for questionnaire).

5.1.2 Profile of the Sample

5.1.2.1 General Characteristics

We discuss the general characteristics of our sample in terms of occupation, income and vehicular ownership of the sample. In terms of gender distribution our sample is highly biased towards males; it consists of only 20 per cent of females. However, the percentage of sample having jobs involving travel is only 21.25 per cent. In terms of education a dominant share of the sample comes under the category of higher level of education, 57 per cent of the sample are graduates and 23 per cent are post-graduate degree holders. The average family size is around 3.85, with a range of 1 to 8 and the average age of the respondents is 37.55 ranging between 21 and 58. The occupational distribution of the sample is given in table 5.1.

Table 5.1: Occupational distribution of the sample

Work-place	Frequency
Banks	27 (17)
Educational Institution	13 (8)
Govt. Office	54 (34)
Industry	36 (22)
Commercial Offices	30 (19)
Total	**160**

Source: Survey Data.

[2] Whenever relevant, we have excluded the perceptions of people who have to travel on job, since that might influence their answer. Thus, the sample size reduces on such occasions.

[3] However, since it is so the results of our survey have to be interpreted with caution and are not generalisable.

We classify the households in the sample according to their level of income, into three groups: low, medium and high. It is from table 5.2 that 33.1 per cent of the households fall under the category of low income group, i.e. with an income below Rs. 10,000 and another 33.1 per cent of the households fall under the middle income category, i.e. with an income between Rs. 10,000 and 15,000. The rest 33.8 percent of households constitute the higher income groups, with an income above Rs. 15,000. 24 per cent of the households have a monthly expenditure of below Rs. 6000, 22 per cent between Rs. 6000 and Rs. 8000, 25 per cent between Rs. 8000 and Rs.10000 and another 29 per cent above Rs. 10000.

With regard to the geographical distribution of the sample households, we see that while 52.5 per cent are from central places 47.5 per cent are from periphery areas.[4] We also see that the average distance and time of travel are more in the case of people who work in the peripheral areas (11.5 km and 27 minutes) as compared to the central areas (7.17km and 21 minutes).

5.1.2.2 Ownership characteristics and expenditure on transport

In all, the sample households own 285 vehicles, out of which 56 per cent are scooters, 28 per cent are motorcycles, 9 per cent are four-wheelers and 7 per cent are mopeds.[5] It is also seen that 52 per cent of households own a single two-wheeler while 36 per cent own two two-wheelers and 10 per cent own three two-wheelers. Bicycle seems to be dominant with 35 per cent of the households having one and another 16 per cent of the households having two bicycles. Only 15 per cent of the households own a car. Thus, our sample consists of a dominant group of single or double two-wheeler owning households. From table 5.2 we can see that this ownership of vehicles moves along with the household income; it changes across different income groups. The lower income groups own lesser vehicles while the vehicular holding increases over medium and large income groups. Also, the vehicle ownership seems to increase with the number of employees in the household. It is observed that 34 per cent of the households which had one member employed in the house had one two-wheeler, while another 33 per cent of the households having more than one employee in the house have more than one vehicle in the house. On an average 1.8 persons per house possessed a license.

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[4] MG Road, Fergusson Road, Station and Swargate are the central business areas surveyed while Yerwada Post and Mundwa are the two periphery areas.

[5] Note that the percentage shares within the two-wheeler populations follow the trends observed in the last chapter, with scooters dominating the scene, followed by motor cycles and mopeds.

Table 5.2: Ownership of vehicles across income groups.

Household Income	Number of Vehicles		Total
	One	More than one	
Low	35 (22.29)	17 (10.83)	52 (33.12)
Medium	25 (15.92)	27 (17.20)	52 (33.12)
High	11 (7.01)	42 (26.75)	53 (33.76)
Total	71(45.22)	86(56.78)	157

Source: Survey Data.

The spending on purchase of vehicles is the lowest for mopeds at Rs. 13,700, while a scooter costs Rs. 21,800 and a motor cycle costs Rs. 39,000 on an average. Interestingly, most of the households in our analysis possessed new vehicles, which were either newly bought or replaced.[6] It is found that 81 per cent of the vehicles were purchased after 1991 and 55 per cent of the vehicles were purchased after 1996. When we look at the mode of finance of the vehicles, a dominant share of 44 per cent of the vehicles were found to be purchased by cash payment while 40 per cent were purchased through loans and 12 per cent by hire purchase system.

In the case of intermediate transport the expenditure per family varies between Rs. 10 to Rs. 1200 with an average of Rs. 228 per month and between Rs. 20 to Rs. 1200 with an average of Rs. 315 per month in the case of bus. The cost of fuel on private modes, however, is the highest with an average of Rs. 970 varying between Rs. 200 to Rs. 5500. Thus, the total expenditure (leaving out expenditure on personal modes for purchase and maintenance) on transport ranges between Rs. 250 to Rs. 5500 with an average of Rs. 1300.

