Transport Problems of Rapidly Developing Cities:
the case of Bombay

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May 1984
Dedicated
to the loving memory
of
Dharmesh Raval
who died in a motorcycle
accident, Bombay, 26.10.83
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The city performs certain essential, unique social and economic functions, the efficiency of which are vital both for the city itself and the whole country which it serves.

Access and mobility are the key to the efficient organization and development of the city. If people continue to move into urban areas that are already overcrowded, the urban area will deteriorate drastically unless steps are taken towards a proper spatial organization of land use. This is especially a problem in the primate cities of the third world, the development of which is in many cases being hindered by ineffective and inefficient transport systems. This results in diseconomies in all sectors of the urban economy.

This research focuses upon the transport problems in third world cities, with special reference to Bombay, India. Having had the opportunity to live and travel in several large cities of the developed economies but as a frequent visitor to third world cities, the contrasts in the character of the urban areas, and particularly, the nature of the urban transport problems was all too apparent and invited examination.

The first chapter introduces the subject, emphasizing that the urban transport problem is in fact a world-wide phenomenon, faced by all large cities. The different uses of transport are outlined, and literature on the influence and interdependence of transport technology and land use is discussed. An attempt is also made to define the urban transport problem. The research methodology used for the purposes of this dissertation is outlined.

The second chapter examines the development of the transport network in Bombay and the city's land use pattern and population and employment distribution.

The third chapter analyses the nature of urban passenger transport demand. The analysis begins with the factors influencing movement.
The spatial and temporal aspects of demand, and particularly the characteristics of commuter travel, are discussed with special reference to rail and bus travel patterns in Bombay.

The fourth chapter discusses the characteristics of the suburban railways and road public transport and is based in part on a sample user perception survey of the city transport. Informal modes of transport are considered, as well as, the role of the motor car in Bombay.

The fifth chapter is devoted to the present transport problems of Bombay particularly as these are perceived by the users themselves. The commuter perception survey conducted by the author provides the basic data for this section.

The final chapter summarizes alternatives to the present transport situation and includes consideration of the non-transport issues, the plans and proposals put forward by various authorities and the need for transport provision based upon an integration of land use and transport planning. In conclusion, there is consideration of the possible role of innovative transport technology in third world cities in general and Bombay in particular.
Abstract

Urban areas present transport planners with some of their most difficult problems. Transport problems in the rapidly growing cities of the Third World are complex and multi-dimensional and the nature of demand and the problems created are discernibly different from those of cities in advanced economies where the principal problem is that of accommodating the private car.

It is proving difficult for the existing transport system of many Third World cities to satisfy expanding demand related to increasing population, present transport systems are seriously over-loaded, there is back-log in service improvement and there is a severe shortage of resources for the development of new capital intensive solutions. This results in transport systems that are inadequate in both quantitative and qualitative terms. A root cause of the present problem is the lack of attention over time to spatial planning and the distribution of population and economic activities.

Bombay is examined as an illustration of the consequences of such a lack of spatial planning. For historical and geographical reasons, Bombay has grown linearly along a north-south axis. While the urban activities and main centres of employment are concentrated at the extreme southern tip of Bombay Island, Residential colonies have developed northwards in a haphazard way along the transport arteries and result in an amorphous city structure. User perception of the existing services and problems are examined by means of a questionnaire survey.

The research suggests that on its own the provision of additional transport will not provide solutions to the city's problems which can be tackled more effectively by greater attention to non-transport solutions - land use planning and influencing the patterns of demand.
ABBREVIATIONS

A.P.M.  Agricultural Produce Market
B. B. & C. I. (Rly)  Bombay Baroda and Central Indian Railway
B.C.T.  Bombay Civic Trust
BEST  Bombay Electric Supply and Transport Undertaking
B.I.  Bombay Island
B.M.C.  Bombay Municipal Corporation
B.M.R.  Bombay Metropolitan Region
BMRDA  Bombay Metropolitan Regional Development Authority
BMRPFB  Bombay Metropolitan Regional Planning Board
CBD  Central Business District
CIDCO  City Industrial Development Corporation
C.R.  Central Railway
D. N. Rd.  Dadabhai Navroji Road
Dn  Down
E.E.H.  Eastern Express Highway
EKU's  Electrical Multiple Units
FSI  Floor Space Index
G.B.  Greater Bombay
G. I. P. (Rly)  Great Indian Peninsular Railway
Ha  Hectare
HOV  High Occupancy Vehicles
IBRD  International Bank for Reconstruction and Development
IIM  Indian Institute of Management
IIPA  Indian Institute of Public Administration
<table>
<thead>
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<tr>
<td>Km</td>
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<tr>
<td>K - W</td>
<td>Kruskal - Wallis Test</td>
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<td>KWC</td>
<td>Kalamboli Warehousing Complex</td>
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<td>MEDC</td>
<td>Maharashtra Economic Development Council</td>
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<td>M. G. Rd.</td>
<td>Mahatma Gandhi Road</td>
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<td>MIDC</td>
<td>Maharashtra Industrial Development Corporation</td>
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<td>MTPA</td>
<td>Maharashtra Town Planning Act</td>
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<tr>
<td>MTP (Rly)</td>
<td>Metropolitan Transport Project (Railways)</td>
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<td>NH</td>
<td>National Highway</td>
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<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
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<td>ORG</td>
<td>Operational Research Group</td>
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<td>PCU</td>
<td>Passenger Car Units</td>
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<td>Southern Business Area</td>
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<td>SI</td>
<td>Salsette Island</td>
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<tr>
<td>SICOM</td>
<td>State Industrial and Investment Corporation of Maharashtra</td>
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<td>Sardar Vallabhai Patel Road</td>
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<td>TSM</td>
<td>Transport Systems Management</td>
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<tr>
<td>TRRL</td>
<td>Transport and Road Research Laboratory</td>
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<tr>
<td>UTP</td>
<td>Urban Transport Problem</td>
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<tr>
<td>VRC</td>
<td>Vashi Residential Complex</td>
</tr>
<tr>
<td>VT</td>
<td>Victoria Terminus</td>
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<td>W. E. H.</td>
<td>Western Express Highway</td>
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Rs. 16.00 = £1.00
One lakh = 100,000
One Crore = 10 million
CHAPTER ONE

URBAN TRANSPORT PROBLEMS
A GLOBAL PHENOMENON
It has been said that man created cities to avoid transport (Dyckman, 1975, 197). Today's cities, however, cannot function without efficient transport arteries for the movement of people and goods. Transport may be viewed as a mechanism for overcoming distance but Thomson (1977) rightly pointed out that while transport requirements are diminished in volume by agglomeration, the penalty is that transport demand is concentrated spatially.

Transport networks are now dominant features of the urban landscape, they are the backbone of movement. Transport is an important and integral part of the physiology of a city, providing it with cohesiveness and giving each city an individually distinct form. Transport networks consist of a given set of specific locations (nodes) that are linked together by a number of routes. The characteristics of the network tend to determine the kind of impact it will have upon the area it serves (Hay, 1972).

Travel within urban areas rarely takes place for its own sake. It is not an end in itself but rather a means to broader ends. The efficiency of any city is greatly dependent upon the efficiency of its transport system which provides the vital links enabling spatially segregated but functionally interdependent activities in the urban area to function properly (Mitchell and Rapkin, 1954).

Since urban activities depend on mutual ease of accessibility, it becomes essential that transport facilities which link them be efficient. People make journeys in order to undertake specific activities and this is in relation to the land use and transport facilities available.

Adequate transport then, is a necessary adjunct to the proper functioning of the city and for satisfying the demands of the individuals within it. In many large cities in the developed countries urban and industrial growth has been intimately related to the provision of transport facilities (e.g. Chicago,
London) and to a considerable degree has allowed the achievement of wider economic and social objectives (Srivastava, 1963). While urban areas grow in response to transport development, their combined growth depends on constant transport improvements. A transport system has varied functions to serve since it has to cater for a multitude of individual demands. The prime objective is, however, to meet the needs of the city dwellers and so contribute to the socio-economic life of the city itself. The value of a transport system is commonly expressed in terms of the accessibility it offers within its area of operation. This is one theme that emerges consistently from the literature (Freeman, 1970; Jones, 1975; Patankar, 1978; McNeill, 1979, 30). Accessibility is an important attribute of place and a function of transport and it can be defined as being 'the ease and convenience with which a given location can be reached from other points'. Transport promotes spatial interaction by simultaneously accommodating a number of diverse trips. The functions of transport can be classified according to the different types of demands that need to be satisfied (Hutchinson, 1970, 284; Meyer, 1965). The three basic functions of urban passenger transport are:

1. Line haul movement
2. Residential collection and distribution
3. Downtown collection and distribution

The entire city transport network is then a system which collects and distributes intra-city traffic of all types. In any urban area the sum total of movements will be vast and the proper functioning of the transport system is, therefore, of paramount importance. Usually, a high proportion of the movements are concentrated at peak periods on the radial line-haul routes, and so dominant is this, that it is often perceived as the entirety of the urban transport problem. However, Meyer (1965) is careful to point out that this is an over simplification since the other functions are just as important and account for many of the visible transport problems in urban areas.
The transport modes that serve the various functions will be different. The line-haul function of transport has to be provided by high capacity modes such as railways and tramways. The residential and downtown collection and distribution can be provided adequately with more flexible lower capacity modes. A transport system will therefore comprise several elements and modes and the real problem is the identification of the most suitable mix to satisfy the particular demand conditions in any urban area. An interrelationship exists between different transport modes and urban land use patterns.

Any understanding of the transport problems of the city must be based on an appreciation of this complex interrelationship. This will clearly differ from city to city as each city will have unique conditions and sets of interrelationship and therefore, transport problems.
1.2 TRANSPORT TECHNOLOGY AND LAND USE

Land use not only has a direct impact on transport demand but is itself affected in various indirect ways by changes in the transport network. Land use, directions of growth and the density and distribution of population are all strongly influenced by the form and character of transport available.

The transport system of today has evolved over a long period of time in response to social, economic and technical changes. Transport development greatly influences the pace and direction of urban growth. Each innovation in transport technology tends to alter the urban structure, transport costs, location significance of areas and as a result changes the overall location pattern of activities. Empirical confirmation of this can be illustrated by the contrasts in city structures between the older historical centres and the modern 20th century cities. The urban form of the older cities are by and large a function of past modes of travel. This is in contrast with the cities of the western seaboard of the United States where the whole-hearted adoption of the motor car has significantly influenced the land use pattern. Each mode of transport has its own individual characteristics and in turn will mould the city structure differently. The different levels of accessibility provided by each transport mode have a dramatic effect upon urban development and urban form. Schaeffer et al. (1975) and Daniels et al. (1980) identify the impact of different transport technologies on the city structure. Schaeffer and Solar (1975) classify cities according to their predominant transport modes.

They noted that the fundamental characteristic of the "walking city" is the concentration of a large number of people in a comparatively small area creating a very dense concentration of activities. The lateral growth of the city was only as far as man could travel on foot. The daily field of man's activities was therefore very limited. The tendency was for the city to develop concentrically if geographical conditions permitted. The city was for all practical purposes very compact and condensed as urban design was based upon the need to reduce
travel. Spatial and functional differentiation was not surprisingly, of a rudimentary kind.

With the use of mechanical modes, man's daily activity field increased considerably. The use of transport modes other than walking has made many independent of the limited geographical space which the walk mode by itself made available. Development of mechanised transport has substantially influenced the urban growth and pattern of urban concentration. The spatial dimension of the city was extended and the functional relationship within it changed considerably. The significant impact that 'tracked transport' (tram and electrified railway) has had on urban form is that it expanded the city's catchment area much wider than had previously been possible and encouraged the growth of suburbs. Its influence, however, is constricted to lineal-type development having its most important influence at stations along its radial lines. The inherent inflexibility of the railway introduced considerable coherence in expansion and regularity into movement patterns. Railways allowed for the centralization of activity and enhanced priority of CBD as the point of highest accessibility while employment centralized, housing spread out along the transport routes, especially around the rail heads.

According to Foley (1972), the most discernible characteristic of the "rubber city", the city of the motor car has been the dispersal and decentralization of activities. The motor car has exerted a radically centrifugal effect on the land use patterns and densities in metropolitan areas. The impact of this mode is best illustrated by North American cities (e.g. Dallas, Los Angeles).