5.1.2.3 Relationship between household income/vehicular ownership and per capita expenditure

The per capita expenditure on transport is a better indicator of the levels of transport spending as it is standardised for the size of the family. We can see that the per capita spending varies positively over the household income classes as well as over the household ownership of vehicles. In other words, the richer households spend more on travel per member and the same is the case with households having more vehicles. This could be because the higher income households travel more or use costlier modes of transport, similarly the households with more vehicles travel more aside from the fact that expenditure

[6] The replacement schemes provided by most of the automobile companies might be an important factor in the households possessing the latest vehicles.

on fuel per km. might be higher than travel by other modes. This observation highlights the importance of growth in incomes in cities. We can see that household income and vehicular ownership is positively related to the increased spending on transport (Table 5.3)

Table 5.3: Relation between household income and per capita expenditure

Household Income	Per Capita Expenditure on Transport		Total
	Low (<than Rs.300)	High (=> than Rs. 300/-)	
1. Rs. 6,000 to Rs.10,000	33 (63.5)	19 (36.5)	52
2. Rs.10,000 to 15,000	22 (42.3)	30 (57.7)	52
3. Above 15,000	19 (35.8)	34 (64.2)	53
Total	74 (47.1)	83 (52.9)	157
No of Vehicles	Low (<than Rs.300)	High (=> than Rs. 300/-)	Total
One	42 (56.8)	32 (43.2)	74
Two	27 (49.1)	28 (50.9)	55
More than two	7 (22.6)	24 (77.4)	31
Total	76 (47.5)	84 (52.5)	160

Source: Survey Data.

5.2 Factors influencing preferences of the present modal choice

In this section we discuss the perceptions, preferences and attitudes of the people for the existing modes being used as well as for alternative public mode. This may help us to explore the extent to which preferences play a role in the determination of modal choices.

5.2.1 Preferred attributes in daily travel

A particular mode is chosen for the basket of travel attributes it represents. Table 5.4 helps to explain the choice of a particular mode. The respondents were asked to rank a set of travel attributes in their daily trip to work. Cost and time were among the first three rankings for more than 70 per cent of the sample followed by safety (65%). Waiting time and walking[7] were allotted the last three rankings by 60 per cent and 75 per cent.

This is interesting in the light of the fact that though safety and cost have been ranked as the most important preferences, it is not reflected in their choice of mode. Two-wheeler is neither the cheapest nor the safest mode in the daily trip to work. Whereas the convenience

[7] Time is split into journey time, waiting time and walking time as all three involve different disutilites and thus might be perceived differently rather than just as the time undertaken in the whole journey.

parameters of a mode i.e. walking and waiting time seem to be perceived as relatively unimportant whereas the choice of the two-wheeler provides the highest convenience in terms of both these parameters.

Table 5.4: Travel preferences in daily work trip

Problems/Rank	1 (Highest)	2	3	4	5	6 (Lowest)	Average Rank
Cost	25 (26)	19 (20)	24 (25)	12 (13)	4 (4)	11 (12)	2.83
Journey time	26 (27)	24 (25)	19 (20)	17 (18)	5 (5)	4 (4)	2.62
Wait time	6 (6)	18 (19)	12 (13)	24 (26)	25 (27)	8 (9)	3.68
Walk time	5 (5)	9 (10)	9 (10)	13 (14)	29 (31)	28 (30)	4.41
Safety	28 (29)	16 (17)	18 (19)	11 (12)	15 (16)	7 (7)	2.94
Environmental factors	7 (8)	8 (9)	12 (13)	17 (18)	15 (16)	34 (37)	4.34

Source: Survey Data.

5.2.2 Attitudes to the use of two-wheeler

As a follow up of the previous question we also asked the respondent to state the reason that best describes his reason for using a two-wheeler to commute to work. While 42 per cent believe that a two-wheeler helps to keep their daily plans flexible 32 per cent believe that lack of a convenient bus forces them to use the present mode. The flexibility of plans can be interpreted both in terms of benefits that might be associated with changes in other factors involved in the daily schedule as well as the intrinsic value associated with such changes (Table 5.5). Cost or the intrinsic utility from driving one's own vehicle were less quoted for using the two-wheeler. We can also see that it might be possible to shift the modal preferences of the majority by improving service quality in terms of convenient timings, direct buses, more routes and stops, differential service level and fares etc.

Table 5.5:Reason that best describes the respondent driving to work

Reasons	Frequency
I enjoy to drive myself to work	9 (9.6)
I prefer to go by a two-wheeler because I can change my daily plans	39 (41.5)
I go by a two-wheeler, because I find it cheaper than the bus	16 (17)
I am forced to go by the two-wheeler because there is no convenient bus for my trip	30 (31.9)
Total	94

Source: Survey Data.

5.2.3 Perceptions about the bus service

In our sample 49 per cent did not have a direct bus to their workplace whereas 46 per cent had a direct bus and 5 per cent did not know about the bus availability in their region. The probability for having a direct bus is higher for a person working in the centre as compared to the periphery. 62 per cent of the people in the centre had an option of direct bus facility, while only 28 per cent of the people in the periphery had this option (Table 5.6).

When asked to specify the reasons for not choosing bus for their work trip[8], 34 per cent of sample population could not specify a particular problem or reason and they did not know the details of the present bus service. A 13 per cent said that they do not prefer bus system, as they were not used to it. Thus, bus is no more being considered even as an alternative by almost 50 per cent of the population even when they have a direct bus available to their work place. Thus, this section of the population will be unresponsive to any changes made to improve either the service quality of the bus service or the fares. In all, only 25 per cent complained about the actual problems with the bus service i.e. inconvenient timings and long walking distances to the bus stops.

Table 5.6: Reasons for not using the direct bus.

Problems	**Frequency**
Don't Know Anything About the Details of the Present Service	16(34)
The timings of the bus are not convenient.	8(17)
I don't prefer the bus/ Not used to it.	6(12.8)
The walking distance to bus stops is too high.	4(8.5)
Others	13(27.7)
Total	47

Source: Survey Data.

5.2.4 Use of other modes

The previous questions analysed the perceptions, preferences and attitudes in deciding modal choice in the context of work trips. However, this attitude may prevail for other trips made by individuals as well. Table 5.7 gives the frequency of use of other transport modes by the respondents. The tendency to use other modes of transport is found to be very low with a possible exception of auto-rickshaws, which is reported to be used by 68 per cent of the sample. A larger share of the population (57 per cent) never use the bus service while a 51

[8] This question was asked only to those people who had a direct bus service.

per cent never use the six-seater. Moreover, the frequency of using these alternative modes is very less among those who have reported to use them. Only 4 per cent use the bus on a weekly basis, while only 5 per cent use the six-seater. Therefore, we may conclude that the dependence on other modes of transport is very negligible and the only mode that seems to occur as an alternative is auto. Bicycle is hardly ever used by a majority of the population.

Table 5.7: Frequency of using other modes

	Never	Few times a month.	Few times a week.	Weekly
Bus	89 (57)	44 (28)	18 (11)	6 (4)
Six-seater	79 (51)	47 (30)	23 (15)	7 (5)
Auto	51 (32)	61 (39)	32 (20)	13 (8)
Cycle	122 (80)	14 (9)	8 (5)	9 (6)

Source: Survey Data.

Thus, summing up in relation to the choice of their present mode we can say that there seems to be no preference for the two-wheeler specifically, either in terms of convenience attributes or for the utility of driving one's own vehicle. Thus, there seem to be no apriori bias against bus except for not preferring it because of its present service levels in terms of frequency, unavailability of a convenient bus etc. But, from the next two questions we can also see that the population has become private mode dependent in the sense that most of them don't consider bus anymore as an alternative mode for their daily journey to work. Personal mode dependence also gets reflected in their low use of other modes in general.

5.3 Shifts in modal choice

In this section, we make an attempt to examine the attitudes of the sample population regarding public and intermediate transport and their willingness to shift to the former. Table 5.8 provides the preference for different types of buses. While around 35 per cent of the sample prefer a hypothetical bus service that provides service and fares equivalent to that of a six-seater[9] (bus type 3), another 35 per cent chose services cheaper than that (bus types 1 and 2). Thus, 70 per cent of the sample are willing to pay Re. 1 or less for their daily trip to work.

[9] Six-seaters operate at high frequencies, can be stopped anywhere in the route, and charge a fare of approximately Re.1 per Km.

Table 5.8: Preference for various bus types

Bus Type	Frequency
1. 10 minutes walking, 15 minutes waiting and 50 paise per km.	24 (15.3)
2. 5 minutes walking, 10 minutes waiting and 75 paise per km.	32 (20.4)
3. 5 minutes walking, 5 minutes waiting and Re. 1 per km.	56 (35.7)
4. 5 minutes walking, 5 minutes waiting, Re. 1.25 per km and high speed buses using special lanes.	21 (13.4)
5. Company bus like arrangement. 5 minutes walking, fixed boarding time and Re. 1.50 per km.	17 (10.8)
6. Luxury bus like services, high speed, available every half an hour, 5 minutes walking and Re. 2 per km.	7 (4.5)

Source: Survey Data.

It is also noticed that the preference for bus type 3 is high irrespective of income levels (Table 5.9). It is the most preferred bus type in all the income groups. While 33 per cent (17 people) prefer it in the low and middle income groups, 40 per cent (21 people) prefer it in the high income group. The reduction in waiting time in spite of increase in fare of 25 paise per km in the hypothetical choice of 3 discussed above indicate the importance of time for all the income groups. This indicates the importance of benefits from other choices available because of saving time leading to the intrinsic value of preferring a mode of travel. Another 26 per cent (13 people) prefer bus type 1 in the lower income group while an equal share of people prefer bus type 2 in the middle income group. Thus, in spite of the fact that bus type 3 is the most preferred in all income groups, a relation between income and the bus type preferred does exist.