While higher speed railways have progressively pushed the city outwards along radial lines, the motor cars have been able to 'fill the space' between the railway lines and between railheads. By changing the land use patterns, road and rail transport systems are directly related to the physical and environmental structure of the city. As the transport system evolves it has
a marked impact on regional development as additional linkages in the transport network bring about accompanying changes in the mosaic of land use. Many factors determine the present land use and structure of urban areas and the directions in which lateral expansion has and can take place. Geographical conditions of an area can be major obstacles or stimuli to growth and development and city structure is, therefore, in part dependent upon the geographical and physical features of the city space. The relative importance of topographical constraints depends on the means available and cost of overcoming the problems they impose. The existing city patterns strongly affect what can and should be done in the way of future expansion of the urban fabric and also the transport network that binds it together. Although the changes in transport technology and the influences they have on demand patterns go some way towards providing an understanding of cities and their transport problems, these factors do not in themselves explain completely changes in the pattern and volume of urban travel and the associated problems that have arisen. The physical and socio-economic environment in which traffic arises, that is, the developmental context, is also important. Rapid urbanization causes land uses to undergo profound changes. In spatial terms, such changes are manifest in increased density, rapid development and a frenzy of building activity. This is typical of what is occurring in primate cities of the third world. The characteristics of rapid urbanization and its impact on transport will be the topic of the following section.
1.3 URBAN GROWTH

At the present time, third world cities are characterized by high rates of population growth and even higher rates of urban population increase. Although LDCs are not yet highly urbanized (25%) compared with the developed countries (65%), because of the absolute numbers involved the totals living in urban areas are about equal. However, such is their rate of urbanization, the LDCs will contain an increasing majority of the world's urban population and this study is concerned with one of these rapidly growing urban areas, Bombay.

It is impossible to define an unique set of conditions characterizing all LDCs, as there are important differences among them. The salient characteristics of resource-poor LDCs are:

1. Per capita GNP less than US.$100.00
2. Dearth of physical and social infrastructure due to the limited resources
3. Population and economic activity is gravitating towards the primate cities
4. Large number of poor inhabitants for whom walking is often the only possible means of transport (Israney, 1971, Ch. 1).

Rapid population growth and urbanization in LDC result in a dynamic demand situation which creates problems in infrastructure provision and particularly for transport. This sets LDCs apart from cities of advanced economies especially in the field of transport. Urban growth rates have been so high that LDC cities have doubled and even tripled their population within a decade or less. Lagos, for example, has experienced a 7.9% per annum increase in population growth over the last two decades, Seoul 8.5% and Bogota 7.3%. In direct contrast, London's population has decreased by 0.7% and Washington by 0.1%.

The circular cumulative causation process that encourages concentration of people and activity appear to operate with unprecedented strength (Myrdal, 1966). Spatial concentration
of population is remarkably high. Bombay, the city with
which this study is primarily concerned, has 13.1% of
Maharashtra State's population and 39% of its urban population.
Cairo accounts for 25% of Egypt's population. Mexico City,
Sao Paulo, Bangkok and Calcutta all show similar primacy and
hegemony within their respective country and/or region. The
operation of 'push' and 'pull' factors possibly of about
equal force in India (Trivedi, 1976) gives rise to rural-urban
migration and also urban-urban migration. This latter
accelerates the stagnancy and decline of smaller towns.
Bhargava (1981, 7) illustrates that in the case of India,
urbanization is biased heavily in favour of a few large cities.
The population living in the large cities, class I, rose from
22.1% in 1901 to 48.9% in 1971. This is in contrast to the
small towns, class IV - VI, whose share of population declined
from 49.6% in 1901 to 19.3% in 1971. The large cities have
the greatest attractive forces and this is compounded by the
'snow-balling effect'. The significance of this type of rapid
urbanisation is that, it is one of the principal factors
underlying the multitude of problems faced by LDC cities today.
Immature urbanization without simultaneous provision of adequate
social and economic infrastructure causes severe strain on the
existing infrastructure and deterioration of the environment.
The larger the city the more severe the problems created for
transport, housing and social provision. There is, therefore,
a vicious circle because the larger the city, the more people
it attracts, which in turn leads to deterioration of city
services and the need for more funds to alleviate the problems.
While there is little empirical evidence to show at exactly
what city size diseconomies set in, there is enough evidence
to suggest that as primate cities grow their capacity to provide
for all types of services becomes severely over-strained. The
sheer scale of the city can destroy the very efficiency they
are meant to sustain because over-concentration and crowding
create its own set of problems of physical deterioration. The
level of social and economic infrastructure provision is often
very poor and in many LDC

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cities has not kept pace with the growth and demand. In recent
years many large cities in the LDCs have become characterized
by their lack of civic services and their inability to cope with
the problems of rapid growth.

Bhargava (1981) vividly illustrates the path along which such
cities are moving when he notes 'Urban momentum continues to
transform towns into cities, cities into megalopolises and
all of them eventually into slums'. The mal-effects of rapid
urbanization cannot be remedied if the process of spatial and
structural concentration of people and activities continues
unabated. The pressures of increased urbanization are well
reflected in transport. In LDCs expansion of the urban areas,
especially in terms of population and aggregate demand has been
far ahead of transport provision. Owen (1956) concludes that
metropolitan cities have grown to a point where they threaten
to strangle the transportation that made them possible.

In this sense, it is an universal problem affecting cities
with long histories or urban creations of the 20th century and
irrespective of the transport modes on which they are based.
However, a case can be made that the problems are especially
acute in the primate cities of the LDCs.
Urban transport problems (UTP) are by no means a new phenomena. They have been in existence ever since man created cities (Dykman, 1965; Thomson, 1977; Daniels and Warnes, 1980). The concept of the urban transport problem first emerged in the early 1950s and until the mid 1960s was perceived almost exclusively as one of road congestion and the solution was seen to be the ability to accommodate the ever increasing number of road vehicles (Altshuler, 1979).

Historically, transport planning has proceeded by adopting the view that transport problems can be treated without considering the non-transport aspects of the urban environment. There has been an over-representation of the transport element in what is basically a complex land use and transport problem, with land use being an equally important contributor to the problems since land use gives rise to traffic flows. The two cannot be isolated and they must be treated as an interdependent whole.

Needham (1977, 145) concludes that 'It is disturbing that the study of the interaction between traffic and land use is so imbalanced. Theories of traffic are so well developed and transport theories of land use so badly developed'. In the early 1970s a common viewpoint was that the transport problem was in fact a complex set of problems and that congestion was only one aspect of it. OECD (1969) pointed out that the complexity of the transport problem can be seen from the fact that any new space created brings about an influx of vehicles and neutralizes the augmented capacity.

The transport problem has been perceived in different ways and there have been changing ideas about how to cope with the problems involved (Freeman, 1970; Bosse, 1974; Dickey, 1975). There is no single clear cut definition of what constitutes the urban transport problem. The term itself is very ill-defined because it means different things to different people in different professions. Characteristics of the urban transport problems have been presented in engineering and economic terms.
The Urban Transport Problem

Fig 1.1

Accidents
Peak-hour crowding on public transport

Parking difficulties

THE URBAN TRANSPORT PROBLEM

Environmental impact

Difficulties for pedestrians

Traffic engineers have been the most influential group in urban transport planning and this has particularly been the case in the LDCs. Their chief concern is to eliminate traffic congestion, thereby, improving vehicle flow and in turn reducing travel time and cost. Their pre-occupation is with 'link-efficiency' at the cost of 'activity efficiency'. Dimitriou (1971) claims that this school of thought has neglected totally the root cause of the urban transport problem. Operational efficiency of transport links have been emphasised at the expense of land use development efficiency.

Transport economists on the other hand are typically concerned with the economic costs and benefits of a transport system. It is more often than not their advice which is weighed heaviest when final decisions are made in the transport sector.

None of the above-mentioned groups nor their operational paradigms have indicated any real appreciation of the fact that traffic and its characteristics are more a reflection of wider development issues. Attention should be focussed on person accessibility involving land use planning rather than the contemporary approach which focus on vehicular mobility. What has been neglected is the very purpose of the function of transport to provide access. OECD (1977) states that 'There is every indication that the present transport goals and standards have produced a system providing increased mobility but failing to provide increased access to opportunities'.

Schaeffer and Sclar (1975, 171) note that the problem of modern urban transport is not only congestion or speed but also access, while McNeill (1977, 2) emphasises the fact that traffic congestion and over-crowded vehicles are only symptoms of a more basic problem - lack of access. Prime emphasis has to be placed on needs of the people and their access to the services they require.

Thomson (1977) gives the most comprehensive definition of what the urban transport problem comprises (Fig. 1.1). He identifies the urban transport problem as being seven sided and he notes
that all cities suffer from these irrespective of whether the cities are in the developed or developing countries.

1. **Traffic Congestion**

Traffic congestion and the delay one vehicle causes another is one of the most popularly quoted of all the transport problems. This may be due to the fact that it is the most discernible of all. The alarming feature of this problem, Thomson notes is the way congestion now tends to spread widely over the built-up area causing overcrowded arteries in the central area.

2. **Accidents**

Road accidents whether involving vehicles or pedestrians and vehicles constitute one of the major problems of our time. This is particularly a problem in areas with high density development and therefore large pedestrian volumes. Thomson (1977, 27) found that the highest incidence of death occurs not surprisingly in those cities with the highest rate of car ownership. Nevertheless, the death rate rises much less than proportionately with the rate of car ownership, indicating that use of the car is much safer in cities with high car ownership than low car ownership.

3. **Peak-hour crowding on Public Transport**

It is characteristic of any city that use of public transport facilities is concentrated in the peak periods. Despite the high levels of frequency, inability to board vehicles due to overcrowded conditions means lengthy delays and longer trip times.

4. **Public Transport - Off-peak**

A direct repercussion of the former problem is the off-peak problem. In large cities, the fluctuations in the demand for services causes a growing gulf between peak and off-peak use of public transport. This is with the exception of large LDC cities which are not as heavily afflicted with the off-peak problem as they are with the peak problem, simply because of the sheer magnitude of users the off-peak demand remains high.
5. Pedestrians
The lack of adequate pedestrian facilities for movement despite the fact that walking account for many of the short and medium distance movements is because pedestrians have for long been neglected in transport studies. However, the increase in the volume of vehicles has made pedestrian movement increasingly difficult with the result that more attention is now being paid to this very crucial problem.

6. Environmental Impact
The increase in vehicular volumes on the road network and the consequent air and noise pollution it causes, has led groups of concerned individuals to look into the hazardous results of continued increase in vehicles. This awareness has given rise to an 'Environmental Impact Assessment' of any road that is to be built in DC cities.

7. Parking
Parking problems have been multiplied because of the increase in the number of cars and the simultaneous decrease in the number of parking space with no new parking space created. This is further complicated by the difficulty of enforcing parking regulations and charges especially in LDC cities.

The causes of these problems are, however, different both in character and relative importance. For example, congestion is seen to afflict all large cities but in North American cities it is the abundance of private cars that provides the principal cause whereas in resource-poor cities of the developing world (to distinguish them from the resource-rich oil producing countries) with low car ownership levels, the urban transport problem is possibly more complicated.

In the cities of the developed world the problem is effectively one of how to wean the motorist away from their cars and to attract them to using public transport facilities, where patronage is declining. In contrast LDC cities have the problem of trying to satisfy an insatiable demand for public transport. At the outset, Thomson (1977) says rightly that one may be tempted to conclude that given the low levels of car ownership,
the high population density and the great dependence of the population on public transport facilities, these cities should not be facing severe transport problems. In fact, the scale of the problems being faced by large cities of the developing world is vast and they are least able both financially and physically to cope with them. The heavy reliance on public transport, the use of a variety of informal, non-motorized means of movement and inadequate resources to keep up with demand leads to problems of a scale and complexity unknown in most cities in advanced economies. Owen (1973) emphasizes the point that 'cities suffer from traffic congestion with or without automobiles and the reasons lie beyond the technology of transport. It lies in unplanned cities' (Bayliss, 1981).

Banjo and Dimitriou (1980) describe lucidly the evolution of transport problems in LDC cities. Their research shows that LDC cities have passed the first generation (colonial) and second generation (post-colonial) transport problems. They note that the first generation problems included the separate development of the colonial and indigenous areas, each with its own transport modes. This gave way to the causes of the second generation problems which were characterized by declining economic resources and marked deterioration of the city's transport network as the number of trips within the urban area increased. Today, the third world cities have reached what Banjo and Dimitriou call the third generation of transport problems which are characterized by increased travel demand both quantitatively and spatially with resultant pressure on the urban form and infrastructure. This they emphasize has been compounded by the relaxation of land use controls, traffic regulation and parking restrictions. The formalized approach to solving the transport problems has by and large been through the urban transport planning process. Since its birth in the 1950s in the U.S., the transport planning process has been the most respectable method by which the problems have been tackled. This process was favoured for
its scientific approach with modelling based on extrapolated demand.

The shortcomings of this demand oriented approach are now being realized as traffic congestion has in many places remained largely unrelieved. Mere addition to road mileage does not necessarily offer any prospect of relief in view of the ever increasing demands (Adams, 1981). The demand argument itself ignores the total situation. Growing disillusionment with this approach has occurred, especially with its application in LDC cities, as it has clearly failed to solve the urban transport problem. A number of researchers (Brenikav, 1969; Viola, 1976; Grakenheimer, 1976; Banjo, et al, 1980) have examined conventional transport planning techniques and conclude that it leaves much to be desired.