Table 5.9: Relation between bus preference and income

Bus Types	Household Income			Total
	Low	Medium	High	
1	13 (26)	7 (14)	3 (6)	23 (15)
2	8 (16)	13 (26)	11 (21)	33 (21)
3	17 (33)	17 (33)	21 (40)	55 (36)
4	3 (6)	6 (12)	12 (23)	22 (14)
5	8 (16)	6 (12)	3 (6)	17 (11)
6	2 (4)	2 (4)	3 (6)	7 (5)
Total	51	51	53	157

Source: Survey Data.

The above analysis helps us to draw certain conclusions regarding the perception and role of cost in the choice of mode. In the choice of their present mode or in not choosing the alternative mode (public transport) cost does not seem to play the most dominant role. Other preferences like flexibility and convenience have dominated in their choice of two-wheeler. Similarly, in not choosing the bus service cost per se is not an important factor. However,

cost is perceived as an important factor in the daily trip to work and in the choice of a hypothetical bus service too, cost play an important role though it is not the most important one. This seems to have certain implications for pricing of bus transport. Cost is not the most important factor indicating that improvement in the service attributes is an important issue. But, since costs are perceived as important, improved service levels accompanied by high costs may again not shift the modal preferences in favour of bus service. Thus cost plays a complex role in determining the modal choice.

5.3.1 Tendency to Shift to Public Transport

When the respondents were asked about the change in their choice if the hypothetical choice was included in their present choice situation, 81 (67.5 per cent) people said that if the bus they opted for was available they would have taken it (divided into 47.5 per cent who chose the option 'Yes, definitely I will' and 20 per cent chose, 'Yes, I might'). Only 28 people (23 per cent) answered that they would not have opted for the bus service in spite of their option available. While 11 (9 per cent) people answered "Can't say".

The occupational character of the sample population seems to have some bearing on people's inclination to shift to public transport[10] (Table 5.10). Employees in banks and private offices seem to have a low inclination to shift to bus service (59 per cent of people working in banks and private offices declined the possibility of shifting to bus service) while it is high in the case of people working in educational institution, government offices and industry.

Table 5.10: Inclination to bus and type of employment

Inclination to change to bus	**Work Place**					
	Bank	**EI**	**GO**	**Industry**	**PO**	**Total**
1	12 (48)	9 (70)	34 (67)	29 (83)	11 (38)	95 (62)
2	6 (24)	3 (23)	15 (29)	4 (11)	17 (59)	45 (29)
3	7 (28)	1 (7)	2 (4)	2 (6)	1 (3)	13 (9)
Total	25	13	51	35	29	153

Note: GO: Government Office, PO: Private Office, EI: Educational Institution
Source: Survey Data.

[10] We make a separate classification according to the type of job apart from classifying groups based on their income, age etc. This is because there might be certain attitudes prevalent to certain nature of jobs which can be captured by the different nature of their institutions. The average income private offices is the lowest at around Rs. 8500 while it is 9200 in government offices, 10,000 in industry, 13000 in educational institution and the highest in banks at 13700. (But the standard deviation is much higher for the private offices at 66%).

The distance of travel of the sample population can further help us to understand the preference for the choice. It is clear from table 5.11 that a greater percentage of people making long distance trips were willing to shift to bus as compared to those making short distance trips (below 9 kms). This shows that long distance journeys by private vehicles are inconvenient and thus, more amenable to public modes.

Table 5.11: Inclination to bus and distance of travel

Distance	Inclination to shift to Bus			
	Yes	No	Can't say	Total
Short	36 (61)	16 (27)	7 (12)	59
Long	45 (74)	12 (20)	4 (7)	61
Total	81 (68)	28 (23)	11 (9)	120

Source: Survey Data.

5.3.2 Preferences for alternative modes

Table 5.12 presents the preferences of the people for alternative modes. The respondents were asked to vote for and against some of the latest developments in Pune's transport system including private bus provision. 65 per cent of the population supports the Janata bus service, which can be stopped and boarded anywhere in the route and effectively, reduces walking time in journeys.[11] This again is in conformity with the majority of the population viewing flexibility as an important characteristic of daily travel. In the previous question we have seen that a majority of the people opted for the bus type 3, which was equivalent to the services provided by six-seater. Yet, here we see that the support for the six-seater as such is low (only 33 percent support it). This is because six-seater is perceived as causing congestion, noise and air pollution apart from causing traffic management problems. 50 per cent of the people felt that the city should have a private bus service to better provide for the travel needs.

Table 5.12: Support for alternative modes of transport

	Janata	Six-seater	Private Service
Yes	104 (65)	53 (33)	79 (50)
No	24 (15)	69 (43)	42 (26)
Cant Say	31 (19)	37 (23)	38 (24)
	159	159	159

Source: Survey Data.

[11] Refer chapter 4 for details on the Janata bus service.

5.4 Willingness to Pay

In this section, we examine people's awareness to transport externalities and also assess their willingness to pay (WTP) and the factors affecting it.

5.4.1 Perceptions on transport externalities

We can see that the major problem encountered by the people in their daily trip to work is air pollution. While 75 per cent of the people felt that air pollution is a major problem 16 per cent felt that it is a significant problem.[12] About 50 per cent of the people feel roads are unsafe, congested and experienced the problem of noise pollution (Table 5.13).

Table 5.13: Perception of transport externalities

Problem	Major	Significant	Minor
Air pollution	120 (76)	26 (16)	12 (8)
Road safety	78 (50)	45 (29)	33 (21)
Congestion	82 (52)	61 (38)	16 (10)
Noise Pollution	80 (52)	56 (36)	19 (12)

Source: Survey Data.

With regard to the causes of externalities, majority of the people (84 per cent) felt that the growth in private transport was a major factor for the increase in transport externalities while 12 percent disagreed with this view. It is clear that majority of the people are aware of the externalities related to transport and also associate the use of their mode positively with these externalities. In the background of this we go on to assess the WTP of the people for continuing the use of their modes and the use of transport infrastructure.

5.4.2 Willingness to pay for the use of private modes

This was elicited through a question asking for the WTP for parking charges, given that a bus service equivalent to the service of Option 2 in the previous question is available. 70 per cent of the population is ready to pay a high parking charge of above Rs. 2 per day even with the availability of this option (with 55 people ready to pay a parking charge between Rs. 2 to Rs.5 and another 55 people ready to pay a charge of Rs. 5 or more). 19 people (12 per cent) declined to pay any parking charge while 28 people (18 per cent) are ready to pay between

[12] In the present context, significant is ranked after major and before minor.

Re.1 to Rs.2. This indicates the preference for using their present mode in spite of the disincentive of paying parking charges further affirming their dependence on the automobile.

We can also see from table 5.14 that respondents in the younger age groups are willing to pay higher parking charges as compared to the older ones. This shows the preference of the youth to use their personal modes of transport and their willingness to pay for the same.

Table 5.14: WTP for parking charges and age

Age	Parking charges			Total
	None	Less than 5	More than 5	
< 30	1 (4)	11(46)	12(50)	24
> 30	19 (19)	43(42)	40(39)	102
Total	20 (16)	54(43)	52(41)	126

Source: Survey Data.

5.4.3 Factors related to WTP for provision of transport infrastructure

Here we analyse the factors that are related to the WTP for transport infrastructure. This was elicited by asking people to select a toll from a range of less than 50 paise per day to more than Rs.3 per day for the provision of special bus lanes.[13] The type of employment, age, income and awareness were the four factors found significantly correlated to the WTP.

Ninety five per cent of the people were ready to pay for transport facilities in the form of special bus lanes. The type of employment (Table 5.15) seems to be related to the WTP as 80 per cent of the people working in the private offices, 70 per cent of the people working in banks and 50 per cent of the people working in industry were willing to pay more than Rs. 90 per month. In the case of people working in the government offices and the educational institution 64 per cent were ready to pay a charge of only less than Rs. 90 per month.

Table 5.15: WTP for transport infrastructure and occupational characteristics

WTP for bus lanes	Office					
	Bank	EI	GO	Industry	PO	Total
< Rs.90 per month	8 (30)	7(64)	34(64)	18 (50)	6 (21)	73 (47)
> Rs.90 per month	19 (70)	4(36)	19 (36)	18 (50)	23 (79)	83 (53)
Total	27	11	53	36	29	156

Source: Survey Data.

[13] Information was collected separately about the WTP for using the bus lanes as a bus user as separately from a two-wheeler user, but, since the difference was not significant, (the average for a bus user was Rs. 3.35 and for two-wheeler user Rs. 3.28) we have taken the average as the total WTP for bus lanes.

WTP for transport infrastructure is also found to be different across different age groups. It is seen that 72 per cent of the younger age groups were willing to pay a high charge whereas only 47 per cent of the older age groups were ready to pay a high charge. This shows a higher consciousness on the part of the youth for transport problems and an attitude to pay as compared to the elder people who felt that it is the responsibility of the 'State' to take care of transport facilities. The WTP is also higher among people who are more aware of the externalities caused by private modes. 56 per cent of those who believed that transport externalities get aggravated by the use of private transport were willing to pay a higher charge, whereas only 33 per cent of those who didn't have this opinion were ready to pay a higher charge. Finally income as expected is an important factor, with 64 per cent of the people in the higher income groups willing to pay a higher charge while only 44 per cent in the lower income group were willing to pay a higher charge (Table 5.16).

Table 5.16: WTP for transport infrastructure and income

WTP for bus lanes	**Gross Salary Per Month**		
	< Rs.9500 per month	**>Rs.9500 per month**	**Total**
< Rs.90 per month	45 (55.6)	26 (35.6)	71 (46.1)
> Rs.90 per month	36 (44.4)	47 (64.4)	83 (53.9)
	81	73	154

Source: Survey Data.