As far as the LDC cities are concerned the conventional planning methods do not take into account the special local characteristics of the area (Adams, 1981). Although the approach is claimed to be unbiased, there is evidence to suggest that it has always been in favour of road building to facilitate the motor car. Wilbur Smiths Report for Bombay in 1963 is a case in point. The consultants recommended the construction of freeways and flyovers crisscrossing the city. This was justified in view of the fact that car ownership levels could be expected to rise and so demand in terms of road capacity should be met. This would seem to be conspicuously inappropriate for a city which has well over 80% of its inhabitants dependent on public transport. The approach clearly neglects the reality of the third world city.

Any strategy that is adopted has to be related to the available resources at hand (Joshi, 1967, Patankar, 1966, 1967). Wiransinghe (1981) points out that to try to solve the transport problem of any city cannot easily be done because 'transport problems are an amalgamation of social, economic, technical and political problems'.

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The need to reorientate our approach toward urban transport problems is more apparent now than ever before as the problems are clearly not being solved by the existing strategies and in many cases the scale of the problem is on the increase and even reaching crisis level. The larger the urban area the greater the diversity of movements because of their variety and spatial complexity of land use and larger movements of people that are generated.

This research, therefore, attempts to focus on transport problems faced by large LDCs and Bombay has been taken as a case study. The method by which the transport problems will be studied and the other hypotheses to be tested are outlined in the following section.
1.5 A CASE STUDY OF BOMBAY - RESEARCH METHODOLOGY

Urban transport problems have been studied extensively in DC cities using sophisticated computer models and simulations. Little attention has been paid to date, to the characteristics of the transport problems that are being faced by LDC cities. Transport studies by foreign consultants have been undertaken using 'western' models to justify highway construction, without any thought being paid to the socio-economic condition for which the plans were made (Chapter 1.4). These transport studies frequently have also been fragmented in their view and have failed to take the urban area as an integrated whole. Bombay illustrates well the limitations of such transport planning. In many ways Bombay would not ideally be representative of a third world city or even an Indian city. Its unusual physical characteristics have been a reason why it has not been studied extensively especially by academics. However, Bombay should be of much interest to third world urban transport Geography specialists as it possesses all the major characteristics of a third world city combined with the additional difficulty of geographical constraint. This provides a challenge in terms of urban spatial structure and adequate transport provision. The themes that will be addressed in this thesis are as follows:

1. Urban transport problems arise mainly due to the maldistribution of causally related activities in urban space.
2. Urban transport problems can only ultimately be overcome by full consideration of non-transport elements within the context of an integrated land use and transport system.
3. In addition to the normal problems associated with transport provision, LDC cities are faced with a very rapid increase in population and constrained by their limited resources.
4. In large LDC cities rail transport is the only mode that can cater adequately for a large number of travellers.

As far as Bombay is concerned, certain specific hypotheses may be advanced:
1. The physical and geographical constraints of the site are important factors in urban development and they have played a major role in contributing to the transport problems.

2. It is the spatial and structural imbalance in the distribution of activities and the unplanned land uses that is basic to the emergence of transport problems.

3. The concentration of tertiary and quaternary activities in a limited geographical area creates more transport related problems than concentration of industries.

In order to test these hypotheses, data was collected from appropriate organizations. These included the census office, Railway and Bus Authorities, appropriate departments in the Municipal office and the University of Bombay. The information so gathered made possible an examination of spatial and temporal aspects of transport demand. In addition, the population and employment distribution was analysed from secondary sources, namely, census data. Land use patterns in Greater Bombay were also analysed using information obtained from the Municipal offices. They also provided for a study of the plans and proposals regarding the traffic and development of Bombay.

Discussions were held with high ranking officials on the topic of transport problems of the city. These meetings proved to be educative, informative and stimulating. Many of the officials expressed their own concern, ideas and which directions they thought should be followed. These officials preferred not to be quoted by name. The overall attitude was, however, one of deep concern about the transport of the city especially by those actively involved in the operations.

Another dimension of the research was a questionnaire survey of user perception of urban transport problems in Bombay. The main objective of doing a survey of this kind was to elucidate commuters attitudes, opinions and perceptions of transport problems in their city.

The results, it was hoped, would help in providing guidelines for future planning and enable us to identify and understand the problems from the point of view of the commuter.
Since the journey-to-work is the most frequent and consistent of all trips undertaken, the questionnaires were directed at the daily commuter. The survey was undertaken at the work place in order to obtain a wide cross-section of the commuting public.

Prior to designing the questionnaire, there were a number of discussions with the Transport and Road Research Laboratory (TRRL) overseas unit. These meetings established the general subject areas around which questions could be developed. TRRL's vast knowledge and experience in the field of transport proved to be of tremendous help in designing the questionnaire. Nearly three quarters of the questionnaires were distributed in the CBD and the rest in the western suburbs. Many of the industrial estates in the eastern suburbs provide their own private transport for workers and since the questionnaire was aimed at perception of transport problems, it was felt that a bias in the results would have occurred due to the convenience of employer provided transport. Some of the industrial estates in the western suburbs also provide transport facilities and these industries were purposely avoided for the same reason. Similarly, railway and bus employees were omitted from the sample because (a) they are given free travel on the transport system and (b) a bias will result because of loyalty to their employer.

Selection of participants for the survey was done on a random basis taking into consideration the above restrictions. Questionnaires were distributed to Government and quasi-Government offices, private companies, industrial estates, entrepreneurs and service industry workers. Questionnaire distribution was restricted to literate English-speaking commuters mainly because of lack of manpower. The survey focussed on commuter perceptions of the quality of a variety of components of their city's transport system, specifically, buses, railways, pedestrian facilities and road traffic.

In the absence of a face-to-face interview, the presentation, organization and size of the questionnaire can be critical.
If too lengthy in terms of pages, respondents may react unfavourably however many questions there may actually be. The final questionnaire is set out in Appendix I.

Most of the questions were categorical, however, there were also a number of open ended questions. These gave respondents an opportunity to voice their opinions. The written answers were analysed carefully and incorporated into the final analysis.

Many of the questions were in the form of ranking the problems and perceived causes of them. This method of collecting the data was thought to be most suitable for three reasons.

1. The limited sample of commuters
2. With perception and attitude questions, ranking of answers provides a broader framework from which the answers can be analysed.
3. It also allows for flexibility within the rigid pre-coded responses in that, it enables those surveyed to judge the various options.

The questions were phrased as simply as possible and avoiding transport terminology so that the questions could be understood clearly. As for example 'pedestrian precincts' was substituted for 'Areas reserved for pedestrians only'. Also, instead of stating 'rank the following', 'Please number in order of importance' was used.

The phrasing of questions was amended following advice from researchers who have done field study in India as well as students from other LDCs. This was valuable because a researcher on his/her own often fails (however objective they try to be) to identify possible confusion in expression. What may be clear and lucid to the researcher may be differently interpreted by the respondent especially when the participants in the study live and work in a totally different cultural setting and where there are language differences.

Bearing in mind that third world dwellers are not as frequently confronted with questionnaires, unlike their North American and European counterparts, efforts were made to approach respondents
via an intermediary, usually, heads of departments in offices. These officers were briefed on the objectives of the survey and the questionnaire was fully explained to them. This was done so that in the event of any problems or confusion in filling out the questionnaire, it could be clarified by them. Respondents were also told that the information they gave would remain entirely anonymous and absolutely confidential, and that the data would be used solely for the purpose of individual academic research. An intermediary known to them was used so that any fear and reservation in stating their opinions frankly would be reduced. The questionnaire was administered using the drop-off/pick-up method. Past experience in questionnaire responses in Bombay have not been very encouraging. Bombay Municipal Corporation attempted to survey 50,000 Bombayites on local traffic problems. A very small percentage (2%) of the questionnaires were returned (Voorhees, 1980). In order to avoid such low returns and to obtain maximum yield, stringent check was kept on the number of questionnaires distributed. The offices approached were first asked if they would be willing to participate in the survey. This avoided the feeling of being compulsorily asked to fill out the questionnaire. This sampling method turned out to be successful. The total number of questionnaires distributed was 400 and 303 were returned. This gives a cooperation rate of 76%. The data was then checked and coded by the researcher onto computer coding sheets. Analysis of the data was made with the help of the University of London Computer Centre. It was felt that the SPSS programme provided the most appropriate basis for the organization and testing of data such as that provided by the survey.
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CHAPTER TWO

TRANSPORT DEVELOPMENT

CITY STRUCTURE AND LAND USE PATTERNS IN BOMBAY

The structure of the city is closely linked to historic, economic and geographic characteristics. In the early days of Bombay city, the city was a small village surrounded by unoccupied land. The city's growth was initially slow, but it began to develop rapidly after the Chhatrapati Shivaji Manual Plan was adopted in 1878.

During the period of British colonial rule, Bombay was made a major railway depot in India to coordinate the activities of British industries (1873 and 1874-1875). The conurbation of the western area, restricted from development into a major part of the province, became the financial and industrial center of the city.

The evolution of the city and its transport network has been largely directed by the characteristics of the city and its historic role. Economic and administrative (1880-1890) and demographic growth have all contributed to the realization of the islands' development and the development of the railway line through successive time periods.

The growth and development of Bombay is intricately linked up with the development of the national railway network. The role of the railways in the initial growth of Bombay was of paramount importance. They have played a crucial role in the city's development and have continued dominating economic development in the city. The network, which was first conceptualized in 1873, has steadily expanded and has continued development in communication. Infrastructure development was initially focused around the financial and port areas in the southern.
The structure of Bombay city is a product of historical momentum and geographical characteristics. In the 17th century, Bombay was a small fishing village comprising seven islets lying off the mid-western coast of India at 18°-15' north and 72°-54' east (Gore, 1976).

During the period of British colonial rule, Bombay was chosen as a western outpost in India to promote the interests of British industry (Noble and Dutt, 1978, 317). The advantages of the natural harbour favoured its development into a major port in Asian-European trade. The islands were eventually connected by raised causeways and bridges and by the end of the 19th century, they were converted into a promontory of solid land by the process of land reclamation. Present day Bombay Island is a long thin peninsular measuring 17 km in length and 5 km at its maximum width. The island is flanked on both its east and west sides by two longitudinal ridges and the central area is flat and low-lying. The island site is physically constrained by the Arabian Sea on the west and south and by Thana Creek on the east (Fig. 2.1).

The evolution of the city and its transport network has been largely dictated by characteristics of the site and by the colonial history. Deshpande and Arunachalam (1981, 187-192) give a comprehensive account of the reclamation of the islands and development of the reclaimed land through successive time periods.

The growth and development of Bombay is inextricably bound up with the development of the suburban railway network. The role of the railways in the initial growth of Bombay was of paramount importance. They have played a dynamic role and have acted as a catalyst in bringing about development in the city region. Edwardes (1902, 304) confirms this by stating that, 'Increase in population recorded in 1882 was assured by the continued improvement in communication'. Urban development was initially focussed around the factory-cum-fort area at the southern...
RAILWAY NETWORK IN THE BOMBAY METROPOLITAN REGION

Legend:
- Quadruple line Rly.
- Double line Rly.
- Single line Rly.

Source: BMRDA, Transport and Communications Statistics for BMR, 1981
extremity of the peninsular and around the port area on its south-east side.

The first suburban railway line from Victoria Terminus (V.T.) in the Port area to Mahim, 13 km to the north, was proposed in May 1849 for the opening up and development of Mahim village. The Great Indian Peninsular Railway (G.I.P. Rly.) opened the line in April 1853. This was the first railway line ever constructed in India. The only intervening station en route was Byculla. At the same time, another railway line from V.T. to Thane was also opened. This line had three stations en route, namely, Byculla, Sion and Bhandup. By 1854, the V.T. - Mahim line had two more stations added, Dadar and Kurla because of residential development under the Improvement Trust scheme. This railway line was extended as far as Khapoli on the mainland. The railway enabled the island city to wield influence in regions far beyond its immediate limits.

It was the availability of transport facilities that contributed to the initial concentration of textiles mills in areas that were then on the outskirts of the city but are now in the central part of Bombay Island. As the cotton trade increased and the textile industry expanded in the 1860s, extra demand pressured the railways to develop further and provide more services. While the G.I.P. Rly. was serving the eastern portion of the city, the western portion was not served by the railway until April 1867, when the Bombay-Baroda and Central Indian Railway (B.B.& C.I. Rly.) inaugurated its first suburban service from Grant Road to Virar. This section initially had three intervening stations, namely, Mahim, Bandra and Bassein Road. In September 1868, the railway line was extended further south to Charni Road. Eduardes (1902, 271) notes the value of the railway in fostering the growth of Bombay and as the railway network evolved it had a marked impact on the area which it traversed. The towns and villages that existed along the railway corridors provided the initial cores for suburban development. Rajagopalan (1962) notes that they formed the nuclei around which urban development burgeoned. Subsequent
growth of the city engulfed these independent entities and they have now been fused into being dormitory suburbs of Bombay. The influence of the railways in inducing suburbanization was apparent and as a consequence a new spatial organization emerged. Deshpande (1980, 9) illustrated this by showing that the peri-urban villages along the railways have had urbanization thrust upon them. Industries continued to expand in the central area of Bombay Island around Dadar, Parel and Mahalaxmi and the first suburbs of Bombay at Hatungka and Sion were being developed on the reclaimed marshes for housing the middle and low income migrants.