Summary

This chapter analysed the information collected from a primary survey of 160 people using two-wheeler mode for their work trips. We have tried to analyse the reasons for their present choice, their willingness to shift to alternative modes and finally the determinants of their willingness to pay for using private modes and for transport infrastructure. The survey was a simple exercise to fill in certain gaps that were totally untouched by our previous analysis. Nevertheless, we could draw some important inferences in terms of the role of individual perceptions in determining the modal choice.

Their present choice of two-wheeler as the mode to travel to work is neither because of any intrinsic characteristics of the two-wheeler in terms of convenience or the utility of driving. However, we see that there is a dependence on personal modes in not considering the bus as an alternative mode for their work trip or in consideration of other modes in general.

Cost seems to play a complex role in determining modal preferences. It is perceived to be a far more important factor as compared to the service attributes of waiting and walking but, we see that in the choice of a hypothetical bus service both cost and service attributes play an equal role. The choice of bus type 3, providing services equivalent to that of a six-seater explain the popularity of this mode in the nineties in Pune. However, the support for the mode itself is less because it is perceived to be inefficient in terms of its social costs. Thus though cost is not important in their present choice, it seems to gain importance in their perception and in their preference of alternative choice. This attains significance while pricing the bus transport.

Distance, age, occupational type and income seem to play a role in the respondent's willingness to shift to public transport, WTP for using personal modes and WTP for transport infrastructure. More people travelling long distances are willing to shift to bus as compared to the short distance ones. The willingness to shift to bus is higher among people working in government offices and lower among those working in private offices, while just the opposite is true for WTP for transport infrastructure. The people in younger age groups are willing to pay higher for both using the personal modes as well as for transport infrastructure. WTP for transport infrastructure also seems to be determined by the type of employment, income and awareness to transport problems.

Chapter 6

A Summing Up

The urban transport problem is a multi-dimensional one. It is not merely quantitative in terms of more people creating more demands on the transport system, but also qualitative in terms of the decisions people make regarding the place to travel, mode of travel, choice of route and time of travel. All these variables are important and need close scrutiny in order to arrive at a holistic approach for curtailing travel demand and modifying the travel behaviour. This is important as urban transport has implications for social equity and efficiency in terms of the externalities it creates in the urban environment.

Modal choice is an important facet of the problem and maybe the most amenable to policy changes as it focuses on altering only the way travel is conducted without compromising on the time, place or the quantity of travel itself. With social and political feasibility of policies being an important issue in the present day context, mode may thus be the first and the most important variable that needs to be studied. Mode is also important because of the crucial consequences it has on the externalities created by urban transport.

We began by locating the problem in the urbanisation context by reviewing the issues around city size and city specific factors. The transport problem cannot be studied in isolation without studying the concomitant processes of urbanisation, which impact not only the extent of travel but also the intensity of travel demand in terms of higher trips made per capita. We study the modal mix in the context of city size across cities with a keener analysis of the determining factors in the case study of Pune. However, our analysis is severely restricted due to data availability especially data on income levels, public transport modes and vehicular data across the range of city sizes.

The cross-city perspective of studying modal mix in the theoretical light of city size as an intervening variable showed that there is no one-to-one relation between city size and vehicular intensities. However, the smaller cities show a greater variation across various parameters indicating that certain local factors within the smaller cities have greater impact on the transport patterns as compared to the larger cities. With the increase in the size we see that the vehicular intensities stabilise. In the disaggregate analysis, population growth rate emerges as the most important factor in the determination of two-wheeler intensities,

whereas the size of the city, income and road availability are important determinants of four-wheeler intensities across cities.

From these results we move on to the specific case study of one city, Pune, to study the factors that affect at the local level which have important implications for modal split. We see that over the years passenger transport and within that personal modes have come to dominate the transport scenario. However, there has not been any foresight in planning for this growing modal bias for private modes, especially, two-wheelers. Some important points emerged from the narrative of the urbanisation process. We saw that the PMR presently consists of two Corporations with significant differences in the urban form, economic activity and infrastructure provision, which has significant implications in determining the transport scene. The present urban form has largely emerged as an outcome of historical processes constituting of influences from the Peshwa period, the colonial period and modern industrial development. These forged a dual identity on the urban form in terms of the better laid out cantonment areas and later through the emergence of the suburbs. Thus the present uneven distribution of commercial, industrial and residential zones within the UA demands greater planning on the part of the public transport systems to meet the increased travel demand of these areas. In the absence of such efficient public modes the supply gap is filled up by dependence on personal modes. The road infrastructure is also extremely location specific, constraining us in making any generalisations about congestion levels in the city as density, road availability etc vary largely within the UA itself.

Present day planning has yet not incorporated any modal specific policies, with emphasis still persisting on passive reactions in terms of provision of extra road space by road widening and other traffic management measures rather than on structural changes needed for a better modal mix. Most of the planning has been passive in terms of road widening, provision of parking spaces, terminals and other transport facilities.

The performance of municipal transport in Pune is also completely shadowed by its ambiguous institutional identity due to which it is unable to maximise either the objective of profit or service. The inability to access ready credit, lack of autonomy to set fares, the increasing financial losses and finally the emergence of six-seaters as a major competitor have all worsened its performance further in the nineties. This has been possible because the six-seater captures the advantages of both the economical fare of a bus service while providing efficient service level.

However this mode has increased the transport externalities, congestion and chaos by their mode of operation. More importantly, in this short period the six-seater operators have become a major pressure group not easily amenable to the control of local authorities. This again reflects the failure of planning at two levels, first, in anticipating and providing for the supply gap that the six-seaters have now successfully filled and secondly, in the inability of adequately providing the legal frame for the operation of this mode.

In a broader view, this lack of planning at the city level just gives a micro picture of what is happening at a national level. There does not exist any national level policy, even in the context of the metropolitan cities for urban transport. Liberalisation and the resulting growth in the automobile industry further set the environment for increased dependence on personal modes. At the city level no policies can be drafted against this broader environment of the national objective for promoting the growth in the automobile industry. This asymmetry of objectives exists even at the city level with each of the concerned authority catering to satisfy their limited objective. At the city level, urban transport scene is painted by a number of authorities, like the RTO, the Traffic Management Branch, Town Planning department, the Municipal Corporation and the Municipal Transport.

Thus, we see a very problematic picture emerging on the supply side. On the demand side we analysed the role of perceptions, preferences and attitudes that determine the modal preferences of the two-wheeler users. The reasons for the emergence of six-seater as the most dominant mode are clearly captured by our survey because of the preferences expressed by the majority of our sample in terms of journey time, cost and by the majority choosing the service, which was equivalent to the six-seater service. The dominantly expressed reasons for using a two-wheeler to work, that is, because it provides flexibility in altering their daily plans and the lack of a convenient bus also point at possibilities of shifting modal preferences through better service provision.

Most respondents agreed to the statement that two and four-wheelers increase transport externalities and majority had a willingness to pay for transport infrastructure. The willingness to pay for transport infrastructure is determined by income, age, by their awareness to the externalities caused by private transport and also by their job status. People working in the government offices have a higher willingness to shift to bus service and a lower willingness to pay for transport infrastructure, while those working in the private offices have just the opposite attitudes.

Thus, our analysis leads us to indicate at certain policy recommendations. There is a need for a unified urban transport authority guiding a co-ordinated urban transport policy at the city level. Policies regarding bus transport, travel demand management, infrastructure provisions etc. have to be linked up with the size of the city. Especially, in the context of larger cities there is a need for travel demand measures as we see that personal mode intensities are bound to be higher unless the cities are provided with rail-based systems. The role of the various actors presently involved in the urban transport scene also has to be co-ordinated. Land use planning becomes important in the light of the fact that it has immediate implications on the trip demand between areas and this is further linked up to providing better public transport provision suiting these demands.

The role of public transport also needs to be clearly defined in consideration to the fact that the transport externalities from this mode are the lowest. Thus, pricing of public transport along with improvement in service levels becomes important. Road pricing gains significance in the light of the fact that the modal mix problem is not only a supply side problem but is also affected by the demand side factors. Particularly, perceptions and attitudes to public modes play a dominant role in the present context of almost comparable relative prices for various modes. Therefore, road pricing is important to make personal mode of transport pay for the externalities it imposes on the urban environment. Finally, it is crucial to collect and disseminate data on important variables related to urban areas and urban transport. A more comprehensive database on vehicular populations, public transport systems, infrastructure provision etc. is necessary, supplemented by travel surveys to study the determinants that affect modal choice of the individual.

Urbanisation plays a crucial role in the demand for travel as a whole and in the determination of modal choice. The problem of mode cannot be separated to an exclusive status as we see that the spatial dimension of urbanisation interlinks it with the problem of total demand for transport in an agglomeration. It has two dimensions both on the demand and supply side. It has to be addressed from approaches at multiple levels in terms of better spatial planning of urbanisation, provision of urban transport, policies for private and intermediate transport and catering to the preferences of the consumers over and above considerations of cost. Further research in this area related to issues like the determinants of modal choice at the micro level, feasibility of various policies in the developing country setting, relationship of incomes, public transport availability to personal modes etc. would be useful.

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APPENDIX A

QUESTIONNAIRE

Exploring the Linkages between Urbanisation and Transportation: A Study of Metropolitan Cities in India with special reference to Pune

A. General Information

1. Personal Characteristics (where ever options are available)

a. Name:	
b. Gender:	Male Female
c. Designation:	
d. Educational Qualification:	<SSC SSC HSC Graduation Post-graduation
g. Gross salary per month:	
h. Do you get a Conveyance Allowance, If yes, how much:	

2. Information on other household members

Member(Please specify the relation to you, for example Son, Daughter, Wife etc)	Occupation Status (State whether the person is employed, unemployed, in school, in college or infant)	If employed, in school or college, please state how they travel to work, school or college, for example walk, cycle, bus, auto,6- seater, two-wheeler	Does the person possess a driving license? Yes/no

3. Please give information on the Vehicles Owned in your household presently, include any four wheelers you own:

Vehicle Type	Year of Purchase	Price of Vehicle at that time	Mode of Finance: State whether Hire Purchase, Loan, Cash Payment
First, the two wheeler you use to come to work			
Other vehicles in the household			

4.Do you own any Bicycles ? Yes No. If yes, how many:

5. Are you planning to buy another vehicle in the next year? Yes No

6. How much does the household spend per month on transport? (In Rs.) Please give details.

On public modes (buses, school buses etc.)	On personal modes (expenditure only on petrol and diesel)	On intermediate modes (autos and six- seaters)	Total expenditure on transport per month
Rs.	Rs.	Rs.	Rs.