In June 1869, the E.E. & O.I. Rly. opened up two more stations, namely, Dadar and Parel, as both population and industrial employment was increasing rapidly in the vicinity of these two places. The railway line was extended further south to Marine Lines; however, there was constant pressure to extend the line into the Port area and so in January 1870, Churchgate became the southern terminus. Suburban travel was becoming popular by this time and industrial workers came into Bombay from as far as Bassein, Virar and Thana. It was not only passenger traffic that was rising steadily but also freight traffic comprising fish, fruit and vegetables.

By 1878, new stations on the G.I.P. Rly. were being opened up (Masjid, Chinchpokli, Parel, Ghatkopar and Diva) and on the E.E. & O.I. Rly. Mahalaxmi and Santa Cruz stations were added. (Arora, undated). With the increasing access provided by the rail network, the pressure for development of the area was evident in the numerous activities and alterations which were taking place. Parel metamorphosed into a hive of industry.

By 1880, the V.T.-Kalyan section of G.I.P. Rly. was opened for suburban travel with the 'local trains' stopping at Byculla and Thana. The habit of living in the country and commuting daily into the city was becoming common. Demand for rail services gradually increased and by 1888 nearly 10 million passengers were using the E.E. & O.I. Rly (Seminar, 1980, 6).
By 1893 the entire suburban section of the line was double tracked. Traffic on the other railway line also expanded greatly. The daily suburban commuters increased twenty times at Dadar and nine times at Sion during the 1888-1898 decade (Arora, undated). Industries too were expanding around Chinchpokli and Currey Road stations in the east.

By the turn of the century, the population of Bombay reached 0.9 million (Fig. 2.2). Although the growth rates prior to 1941 were slow, suburban travel had become an essential part of Bombay life. Due to the problems being faced in providing adequate suburban services, both railway companies in 1904 agreed to the electrification of the lines (Seminar, 1980). In 1925, the V.T.-Thana section was electrified and this marked a new beginning in the development and expansion of Bombay as the railways could now provide a more efficient, reliable and regular service. By 1928, sections between Churchgate and Borivli on the B.B. & C.I. Rly. and Thane-Kalyan on the G.I.P. Rly. were also electrified. New stations had also been opened up as demand warranted. In 1907, Nautana Road, Vile Parle, Islaad and Elphinstone Road stations were opened along the Churchgate-Borivli sections. The large residential developments at these access points brought considerable traffic to the railways. Suburban development was more pronounced on the west coast along the B.B. & C.I. Rly. than in the east, which had a higher concentration of industrial development.

In 1912, a campaign was launched by the G.I.P. Rly. in conjunction with the local Government to encourage people to migrate to and reside in the suburbs. This led to the emergence of new work-trip patterns. The campaign to 'live around King's Circle Garden', (Arora, undated, 9) is evidence that the railways were as much involved in the development of the fringe areas beyond Bombay Island as was the municipality.

In March 1913, quadrupling of railway track from V.T.-Thana started and at the same time extra corridors from Thana to Kalyan were being constructed. The local Government in December 1920, after careful scrutiny of the Bombay development scheme outlined by the Improvement Trust, advised the railways to alter their services to provide the
Population trends in Greater Bombay

**Fig. 2.2**

**LEGEND**
- Bombay Island
- Inner Suburbs
- Extended Suburbs

**Source:** Based on BMC, Development Plan for Greater Bombay 1964
Census Data 1971, 1981
characteristics of a rapid transit system in order to ease the problems of overcrowding. The local Government also had plans to develop Sewree, Coliwada, Vadala, Trombay and Dharavi along the G.I.P. Rly. There is no doubt that the success of these housing developments in the north were made possible by the provision of efficient means of transport. Kurla had become by this time a busy railway terminus and was transforming into a great industrial area.

By 1921, the population of Bombay had increased to 1.2 million (Fig. 2.2) and the G.I.P. Rly. had increased its suburban services by over 60% (Arora, undated, 11), but the problem of overcrowding could not be solved. In February 1924, the G.I.P. Rly. completed the railway line from Kurla to Chembur in Trombay, to open up still more residential areas potentially dormitory settlements to the city. As each new station opened, suburban expansion took place around it. A further extension of the railway south-east to Nanavir was completed in July 1927. This section of the railway, known as the harbour branch line, had attracted a large number of passengers due to the residential/industrial nature of the area. Electrification of this line was completed in 1951. The B.B. & C.I. Rly. also joined in with the local Government in a 'live in the suburbs' campaign. There were over thirteen town planning schemes under way between Bandra and Borivli for the development of new residential areas. Shivaji Park and Mahim schemes of the late 1930s and the Khar model of the 1940s provided accommodation for the rapidly growing population. Khar Road station was opened up to help with the town planning scheme. Those who settled up north and bought land were given free travel on the railway for a year. The heavy peak hour traffic induced the railway company in 1936 to electrify the Borivli-Virar section as a result of which the traffic increased by 33% within the year.

Several stations, Thakurli, Donbivli, Numbra, Lalund and Vikhorli further north-east were added to the G.I.P. Rly. with the subsequent effect of rapid urban development in the vicinity of the railheads.

Although this synopsis of the development of railways and its impact on Bombay has mainly concerned itself with passenger traffic, freight traffic on the suburban services was increasing as well. It was noted
that in 1929, over 600 'milkmen' arrived daily at Dadar and other stations in Bombay south along with vegetable and fruit vendors from Vile Parle, Andheri, Borivli, Bhayander, Bandra Road, Nala Sopara and Virar (Arora, undated, 12).

Most of the population growth took place on Bombay Island prior to 1931 after which the suburbs contained most of the population expansion. After 1947, post-independence suburban growth was phenomenal. It seems as if Bombay Island had reached its peak in attracting migrants. The percentage growth rate on the island since 1951 has been steadily decreasing from its peak in the decade 1941-51 of 56.3% to 6.1% in the decade 1971-81 (Table 2.1). In contrast the suburbs have had high percentage growth rates with a peak of nearly 150% for the inner suburbs in 1971-81 (Table 2.1). Johnson (1979, 190) calculated that between 1961-71 the population of Salsette Island grew 110%, while the population on Bombay Island increased 11%. Suburban development has therefore been extremely rapid and has been aided primarily by the provision of rail transport. The Operational Research Group (1972, 4) observed that employment also grew rapidly from an average increase of 16,000 jobs per year between 1941-51 to 27,000 jobs per year between 1951-71. Commercial and financial organizations developed to facilitate international trade.

The spill-over of population into the new areas of Salsette Island has been insufficient to relieve the pressure on Bombay Island. The 'extended' suburbs have also had high growth rates with a peak of 121.4% during the 1951-61 decade. In the 1971-81 decade, however, they registered the most growth of all areas registering an increase of 97.3%.

The population of Greater Bombay doubled between 1951-71 and increased nearly 1.3 times in the last decade. The population grew by 38.7% between 1951-61, by 43.9% between 1961-71 and by 37.8% in the last decade. Although the rate of growth is decreasing, in terms of absolute numbers, the growth is still very substantial.

In 1941, Bombay could genuinely claim to be the 'Urbs Prima in India'. Greater Bombay then had a population of 1.8 million and Bombay Island, 1.5 million. Today, 3.3 million people are crammed
## Table 2.1

**Decennial Percentage Growth Rates In Greater Bombay from 1901 to 1981**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Bombay City (%)</th>
<th>Inner Suburbs (%)</th>
<th>Extended Suburbs (%)</th>
<th>Total for Greater Bombay (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901 - 1911&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.2</td>
<td>14.8</td>
<td>8.4</td>
<td>23.8</td>
</tr>
<tr>
<td>1911 - 1921&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.1</td>
<td>44.1</td>
<td>-1.1</td>
<td>20.2</td>
</tr>
<tr>
<td>1921 - 1931&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-1.2</td>
<td>19.4</td>
<td>10.4</td>
<td>1.3</td>
</tr>
<tr>
<td>1931 - 1941&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.3</td>
<td>45.5</td>
<td>11.4</td>
<td>28.9</td>
</tr>
<tr>
<td>1941 - 1951&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.3</td>
<td>148.6</td>
<td>46.1</td>
<td>66.2</td>
</tr>
<tr>
<td>1951 - 1961&lt;sup&gt;b&lt;/sup&gt;</td>
<td>19.0</td>
<td>103.2</td>
<td>121.4</td>
<td>38.7</td>
</tr>
<tr>
<td>1961 - 1971&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.8</td>
<td>108.8</td>
<td>113.5</td>
<td>43.8</td>
</tr>
<tr>
<td>1971 - 1981&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.1</td>
<td>62.6</td>
<td>97.3</td>
<td>37.8</td>
</tr>
</tbody>
</table>

**Based on:**

**Source:**


b. Census of India, Maharashtra Series, Housing and Population Totals, paper-7, 1981 supplement
into the small island area. According to the Bombay Development Plan (1964), the maximum realistic capacity of Bombay Island is 1.5 million on its 26 sq. miles.

Since independence in 1947, Bombay has tripled its total population and a figure of 7 millions was expected to be reached in 1981 but was in fact achieved five years earlier.

Prior to 1950, jurisdiction of the Bombay Municipal Corporation (B.M.C.) extended as far as Mahim Creek. The spurt of industrial activity and commerce accompanied by the steep population increase after independence pressured the B.M.C. into extending the city limits (Fig. 2.3). In 1950 the B.M.C. limit was extended as far as Bhandup on the Central Railway (C.R.) and Jogeshwari on the Western Railway (W.R.). In February 1957, the municipal limits were further extended to Mulund on the C.R. and Dahisar on the W.R.

Geographical, geological and man-made features may prove to be either obstacles or stimuli in the expansion of a city. Bombay was unable by virtue of its site to expand in all directions. Edwardes (1902, 255) commented on the fact that Bombay possesses great advantages but these are counterbalanced by a serious inconvenience, that of the limited extent of the Island. Expansion possibilities for Bombay are severely restricted due to its insular nature. Thana Creek, Bombay harbour, Bassein Creek and the Arabian Sea have been and will continue to be restrictive to the lateral expansion of Bombay. The annexing of Salsette Island to the immediate north of Bombay Island in 1950, instead of curing the problems of a rapidly growing city, intensified the existing ones and created others. Rajagopalan (1962, 39) noted that 'the suburban phenomena are essentially a manifestation of the way in which a city tends to react to the spatial problems confronting it'. This is very true, but rather than giving the benefits of relief to the city, the continuous expansion northwards created many problems and difficulties which are becoming apparent now. Further extension of the city limits in 1957 to include most of Salsette Island further elongated the north-south administrative area. Correa (1965, 34) vividly described this situation when they wrote that the growth has stretched the north-south pattern to such an extent that 'like a
Directions of urban sprawl in Bombay

Source: City Industrial Development Corporation, New Bombay - The Twin City
rubber band it is ready to snap'.

In the absence of proper land use planning, expansion of the urban area beyond the old city limits has taken place without consideration of the city's needs in the foreseeable future with regard to adequate transport provision.

Datta (1981, 39) pointed out that it was an attempt to extend the city's jurisdiction so that a single municipal corporation could cover the urban spillover. Extending the city boundary no doubt helped initially to relieve the pressure on the existing city, but this has not been adequate to discourage migration and arrest city growth, which has been without any policy of limitation. Deshpande (1980, 13) pointed out that the transformation of primary agricultural market centres like Panvel and roadside settlements such as Kharapoli along Pune and Goa highways is evidence of contemporary urban sprawl.

In many ways, Salsette Island represented a clean slate, an opportunity for providing an alternative to the cramped monotony and problems of Bombay Island. Unfortunately, it has not turned out that way and the development process has just reproduced all the problems of the earlier development and Salsette has become a victim of uncontrolled urban sprawl. The suburbs were formed by a sudden mushroom growth, without comprehensive land use planning. Growth has been both intensive, in terms of high density and extensive, in terms of lateral expansion. Although the municipal limits kept pace with the city's overall requirements for land area, the amorphous, haphazard and unplanned nature of the development has caused many problems far too complex to be resolved by any simple measures. Urban sprawl is no longer a western monopoly and occurs in LDC cities just as much, if not to a greater extent than in DC cities. The suburbanization process results from the dearth of land for expansion in the core areas.

The directions of city growth are closely related to the degree of accessibility provided by the transport network, as there is clearly a close relationship between the geography of urban expansion in Bombay and transport provision. The primary pattern is one of corridor development along the railway lines with high concentration
at rail heads. Railway use has been possible in Bombay because of the city's long, narrow configuration. The railway lines run parallel to the length of island and they have acted as the backbone for suburban development and expansion. Electrification of the railways further assisted in the northward expansion of the urban area by facilitating long distance commuting.

Although the rail network is very simple and not comprehensive in terms of connectivity when compared to London or New York, it has nevertheless been sufficient to serve as the basis of the city's growth and development. The railways inherent lack of flexibility did not act as a deterrent to the demand for rail transport. The phenomenal increase in patronage over the last two decades is shown in Fig. 2.4. The rapid increase is due to the extensive development of the suburbs. The traffic growth is rising at a rate of 8-10% per annum.

Fortunately, the railways were in existence before major developments in the city took place. The availability of surface railway lines which penetrate into the CBD has become a great boon to the transport of the city. There is little scope for the expansion of the railways within Bombay Island. This will no doubt limit their capacity to meet future demands because rapid growth of the suburbs is already putting serious strains on the railways. Perhaps even more important is that the lack of overall planned development of Bombay and its environs is making the task of supplying adequate transport an impossible task.

Having discussed the importance of railways in Bombay's growth and development it is now necessary to discuss the history and characteristics of the road network and its influence on the city's expansion.
Growth Of Suburban Traffic On Central and Western Railways.
2.2 **ROAD NETWORK**

The road network constitutes the framework of the city and is the product of evolutionary development. In Bombay, it has been strongly influenced by the insularity, lineation and topography of the Islands.

The road system can be classified as consisting of streets that serve local needs for access and circulation, and of routes used for travelling long distances between different parts of the city (Municipality of Greater Bombay, 1964, 131).

The layout of the arterial routes have been guided by several factors:

1. As a result of geographical features, which effectively make the city an elongated peninsular, the major arterials have, as in the case of the railways, tended to a north-south orientation, parallel to the city's longitudinal axis. East-West connections have been severely restricted due to the railway tracks and historical growth patterns. As a result, the north-south streets carry the burden of traffic. The narrow cross streets are inadequate as feeders and inefficient for access. Kahir and Thana creeks have acted as bottlenecks and hindered road communication with the suburbs.

2. Although roads have a great influence on the land use pattern by establishing the basic avenues of accessibility, land use also has a major influence on road development. This is clearly seen in the case of Bombay Island, where there is a convergence of several major routes in the CBD as opposed to the relatively sparse road development in the vicinity of Mahalaxmi. North of the business area, the principal corridors focus on the two causeways connecting with Salsette Island.

The history of road development dates back to the period of reclamation of the low-lying areas. In 1806, the British started road building on the newly reclaimed areas. Edwardes (1902) gave a very detailed account of the road development in Greater Bombay. As the town gradually extended over reclaimed
land both westward and northward, it became imperative to construct new communication links. The main arterial from Grant Road to Byculla and Chaupatty is a case in point. By 1830, most of the main roads were constructed on Bombay Island. The first road link connecting Bombay Island to Salsette Island was via the Sion causeway, formerly known as Sion Vellard, which was opened in 1805. Today, this causeway links Bombay proper with the Eastern suburbs of Chembur, Ghatkopar, Trombay, Deonar and Thane. The causeway was initially constructed to help market gardeners from Salsette Island to bring their daily produce into the city. In addition, the causeway has also proved beneficial to the migratory population and daily commuters (Edwardes, 1902, 231).

Kalim causeway was opened in the 1840s, linking the western suburbs of Bandra and Kalina to Bombay Island. Both causeways have been widened since their opening.

During the 1860s new roads were constructed and old tracks improved and rebuilt on Bombay Island by Improvement Trusts with the object of improving urban living. The new road developments did open up some areas and accelerated their pace of development, especially areas which were not readily accessible to the rail station, including areas such as Worli, Prabhadevi in the north-western part of Bombay Island.

During the mid-1870s the opening of new roads at Cumballa and Malabar Hill benefitted the area through increased residential development. Edwardes (1902, 315) noted that the municipality throughout the entire period was actively engaged in rendering the island better suited to needs of the population. Land was purchased from time to time to widen streets, houses were demolished at other times to open a new road in overcrowded areas. This was especially so in the port area where increased activity on the old narrow streets choked the area completely. The road schemes, further augmented and maintained the north-south thoroughfares. The unplanned approach to road building of the past has given rise to the present traffic problems.
For example, the innumerable inter-sections today jeopardize the smooth movement of traffic especially in the south. A closer analysis of the road network reveals the influence of the period in which they were constructed. Different areas in Bombay have distinctly different types of road layout.

In the indigenous core area the streets are narrow and tortuous, suitable only for pedestrian and handcart traffic. The area is also characterised by poor transport access both to the rest of the city's transport network and also within the area itself. Roads in this area were constructed prior to the automotive era and despite widening, they cannot perform the functions they are now required to carry out. The whole area is covered by innumerable and insignificant minor streets and alleyways, their random development evident in the fact that there is no element of cohesiveness or hierarchy in the road network.

Edwardes (1902, 290) pointed out that although road building and widening schemes took place extensively in the city, little money or effort was spent on road widening in the 'native town'. It attracted very little official attention and the area was not included in any major transport plans at that time. Banjo and Dimitriou (1980, 12) observed that 'The high population density of the indigenous residential areas and their low levels of basic infrastructural facilities were in stark contrast with the low density and good infrastructure provision of colonial residential areas. Distribution and access roads within the latter were both well-planned and well-maintained providing good access to the city's wider transport network'.

Edwardes (1902, 253) said of the traditional core that 'it was only for an hour or two after sunrise that horsemen and carriages can pass unimpeded by stoppages of varied character'. There have been subsequent changes in land use and location of new traffic generating activities which were not anticipated but no comparable changes in access routes have meant that Edwardes's comment is still very true today.
Roads in the Fort area, which were constructed in the mid-1800s are based on a gridiron pattern where wide arterials all connected to narrow streets at right angles. Since the beginning of the 20th century, road building activity has been increased especially to the central and northern parts of Bombay Island and this is reflected in the fact that the road network in these areas has a more open and spacious layout with roads generally of greater width.

Fig. 2.5 shows the major arterials in Greater Bombay. It can be seen that three major north-south routes form the basis of the arterial system.

1. **Western Route**: This route connects the Fort area to Mahim causeway via Netaji Subash Road, Pedder Road, Dr. A. B. Road and Cadel Road.
2. **Central Route**: This route connects the Fort area to Sion causeway via Dadabhai Naoroji Road, Mohamedali Road, Dr. Ambedkar Road and Sion Road.
3. **Eastern Route**: This route also connects the Fort area to Sion causeway via D'Mello Road, Reay Road, R. A. Kidwai Road and Sion Road.

It is interesting to note that the three arterials all run parallel to the railway lines.

There are major east-west links, the most important ones being Tilak Road, Vir Nariman Road, S. V. P. Road, Grant Road, Clerk Road and Bellasis Road.

In the suburbs, development away from the railheads has been facilitated by roadways. There is more scope for planning of roads in the suburbs. The arterial roads here also run in a north-south direction, (Fig. 2.5) but the network is much sparser and simpler. As on Bombay Island, the arterial routes also converge on the two causeways and they traverse on either side of the hills and lakes, parallel to the railway lines.

Until 1966, there were only two arterial roads, but in order to relieve the burden of traffic that was growing, two Express
highways were constructed.

The eastern suburbs are served by two arterial routes, the Bombay-Agra Road and the Eastern Express highway. The western suburbs are also served by two principal axes, the Swami Vivekanand Road and the Western Express highway. The channelling effect created by the topographical features has also severely restricted east-west communications in the suburbs. Vital cross links do, however, exist between the inner east and west suburbs, such as Santa Cruz - Kurla Road, Andheri - Kurla Road, Vile Parle - Kalina Road and Goregaon - Aarey Road.

Road development is sparse in the extended suburbs, with no east-west links. The sparse development of this area suggests that the lack of proper access roads has retarded development in areas not within the catchment area of the railway stations.

The other road links in the suburbs are those that connect the coastal hamlets to the railway stations. These road links are found mostly in the higher class residential areas on the west coast around Juhu and Versova.

The rest of the roads in the suburbs serve local needs and act as feeders to the arterials. It can be seen therefore that while the roads in the suburbs have been aligned to link the individual suburbs to the nearest railway station and to serve the local access needs within the suburbs, the roads on Bombay Island have been aligned to act as feeder roads to the main arteries and to converge on the CBD. The north-south elongated nature of the two islands and their topography provide the basic orientation to the growth of Bombay, its expansion, extension and pattern of transport and communication.
2.3 **LAND USE PATTERNS**

Having discussed the evolution of transport and the directions in which Bombay has sprawled, attention can now with benefit be focussed on analysis of the overall land use patterns that have emerged. Land use, by its type, location and intensity in urban areas becomes significant because urban movement is very much a reflection of the spatial distribution of economic activity, services and amenities, and therefore, the amount of travel generated in any given area is a direct function of the location of residences vis-à-vis the location of employment opportunities and amenities (Pavaskar, 1978, Ch. 3). Each city has a particular distribution of activity which offers trip makers a finite set of trip termination opportunities. As these opportunities are not uniformly distributed throughout the urban fabric it follows that each location within a city has unique spatial attributes and trip generation opportunities.

It is in this perspective that an examination of the existing land use patterns, population and employment distribution will be analysed since they provide a good indication of the internal commuting and spatial order of movement patterns which dictate transport demand.

Greater Bombay as it is known today came into existence in 1957 (B.I.C.C., 1964). It has within its boundary, Bombay Island, Trombay and a major portion of Salsette Island, having in total an area of 438 sq. km. The structure of Bombay reveals quite clearly that it is a linear city and as Rajagopalan (1962, 52) described it 'Bombay is all length and no breadth'. Bombay like most other cities in India is characterized by three distinctly different urban forms. Taneja (1971) classified these as:

1. An indigenous form
2. An Anglicised form
3. The newly developed planned areas.

The co-existence of quite contradictory land use patterns is unique to newly industrializing countries. Both the modern and traditional areas display their own morphological patterns.
Bombay's land use pattern is a product of both indigenous and intrusive foreign traditions and there is a striking contrast between the two. A usual feature of the former is that it is unplanned and crowded with the intermingling of residential areas, business and industrial activities forming a complex and confused type of land use pattern with a low incidence of functional differentiation. No single land use dominates the area, there is an 'involution' of space in the traditional city area.

Bombay also displays aspects of a western city such as sectors focusing on a central area, together with a fairly well-developed areal differentiation of activities. This is especially so in the Fort area where aggregational and segregational tendencies along lines of social status, ethnic groups and caste prevail.

Bombay Island is a closely built up urban mass with a heavy concentration of Government offices, commercial establishments, business houses, industrial and port activity (Fig. 2.6). This has created very high building and population densities. Bombay Island comprises seven wards, which for convenience may be used as a basis for the examination of land use (For ward boundaries ref. Fig. 2.7).

WARD A: The Fort was originally a strategic defence point which later developed into a convenient business area during the days of British trade (Deshpande, 1981, 187-217). It has continued to dominate all of the city as the main business district. The multi-functional nature of the land use has undergone gradual transformation and it now comprises a financial-servicing centre dominated by tertiary and quaternary functions of the formal economy with a large and growing part of the total city labour force. The concentration of service function here has further been accentuated by the proliferation of commercial activity in the adjoining areas at Nariman Point and Cuffe Parade. This has extended the CBD functions spatially southwards. It is the high level of accessibility that attracts more activity to be located there. High class residential and fashionable
Land Use Pattern in Bombay

LEGEND
- INDUSTRIAL
- RESIDENTIAL
- COMMERCIAL
- PUBLIC
- MARSHLAND
- PARKLAND

Figure 2.7: Percentage growth rate of population in 1971-1981 decade.
shopping areas are also present in this ward especially in Colaba district.

WARD B: A sharp contrast with the CBD in terms of land use is seen in the eastern half of the indigenous core area. Tertiary functions, retail, wholesale trade and small scale industries of the informal economy are intermixed, producing a combination of intensive and diverse land use functions. Wholesale and warehousing dominate in the extreme eastern part of the ward together with godowns (store houses), this being mainly a reflection of its close proximity to the docks area. Drolens predominate in this ward and provide cultural and ethnic distinction.

WARD C: A distinctive feature of the western part of the indigenous core area is the lack of spatial organization. Land use is chaotically mixed up. Bazaars and markets dominate, providing an excellent example of a 'typical' Indian urban landscape. Although the Fort area accounts for the major administrative functions, it is here also that business activity is thriving. Corn, cotton and bullion exchanges are located here along with the agglomeration of Diamond merchants and Goldsmiths. Asia's biggest textile trading complexes, Kulji Jetha and Mangaldas markets are also located here.

The 'high rent' retailing outlets and offices, initially on the ground floors are now steadily extending themselves to the upper floors, pushing the residential functions steadily outwards into the suburbs.

WARD D: The eastern district of this ward, namely, Khetwadi and Girgaum is a continuation of the indigenous area with similar land use functions to Ward C. The western half of this ward is a high class residential area, the proximity to the sea having made it an attractive residential area for the wealthy. Banjo and Dimitriou (1980) noted that it is common for residential areas of colonialists to be adjacent to the business and commercial sector. The mansions and
villas have now been supplanted by luxury high rise apartments due to the escalating land costs. Illustrated Weekly (1980, 10) calculated that an apartment in this locality costs Rs. 2,000 per sq. ft. in contrast to an apartment in the suburbs which costs Rs. 200 per sq. ft.