7. Household Details

a. House locality			
b. Since how many years have you been living in this locality?			
c.Ownership of residence	Own	Rented	
d. Indicate your gross monthly total household income (tick one)	< 10,000 15,000-20,000 25,000-30,000 40,000-45,000 45,000-50,000	10,000-15,000 20,000-25,000 30,000-35,000	35,000-40,000
e. Indicate your total monthly household expenditure (tick one)	< 6,000 8,000-10,000 12,000-14,000 18,000-20,000 >20,000	6,000-8,000 10,000-12,000 14,000-16,000	16,000-18,000

B. Trip information

1. Trip details of the respondent

How far is the distance (in kilometers) from your home to office?	
How long on an average does your journey take one way? (in minutes)	

2. Do you have a direct bus from your area to this area? Yes No Don't Know

3.What are the problems in using the bus service to make your work trip? Tick one

Don't know any thing about the details of the resent bus service	
Too costly	
Walking distance to bus stop is too high	
Not convenient timings	
Not reliable	
Waiting time too high	
Other reasons, please specify	

4. How would you rank these as your preferences or your daily trip to work? Give rank 1 for the most preferred activity

Travel Preferences	Rank
Journey cost: my trip to work should be as cheap as possible	
Journey time: the journey should take as little time as possible	
Waiting time: I would like to wait as little as possible	
Walking distance : The journey should involve as little walking as possible	
Travel safety: the journey should be as safe as possible	
Environmental factors: the journey should have as little exposure as possible to the sun, pollution etc.	

5. Which of these statement *best* describes the reason you drive to work by a two- wheeler? Tick one

I enjoy to drive myself to work	
I prefer to go by a two wheeler because I can change my daily plans (*for example , do some shopping before returning home, visit a friend etc*)	
I go by a two- wheeler because I find it cheaper than the bus service	
I am forced to go by the two wheeler because there is no convenient bus for my work	

6. How often do you use other modes of transport? Tick the appropriate block.

Mode	Never	Less than once a month	Sometimes (more than once a week, a few times a month)	Usually (once a week or more than that)

7. How would you rate these problems as the problems you face in your daily trip to work on your particular route?

Rate the problems	Major	Significant	Minor
Air pollution			
Fear of accidents			
Congestion, traffic jams, delays			
Noise pollution : sound of traffic, sound of horns etc.			

8. Which of these transport systems would you support if you were asked to vote on them ?

Modes	Yes	No	Can't say
Janata bus service			
Six- seater service			
Private bus service			

C. Preferences

1. Which of the bus systems below would you find suitable if you had to make your daily trip by bus? Tick (√) ONE: (All the figures are given for a one-time journey)

Bus type 1 10min walking time, 15 min waiting time, Bus fare of 50ps per km.	Bus type 2 5 min walking time, 10 minute waiting time, bus fare of 75ps per km.	Bus type 3 5 min walking time, 5 min waiting time, bus fare of Re.1 per km.
Bus type 4 5 min walking and 5 min waiting time, high speed buses using special lanes. Fare of Re.1.25 per km.	Bus type 5 A Company bus-like arrangement, 5 min walking time, fixed boarding time, bus fare amounting to Re.1.50 per km.	Bus type 6 Luxury bus-like services, high speed, available every half an hour, 5 min walking time, bus fare of Re.2 per km.

2. If the option you ticked above had been available, would you make your daily trip to work by bus?

Yes No Can't say

3.Imagine that Bus type 2 (refer question no. C.1) is available to you and if a parking charge was imposed payable on a per month basis for using your two wheeler to work , then which option will you chose?

I would shift to bus service if the parking charge imposed is
Rs.50 Rs.100 Rs.200 Rs.250 more than Rs.250
Can't say

4.Do you agree with the statement: Increased use of private vehicles (two and four wheelers) is compounding the traffic problems of the city?

5. If special bus lanes were constructed, which would be used exclusively for buses then this would increase the speed of the buses as well as reduce the congestion on the ordinary roads due to buses. Such a road improvement would require additional improvement which the municipality cannot afford. For such a road improvement , on your route from home to office , how much would you be willing to pay per day? Tick one from each category.

If you used the bus:

Less than 50 ps. 50 ps. Re 1 Rs 1.50

Rs 2 Rs 3 More than Rs 3

If you used the two- wheeler:

Less than 50 ps. 50 ps. Re 1

Rs 1.50 Rs 2 Rs 3 More than Rs 3.