WARD E: This is a zone of highly mixed land uses. Residential land use is intermixed with commercial activity and small scale industrial workshops and the southern part of this ward is occupied by textile mills.

WARD F & G: These two wards house the old industrial core of the first textile mills that have been all pervasive in Bombay's development. Also present in this mill area are pockets of residential chawl-type tenements. The lack of segregation of residential and industrial functions constitutes serious problems as a result of the existence of a large number of heavy industries, especially on the east, which are intermixed with residential land uses. This industrial nucleus was initially designed to be outside the city (Chapter 2.1). The northward expansion that has taken place was not visualized. Effectively, the industries are now situated in the geographic centre of the city, far from a propitious location. The establishment of industrial areas in the inner and middle zones of Bombay Island is defective and has created numerous spatial and social problems for the industries themselves and the workers who have to face transport problems getting there. Bombay has an extremely high concentration of industries. Industrial zones are dispersed over the city area but there is a particularly marked concentration in Wards E, F and G.

Harris (1978, 26) estimated that a low proportion, 25%, of the land in Bombay Island is used for residential purposes and even if residential intermixed with other land uses is included the percentage still totals 32% only.

The land use pattern of Bombay Island emerges as a confused picture of highly mixed uses that have developed amorphously over the past six decades. Closer scrutiny of the land use
map reveals that there is a certain pattern to the organization. The two railways that traverse the island divide it up into three parts. The eastern portion is occupied by port activity which includes docks, warehouses and wholesale areas. The western portion is predominantly a high class residential area with commercial complexes that has emerged in recent years. The central and northern portion of the island between the railway lines houses the CBD in the south and both large and small scale industries together with middle and low income residences. Broad land use zones conceal the misuse of land, but it is here at the micro level that the most extraordinary examples of misutilization occur. Although the condensed and compact land use pattern may be mistaken for intensely used space, Harris (1978, 60) suggests that 'Intensity of land use in LDC cities is notoriously poor. Refinement of land use in CBD is still a slow process ... poor utilization of land in the central area is one aspect of the general underutilization of Bombay's existing capacity, there is appearance of overutilization, but it is a poor level of organization'. The land use on Bombay Island is not optimally organized with the correct activities.

Salsette Island, north of Mahim Creek represents the dormitory area of Bombay city. The development patterns of the island have closely and clearly aligned themselves to the major transport arteries, representing ribbon-type development. The suburban electrified railway service, express highways and trunk roads have strongly influenced the city structure and land use pattern. Kulkarni (1975) gives a detailed analysis of the retail and ancillary services in suburban Bombay and the influence of rail stations on location of local retail trade. He found that the retail shops which are both multifunctional in nature and diverse in the goods and services offered. This clustering of market retail outlets and residences around the transport access points confirms the already noted importance of transport network in influencing the structure of land use patterns on Salsette Island.
The western portion of the island extending from Bandra to Borivli is predominantly a dormitory residential zone. Planned industrial estates north of Andheri, especially in Jogeshwari, Goregaon, Lald and Kandivli have emerged along the arterial roads but they have not developed in intensity and importance as those in the eastern suburbs. The eastern portion of the island extending from Kurla to Ulund is primarily residential-cum-industrial area. The location of the harbour on the east and improved accessibility have been instrumental in stimulating the industrial development of this region.

Land between the railway lines is occupied by the airport in the south, Government milk colony in the centre and by the National Park and three lakes in the north and east. These natural barriers occupy one-quarter of the total area. They have severely inhibited the east-west transport connections and the lack of transport links has in turn impeded the economic development of the area. Where no physical barriers are present as in the southern portion of the island, urban sprawl has been continuous. The area between the Central and Western railways, south of Ghatkopar and Andheri is well developed. Wards 'A', 'P' and 'R' along Kalad and Kanori creek and Ward 'R' and 'T' along Thana creek have large stretches of marshy land which are open and remain undeveloped.

Trombay in the south-east of the island houses a heavy concentration of industries including refineries, fertilizer plants and an atomic energy plant. The location of the port in close proximity has favoured the development of industries dependent upon imported raw materials and crude oil. Deshpande and Arunachalam (1980) identify the differing characteristics of towns along the railway line. They note that towns can be generally categorized as:-

1. Inner suburbs located on the urban fringe which extend to Andheri in the west and Ghatkopar in the east.

2. Extended suburbs, located on the rural fringe which extends as far as Dahisar in the west and Thana in the east.
This distinction is based on the land use composition and density.

Although industrial activity is spreading in the suburbs, this is mainly in addition to and not a replacement of the heavy concentration of industries in the central and northern portions of Bombay Island. Unlike the trend in DC cities, where there has been a noticeable exodus of industrial activity from the central city to the more spacious outlying suburbs, because they cannot procure the requisite space for expansion, industries in Bombay remain strongly at their point of inception, showing no real signs of relocation, only further growth and expansion in the suburbs.

The E.I.C. (1964, 38) found that Greater Bombay which has an area of 0.1% of the total area of Maharashtra state, accounts for more than one third of the factories in the state. More than 75% of the factories in Greater Bombay are located on Bombay Island. Wards G, D and E alone account for 42% of factories in Greater Bombay. The southern parts of wards F and G comprising Worli, Parel and Sewri area accounts for 15%. Therefore, approximately 57% of the industries are located in a more or less continuous belt ranging from Dadar in the north to Carnac Road in the south. The industries located in the suburbs are mere appendages to the industries in the city and often retain strong ties with them. Bombay Island continues to be the focus of industrial concentration irrespective of the grossly inadequate services, utilities and facilities. Reasons for such industrial concentration can mainly be attributed to geographical inertia and the external and agglomeration economies created by the large concentration of population and economic activity. The entire industrial location policy in and around Bombay has been haphazard and piecemeal due to the irrational approach taken by the authorities.

Harris (1978, 127) points out that 'there is an inherent problem in LDC cities since there is no conceptual framework
about industrial and urban location within which it becomes possible to understand the forces of centralization and dispersal.

Proximity of Salsette Island to Bombay Island, alignment of the transport system and location of the rail access points have all influenced the structure of suburban development. The whole of Salsette Island can today be regarded as a conurbation, having amalgamated many of the small towns within it. Economic ties and the close interrelationship between the two islands is paramount and is reflected in the transport and traffic problems that are evident in the city area. Bombay is by any standards a linear city and successive expansions of the city northwards, from the even more eccentrically located CBD has brought many problems. Given the geographical characteristics of the city site it is doubtful if it could have been otherwise.

From the land use pattern, it can be seen that a heavy concentration of economic functions is clustered in three wards, namely, 'A', 'B' and 'C', in the southern part of Bombay Island, while the residential areas have sprawled linearly along the transport arteries for over 60 km northwards. If development policies cannot slow down this explosive and skewed growth there will be a great wastage of resources. Rajagopalan (1962, 40) points out that in Bombay 'the problems are due not only to overgrowth but also lack of design in that growth'.

In spite of the serious resource constraints a land use pattern has been promoted which is not easy to manage as the cost involved is beyond the financial competence of those who plan. The contemporary land use pattern of Bombay does not conform to any one of the conventional city structure models of Burgess (1925)-concentric development, Hoyt (1939)-sector development, nor Ullman and Harris (1945)-multi-nuclei development, although certain elements of each are represented in particular portions of the city. Deshpande and Arunachalam (1980, 13) demonstrated that Von Thunen type land use rings around the city can be observed, especially the western
coastal strip which has had little industrial penetration. Continued agricultural production in this zone and its ready accessibility to the city reflects the Von Thunen model of agricultural activity around a city market.

It is becoming evident that a well-organized structural arrangement of land use is vital for a city if it is to function efficiently and this is precisely what Bombay lacks. The distribution of land use is noticeably skewed with the city having spread out in a disorganized and disorderly fashion. Land use patterns govern the traffic generation in relation to the volume and distribution of passenger trips. An important relationship exists between travel demand and the location of employment (traffic attracting) and residential (traffic generating) areas. This will be discussed in the following section.
2.4 POPULATION AND EMPLOYMENT

Having discussed the land use pattern of Greater Bombay, it becomes apparent that its distorted land use pattern is a major cause of the transport problems that the city faces. The primary objective of this analysis is to show the magnitude and spatial distribution of population and employment in Greater Bombay. They are the key parameters providing empirical reasons for the severity of the transport problems.

Densities are based on census boundary enumerations, both wardwise and district divisions (Appendix II). There are fifteen wards in Greater Bombay and these are in turn divided up into 88 districts. These divisions were made in 1865 by the Municipality. Population density indicates the degree of physical overcrowding, congestion and the intensity of demand for civic services.

Population trends between 1971-81 reveal some interesting variations. Population on Bombay Island has more or less remained static while the population on the periphery has expanded rapidly outward at a lower average density. Bombay Island in 1971 had 51.4% of Greater Bombay's population but by 1981 its percentage had decreased to 39.6%. This indicates that the suburbs have had a higher demographic growth rate than Bombay Island. In terms of the share of absolute growth, the suburbs absorbed 60% of additional population, 2.26 million. For the first time more people live in the suburbs than on Bombay Island. The population in some wards of Bombay Island has ceased to grow and some have even been characterized by declining population. The population within Bombay Island is not evenly distributed and marked variations exist between different districts.

A closer examination of the data reveals that wards 'B', 'C' and 'L' have had a net decrease in population over 1971, with ward 'C' having the largest percentage decline of -20.5% (Appendix II). This has mainly resulted from the fact that
land uses have undergone change from residential to tertiary and quaternary activity. Despite loss of population, the highest residential densities still occur in ward 'C' at 1404 person per ha. (Gore, 1976, 417). The district of Bhuleshwar claims to have one of the highest densities in the world at 2990 person per ha., at what Bombay Civic Trust (1970, 3) call 'ant hill density'.

Early development in the south of the city and the absence of land use control permitted the entire site to be built upon with little attention paid to the prerequisites of open spaces, lighting, ventilation, density and other civic requirements. Ward 'A' shows a net gain in population, this is because of the development of the reclaimed area under the Backbay Reclamation scheme in the southern district of Colaba. This is the only district of the ward that has gained any substantial population, having a growth rate of 89.2% giving it an increase in population density from 129 persons per ha. in 1971 to 243 persons per ha. in 1981.

Ward 'D', excepting districts of Walkeshwar and Sahalaxmi, have lost population, however, the net density has remained about equal to that of 1971 at 579 persons per ha. This fairly high density can be attributed to the vertical development that has occurred on the west coast. The northern section of the island is another area of extreme high density wards 'E' and 'G' having had net gains in population of 19.8% and 18.9% respectively. However, the gains are not significant enough to prevent the decline of the share of the islands total population with respect to the suburbs. Growth on Bombay Island has predominantly taken place in the industrial wards.

A decline in urban density rates over 1971 does not prove that there has been a decline in the physical growth of the city. Population in Greater Bombay has been growing on the periphery and this can be shown by the growth rates and density in the suburban wards. All the wards in the suburbs show high net
population increases. The eastern suburbs wards, 'E', 'H', 'N' and 'T' registered higher rates of growth than the western suburbs, wards 'A', 'K', 'F' and 'R'. Eastern suburbs had an average growth rate of 75.4% and western suburbs had an average growth rate of 66.4%. The overall densities between the two do not vary much, 135 persons per ha. for the eastern suburbs as compared to 139 persons per ha. in the western suburbs. The east coast expansion has gained momentum because of the construction of Vashi Bridge which connects Salsette Island to mainland India.

When analysis is made between inner and outer suburbs, the spatial variation is more marked. While the inner suburbs, wards 'A', 'H', 'E', 'K' and 'N' recorded a 62.6% increase in population, the outer suburbs, wards, 'F', 'T' and 'R' recorded a growth rate of 97.2%. This indicates that growth is taking place at a faster pace in the outer suburbs, where there is more land for development. The tendency toward outward spatial growth has important implications for transport as demand is dispersed at lower density (Fig. 2.7).

Suburban wards have experienced high growth rates. Ward 'R' in the extended/western suburbs registered the highest growth rate in Greater Bombay of 138%, the district of Nagathane registered a staggering growth rate of 344%.

The influence of rail and arterial roads on the density pattern in the suburbs is discernible. Keiser (1970, 27) has pointed out an interesting relationship between location of railway stations and density of development "Bombay suburbs are being built up at four to eight storeys near the railway stations and three to four storeys within walking distance of it ... when the bus is used to reach the station, building height drops to one to two storeys".

The dense concentration around the suburban transport nodes is now being followed by a recent tendency toward in-filling of low density areas farther away from transport access points. Thus growth rates are now greatest in the east and west coasts.
rather than, as in the past, clustered around the railway stations (Appendix II).

The city as a whole appears to reflect the general rule that density tends to fall off as negative exponential function of increasing distance from CBD (Brush, 1960) (Fig. 2.8). Most parts of wards 'A', 'C', 'D' and 'E' have no large open spaces and it is here where the population density is highest. Pressure of population within this limited area on Bombay Island and high land values have caused people to migrate northwards. The existence of overall low density levels in the suburbs does not necessarily indicate an absence of overcrowding locally and the conditions in places are much worse than the density figures might suggest.

At the present growth rate, it is not difficult to visualize Greater Bombay having over 10 million people by the next census in 1991. This has obvious implications from the point of view of urban services, especially transport demand.

Suburban expansion greatly adds to the traffic and transport costs of daily commuting and also leads to an increase in intra-urban movement. A declining proportion of the workforce now live on Bombay Island.

Although it is impossible to prescribe an optimum size city because the physical characteristics and socio-economic conditions are different for each, it is incontestable that in relation to Bombay's specific land area and provision of transport services the optimal population size has been exceeded. The changes in population distribution must be seen against the background of the location of employment. Past trends in growth and development of Bombay have not laid particular emphasis on a balanced and rational siting of industries and commercial activity and this is evident from the present distribution of employment.

Data on the number of jobs in Greater Bombay clearly shows the importance of Bombay Island — Wards 'A' to 'C' as the main employment opportunity area, having 1,735,552 jobs in
Figure 2.8

Legend:
- MORE THAN 1000
- 501 - 1000
- 100 - 500
- LESS THAN 100

Source: Based on Census Data 1981
1973 (Appendix III). This is in contrast to the suburbs which have much less employment opportunity, having only 625,640 jobs in total. Fig. 2.9 shows the population and 'formal' employment distribution in Greater Bombay. The original city Island, extending from Colaba to Mahim holds 74% of the jobs in Greater Bombay but has only 40% of the total population. In contrast, the suburbs have only 26% of the jobs but 60% of its population. This is critical from the point of view of transport since it leads to long journey-to-work trips and high work trip densities in Bombay south as a declining proportion of the employed population live on Bombay Island.

Population distribution is showing signs of a centrifugal effect similar to those of suburbanization in DC cities but on the other hand centripetal forces are still strong and working towards concentration of employment activity in the south.

When the job distribution data is analysed wardwise, some interesting trends are observed. 18.6% of the jobs are located in ward 'A', the CBD, followed by ward 'C' which has 17.5% of the jobs and, as noted before, this is the industrial zone. The indigenous core area has 13.3% of the jobs and ward 'F' having 10.0% of the jobs. These five wards in Bombay Island are the most important in terms of employment opportunity and activity. The rest of the wards show a relatively small number of job opportunities.

Fig. 2.10 shows the employment density decay map. The highest employment density is found in ward 'C' which registered 953.00 jobs per hectare, this being a very high concentration of jobs in a small area. Ward 'B' has 585.00 jobs per hectare followed by ward 'A' with 419 jobs per hectare. The high concentration of the city's activities in a relatively confined and geographically unsuitable area at the southern tip of the island is the major cause for the high proportion of trips originating from and terminating in this zone.
Population and Employment Distribution in Bombay.

**Fig 2.9**

**PERCENTAGE DISTRIBUTION (1981)**

<table>
<thead>
<tr>
<th></th>
<th>POPULATION</th>
<th>EMPLOYMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CITY BOMBAY ISLAND (B.I.)</td>
<td>39.60</td>
<td>73.90</td>
</tr>
<tr>
<td>INNER SUBURBS</td>
<td>42.82</td>
<td>18.90</td>
</tr>
<tr>
<td>EXTENDED SUBURBS</td>
<td>17.58</td>
<td>7.30</td>
</tr>
<tr>
<td>N.T.S.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**POPULATION : EMPLOYMENT RATIO**

- CITY: 2:1
- INNER SUBURBS: 8:1
- EXTENDED SUBURBS: 8.5:1
Employment Density in Greater Bombay

Fig. 2.10

Source: Based on Census Data 1981
Wards 'D', 'E' and 'F' have, compared with the suburban wards, high employment densities per hectare, of 187, 295 and 110 respectively. In contrast with the high average density of 257.00 jobs per ha. on Bombay Island, Salsette Island has a mere 17.00 jobs per ha. On Salsette Island a drastic drop in employment density is discernible. Wards 'K', 'L', 'P' and 'R' in the western suburbs have a steady decrease in employment density northwards. It is only ward 'L' in the eastern suburbs that has a moderate employment density for the suburbs of 66 jobs per ha. In the suburbs, employment is concentrated in a few pockets such as Kurla, Chhatkopar and Vikhroli along the rail line. Although industrial expansion and development determined the earlier employment growth, in recent years it can be attributed to the phenomenal increase in tertiary and quaternary activity which have been multiplying at an ever accelerating pace. For example, L.E.D.C. (1978, 26) estimate that Government employment has increased by 151% since 1951.

The high interdependence of economic activities in terms of both personal communication and economic links has led to a natural tendency toward increasingly high concentration of employment in the CBD. The result in geographical terms has been an extension of the business area both north and south from ward 'A' to wards 'B' and 'C'. A total area of 233 ha. is being developed in the southern part of ward 'A' for commercial use at Nariman Point and Cuffe Parade under the Backbay Reclamation scheme. This will result in further concentration of job opportunities in the south as an estimated 200,000 white-collar jobs are being planned for.

The suburbs on the other hand are growing only as residential centres without concomitant growth in employment activity. Suburban wards represent in effect an extension of the city primarily for residential purposes and therefore, a growing disparity between the distribution of population and employment. The number of people who are both resident as well as employed on Salsette Island is negligible.
Table 2.2 outlines the Floor Space Index (F.S.I.) for each ward in Greater Bombay. The zoning clearly shows the bias in favour of high density development in the south. The F.S.I. may be used as an indicator of and central criterion for density of development but in the case of Bombay it has not been put to this use. BHRPE (1974, 23-24) noted that the centre of gravity of Greater Bombay is clearly located near the southern tip where almost all the tertiary sector employment is concentrated. The distorted position of the centre of gravity in relation to the entire metropolitan mass has created an imbalanced structure in which the north-south transport arteries have become heavily overloaded. In the absence of a properly planned relationship between home and work location, workers will be forced to travel long distances.

The land use pattern and population distribution in Bombay represents something of a paradox. Harris (1978, 80) points out correctly that urban sprawl and diffusion, causing long distance commuting, exist alongside the 19th century phenomenon of population concentration in the central industrial areas of the city.

Urban sprawl has mainly been caused by the dearth of land on Bombay Island and the need to locate in close proximity to the extended linear public transport axis. Such growth patterns and distribution of activities have given rise to Bombay's unique transport demand characteristics and these will be the concern of the next chapter.
## Table 2.2

### FLOOR SPACE INDEX BY WARD

<table>
<thead>
<tr>
<th>WARD</th>
<th>Floor Space Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.45-3.50</td>
</tr>
<tr>
<td>B</td>
<td>1.66</td>
</tr>
<tr>
<td>C</td>
<td>1.66</td>
</tr>
<tr>
<td>D</td>
<td>1.66</td>
</tr>
<tr>
<td>E</td>
<td>1.66</td>
</tr>
<tr>
<td>F + G</td>
<td>1.33</td>
</tr>
</tbody>
</table>

**Suburbs**

(inner and extended)

- M + N 0.75

**Villages**

(Erangal, Kse. and Marve in Ward 'P').

0.50

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CHAPTER THREE

NATURE OF URBAN PASSENGER

TRANSPORT DEMAND
3.1 FACTORS INFLUENCING TRIP GENERATION

Man has the need to carry out a variety of activities including earning a living, shopping, recreation, socializing and educational pursuits. The fact that these cannot be carried out all at one location implies that transport is of great importance in many aspects of the lives of individuals. Journeys are, therefore, a preliminary to the fulfilment of man's needs. Transport is the medium by which activities can be reached and necessary access to such activities is the prime motive behind our requirements for transport. The demand for transport is essentially a demand for movement. Factors influencing movement need to be considered in relation to the superior objectives that man strives for. Travel for the most part is not a goal in itself, it is needed to fulfil basic human needs (Hay, 1972, 30).

Buchanan (1963) concluded that 'Traffic is a function of activities and it is concentrated at certain places because activities are concentrated there.' The reciprocal relationship between the location of activities and their spatial separation requiring links between them is the fundamental underlying factor determining transport demand. The ideal situation for the individual is where demand for transport is minimized and access to activities maximized. Geographic factors have an influence upon movement since the activities pursued by each individual are affected by their access to means of transport and the ease with which they can travel. The structure of land use in cities is a definite factor in trip motivation and determines the number of trips, average trip length and trip pattern. It is the complexity of the location of origin and destination points that creates the huge problems associated with urban transport provision. The need for very basic thinking about the physical structure of cities becomes apparent. Day to day movement is the major source of demand for transport, with the journey to work dominating travel patterns today. It is the most regular and frequent of all trips taken. If there were no constraints and influences upon the manner in which
journeys are undertaken, the result would be completely random, unorganized distribution of movement.

Daniels and Warnes (1980) identify six organizing principles of movement which influence movement patterns in urban areas (Table 3.1). They note that the aspatial characteristics of temporal co-ordination by itself creates the spatial effect of concentration in transport demand. The minimization principle is revealed by the strong distance decay relationship that exists for most urban movement.

In certain circumstances, as in the case of Bombay, skewed land use arrangement and geographical disposition of routes produces journeys longer than would be ideal. The size of the urban area effects the diversity of movement patterns. In large urban areas, movement reveals atypical features. Concentration in movement both spatially and temporally encourages the development of high capacity facilities.

Passenger traffic has its own particular characteristic in that it is largely self-balancing with passengers making an outward and return journey. The pattern of traffic is a result of the interaction between peoples' need to travel and the characteristic of the transport system. An individual's demand for travel varies according to his/her socio-economic characteristics and stage in the life cycle. A number of studies (Page, 1974; Jones, 1975; Daniels & Warnes, 1980) have comprehensively covered and shown the importance of personal characteristics in influencing transport demand. Personal movement is highly dependent upon individual behaviour patterns. Different sections of the population have different needs for transport. The influences upon personal movement are manifold. Personal characteristics and perceptions as well as the principal activities that an individual pursues induce them to make specific trips in a particular way. The resultant overall pattern of demand is a product of innumerable decisions to travel made by many individuals.
### Table 3.1

**Organizing principles of urban personal journeys**

<table>
<thead>
<tr>
<th>Principle</th>
<th>Some Geographical effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Temporal coordination of human activity</td>
<td>Creation of parallel daily, weekly and seasonal rhythms of activities and movements for large groups of the population.</td>
</tr>
<tr>
<td>2. Spatial coordination of human activity</td>
<td>Spatial agglomeration at different scales of activities and land uses, leading to a focusing and segregation of movements for different purposes and by different groups. Volume of movement to each part of a town related to its attractiveness, or number of activity-opportunities.</td>
</tr>
<tr>
<td>3. Minimization of travel effort</td>
<td>Strong distance decay effect among urban movements. Domination of short-distance movements, creating a relationship between the population and movement distributions. In each purpose category, relationship between accessibility to opportunity and frequency of journeying.</td>
</tr>
<tr>
<td>4. Economies of scale in provision of movement facilities</td>
<td>The controls of threshold demands for higher-capacity and higher-speed facilities limit their provision for the dominant medium- and longer-distance journeys. A hierarchy of roads and a mainly radial pattern of public transport routes is produced, leading to a relationship between the distance and mode journeys, and generating feedback effects on individuals' destination, route and frequency decisions.</td>
</tr>
</tbody>
</table>
5. Structuring of human activity by position in the life cycle or role in the household

Temporal and spatial ordering and grouping of journeys by personal characteristics. Creation of contrasting movement patterns for schoolchildren, housewives, the employed and the retired.

6. Increasing differentiation of activities, land uses and movements with increasing urban size

Economics of urban size determine a greater range and volume of activities in larger places. Geometry determines an increasing diversity of journey distances with increasing scale. Together they produce both greater complexity of the aggregate movement pattern and greater diversity of individuals' patterns with larger town size.

3.2 SPATIAL ASPECTS OF DEMAND

The size of a city is determined by its geographical spread and population distribution and its shape by historical influences and physical possibilities. Within the city these factors also affect the distribution of particular activities and ease of access to specific location points.

The volume of traffic and frequency of use of transport is determined by the type and density of various urban activities. The spatial pattern of demand depends on several factors, with the main determinants being area and population, the pattern of dispersal and/or concentration of employment centres and the nature and extent of transport services, thereby, making distance the most important factor.

Thomson (1977) developed the idea that a particular type of city centre and the characteristics of the transport network will produce a demand for certain types of movement. In the case of Bombay, the combination of a strong city centre and strong radial transport network make necessary a high capacity movement system. Trip generation potential varies with land use. In Bombay, BMRPB (1974, 54) estimated that 626 passenger trips per ha per day are generated in areas occupied by offices, 512 trips per ha by land used for shops and warehouses, 241 trips per ha by land used for transport, 214 trips per ha by residential land use and 110 trips per ha by industrial areas. Land occupied by commercial/office purposes, therefore, generates the maximum number of trips per hectare. The examination of the functional zones of Greater Bombay (Chapter 2.3) showed that the main areas of commercial activity are concentrated in wards 'A', 'B' and 'C'. A more detailed study of the economic activity profile of Bombay by the O.R.G. (1972, 189) found that offices of Government, Banking and Import-Export firms have the highest indices of trip attraction of 2.7, 7.8 and 2.1 respectively, where the index is calculated by the total number of trips attracted as a ratio of trips generated. These three activities clearly predominate in the three southern wards.
Figure 3.1 shows the total number of trip ends, that is, the trip attractions and trip generations, in Greater Bombay.

The Fort area, indigenous core and Nariman Point all have very high densities of trip ends, over 100,000. These are followed by museum area which has a density of trip ends of 80,000 – 100,000. These areas comprise the main focus of employment. Dadar, Sion and Bandra areas also have relatively high density trip ends of 60,000 – 80,000. On the rest of Bombay Island, trip end density varies between 20,000 – 60,000 with higher trip end densities in the central zone of Bombay Island and tapering off to a lower density at the northern periphery. On the Salsette Island, high trip end densities are discernible along the transport arteries and low densities of below 20,000 in the central part of the island and in the peripheral areas along the west coast. Trip end density rapidly falls with increasing distance from the Fort and Bazar area, the rapidity of fall being all the more conspicuous in the suburbs. Land use would appear therefore to be an important tool for regulating traffic generation.

This general pattern of trip end densities, reflects the land use, population and employment in Greater Bombay. The greatest concentration of trip generation and attraction is located not surprisingly, where the highest employment opportunities exist. The CBD emerges as the geographical area with the highest concentration of trip ends.

Land use and daily person trip destinations are strongly related. Residential trip end densities are low while commercial land use generates high trip end densities. The location of the CBD in the extreme south of Bombay Island has created a strong unidirectional traffic flow.

The distorted land use pattern, with work centres progressively concentrated in the southern extreme portion of the city and the north and north-eastward expansion of the sprawling residential colonies has resulted in journey-to-work increasing both in terms of the number of commuters and the distances they travel (IBRD, 1976).
Spatial distribution of Trip Attraction and Trip Generation

LEGEND (in 000's)

Density

- Below 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Above 100

The structural and spatial imbalance in the distribution of activities and the unplanned land uses are basic to the emergence of commuting problems and have imposed a heavy burden on the present transport system. The increased commutation distances can be shown by the average leads, that is, the average passenger journey distance. For all commuters the average lead was 13 km in 1950-51 and this had increased to 18.53 km on the Western Railway and 20.99 km on the Central Railway by 1980-81 (MTR (Rly.), 1980, 15).

The average lead on the Central Railway is higher due to the fact that the suburban network is more extensive. The suburban lines extend to Karjat in the south-east and Kasara in the north-east, a distance of 100 km and 120 km respectively from V.T. The Western Railway suburban network, on the other hand, extends to Virar, a distance of 60 km from Churchgate.

The long average leads indicate that long distance suburban commuters constitute a high percentage of passengers.

Table 3.2 shows the geographic pattern of movement within Greater Bombay. This further illustrates the impact of the distorted land use pattern. Traffic that originates and terminates on Bombay Island accounts for 23.6% of the total passenger traffic movement. Traffic between the suburbs, external areas and the city accounts for 55% of the total. The bulk of the passengers carried are, thus, the long distance commuters forced to travel into the city centre by the largely unrelated location of employment centres and residential colonies that have developed over time. The spatial concentration of transport demand from the suburbs to the city in the morning and vice versa in the evening invariably gives rise to problems for the transport operators who are unable to satisfy the demand adequately.

Urban sprawl, if allowed to continue unhindered and without re-arrangement of land use patterns will increase the average trip length further and will accentuate the existing problems. It is imperative to control the density and location of heavy traffic generators otherwise great demands will be placed on the city's infrastructure which already has problems resulting
Table 3.2

Geographical Pattern of Movements in Bombay

<table>
<thead>
<tr>
<th>Trips between</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. City-to-City</td>
<td>23.60</td>
</tr>
<tr>
<td>2. Suburbs-to-Suburbs</td>
<td>12.99</td>
</tr>
<tr>
<td>3. Suburbs City-to-Suburbs</td>
<td>45.74</td>
</tr>
<tr>
<td>4. External areas-to-city-to-external areas</td>
<td>9.36</td>
</tr>
<tr>
<td>5. Suburbs to external areas to suburbs</td>
<td>4.97</td>
</tr>
<tr>
<td>6. External areas to external areas</td>
<td>3.34</td>
</tr>
</tbody>
</table>

100.00%

NOTE: Bombay Island is considered the city, Salsette Island upto B.M.C. limit is the suburbs and external areas lying beyond B.M.C. jurisdiction.

from the many activities that are concentrated in a small area. Land uses must be so developed and located that the trip attractions and generations created are within the capacity of the transport system. The inter-mixing of employment and residential activity would be advantageous since it not only creates opportunity for shorter distance journey-to-work but promises more even loads on the transport system.

In Bombay, the present movement characteristics are such that the transport system is compelled to carry more passengers into the CBD than its capacity theoretically allows. Travel desire lines run predominantly north-south along the length of the islands and newer industrial employment in the northern suburban strips, along the railway lines, has not been sufficient to dampen the problems of uni-directional peak hour traffic. The eccentric location of the CBD and the skewed land use pattern has resulted in a spatial concentration of transport demand, with trip orientation strongly focused on the CBD. The effect is such that occupation of trains during the peak hours is 300% of the normal seating whereas in the anti-peak direction it is as little as 2-12% (Central Planning Organization, 1981, 2). This causes inefficient use of public transport infrastructure.

The overall spatial imbalance of economic activity within Bombay has placed great demands on the city's transport infrastructure and has been a main cause of the traffic problems that exist.

Land use patterns, the amount and nature of passenger travel and transport system are inextricably inter-related. If properly understood and manipulated they can provide the necessary tools for those concerned with alleviating transport problems.

The flow patterns of commuters on the transport network will now be analysed as this reflects the spatial aspects of transport demand. Analysis of the commuting pattern in the city and the areal variation in the commuting behaviour will help to highlight the transport problems and difficulties faced by both transport operators and commuters in Bombay.
Rail Commuter Flows:
Study of the flow pattern of commuters along the railway corridors reveals some interesting and noteworthy points. The analysis is based on the data given in BMRDA (1981, 73-75) and the trip distribution is a reflection of the land use patterns already described. BMRDA's data for sectionwise traffic volumes (Appendix IV) shows that the number of commuters travelling between Kalyan and V.T. is two-thirds that of the flow of commuters between Borivli and Churchgate. This can be explained by the fact that the western suburbs are more residential in character and have higher population densities. This is confirmed by the findings of the present research. Table 3.3 shows the residential location of commuters. 44.2% of those surveyed lived in the western suburbs as opposed to 26.4% who lived in the eastern suburbs. This clearly reflects the residential significance of the western suburbs.

(MTP (Rly.), 1980, 165) notes that during the decade 1971-81, traffic growth per annum registered an increase of 10.8% on the Western Railway and 6.6% on the Central Railway. Sectionwise analysis of travel patterns along the Western Railway shows that the number of commuters at Virar, Vasai Road, Bhayander and Dahisar Station are relatively high and the line volumes shows a steady increase. The high commuter volumes are due to the fact that a considerable number of market gardeners from this zone commute into the city with their goods everyday.

The station volume at Borivli is 446,442 passengers which is high. The suburb of Borivli is fast developing in terms of its residential function. The volume of traffic increases steadily in this section. This has been because of the large population increases in wards 'K', 'P' and 'R'. Versova and Marol for example, had in 1971-81 growth rate of 102.3% and 163% respectively. (Chapter 2.4) The traffic for suburban railways has tended to shift from inner to extended suburban areas. This change has been fostered by the higher speeds that have progressively been offered by the railways.
### Frequency Distribution of Residential Location of Commuters

<table>
<thead>
<tr>
<th>Residential Location</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>CITY - BOMBAY SOUTH</td>
<td>29.4</td>
</tr>
<tr>
<td>BANDRA - BORIVLI</td>
<td>36.3</td>
</tr>
<tr>
<td>BORIVLI - VIRAR</td>
<td>7.9</td>
</tr>
<tr>
<td>KURLA - MULUND</td>
<td>15.2</td>
</tr>
<tr>
<td>MULUND - KALYAN</td>
<td>11.2</td>
</tr>
</tbody>
</table>

100.00%

---

**Source:** Field Survey, July, 1982.
Industrial estates that have developed along Kurla-Andheri Link Road also create a large commuter traffic. These industrial estates are more accessible from Andheri than from Central Railway stations. This results in considerable inflow of workers to the industrial areas and outflow of commuters to the CBD. This is reflected in the very high station volume at Andheri of 591,951 persons daily. The area between Andheri to Bandra is a large suburban agglomeration, with the result that Vile Parle, Santa Cruz, Khar Road and Bandra are all well-developed residential suburbs with a large population base. This accounts for the large number of commuters from these inner suburbs to Bombay south. In fact, the station volumes are high throughout the Borivli-Bandra section and with the line volume increasing steadily.

Dadar is a main line interchange point between W.R. and C.R. It caters for the 'U' turn traffic, that is, those people living in the western suburbs but with work places in the industrial areas of the eastern suburbs and vice versa. In the absence of vital east-west rail connections linking the East and West suburbs, problems are encountered at this station due to inadequate capacity and poor transfer facilities.

South from Dadar to Churchgate there is a decrease in line volume as commuters detrain at various mill areas of Central Bombay and this accounts for the high station volumes at Elphinstone Road, Parel and Mahalaxmi stations. There is a further decline in volume south of Bombay Central as commuters alight at the commercial zones of Grant Road, Charni Road, Marine Lines and Churchgate. Grant Road and Charni Road stations have high station volumes which can be accounted for by the proximity of these stations to the indigenous core and Bazaar area which has high density employment and residential land use. Churchgate station has the highest station volume of 841,598 persons. It caters for the CBD area to the south of the termini extending towards Colaba, Cuffe Parade and Backbay Reclamation.
Analysis of the line volume (Appendix IV) shows that long distance commuters form the bulk of the suburban traffic. Virar-Khar section passengers commuting directly to and from Grant Road-Churchgate section account for more than 57% of suburban traffic. The long distance traffic composition is as follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandra - Andheri</td>
<td>26.00</td>
</tr>
<tr>
<td>Jogeshwari - Borivli</td>
<td>26.00</td>
</tr>
<tr>
<td>Dahisar - Virar</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57.00%</strong></td>
</tr>
</tbody>
</table>

Long distance traffic reaches its saturation point during the peak period when this traffic comprises 80–85% of the total commuters. Short distance commuters have been classified as those who originate and terminate their journey between Goregaon and Bombay Central. Gandhi (1973) found that they form on average 30% of the total traffic. Commuters whose journeys originate between Virar and Malad or Grant Road and Churchgate, that is, at either end of the line haul and whose destination is in the intermediate section between Goregaon and Bombay Central contribute only 20% of the total daily traffic. During the office peak hours, however, this type of traffic falls to about 5% (Gandhi, 1973) and long distance traffic then dominates.

Central Railway commuter lines also have high line volumes following a similar pattern to that found along Western Railway although the maximum load on W.R. is much higher than C.R. The lower station volumes along C.R. are better understood when we consider the nature of these suburbs. As described in the land use analysis, Chapter 2.3, they comprise mainly residential/industrial areas having a lower population base than the western suburbs. The high station volumes at Thana, Mulund, Bhandup, Vikhroli and Ghatkopar are due to the well developed nature of these suburbs both in terms of residential and industrial activities.
The high station volume at Kurla can be accounted for by the fact that it is a major interchange terminal:

1. Main line commuters on the C.R. change trains at Kurla for the harbour branch line to get to the industrial areas of Trombay and also residents of Mankhurd and Chembur to get to main line stations.

2. Modal interchange of bus/train is available here. A large number of bus commuters from western suburbs board here for trains on main or harbour branch lines to reach industrial areas in the east.

High line volume exists between Kurla and Dadar. From Dadar to V.T. the line volume steadily decreases. There is an outflow of commuters in mill areas of Parel and Currey Road and also in the business/market area of Sandhurst Road and Masjid stations. A further steady decline in volume to V.T. is discernible. Dispersal of commuters on both railways, therefore, takes place south of Dadar station and there is a gradual decrease of commuter line volume approaching the two CBD termini, Churchgate and V.T. On the C.R. too, long distance passengers make up the majority of commuters outlined as follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kurla - Thana</td>
<td>43</td>
</tr>
<tr>
<td>Kalva - Kalyan</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>53%</td>
</tr>
</tbody>
</table>

The harbour branch line does not show much variation in passenger volume. This is a feeder line of C.R. which serves mainly the industrial area of Trombay and the white collar workers residing there but working in Bombay south. C.R. trains running between V.T. and Bandra, although having a tremendous potential for serving the north-south heavy traffic, is not being patronized by the commuters. This is mainly because of its very low frequency and poor service. Instead,
commuters interchange at Bandra to W.R. and travel to Churchgate. They then either walk or catch a bus to their work places in the V.T. area.

The station volumes of the terminal stations are inflated to some extent. This feature is due to the fact that season pass holders purchase their passes to the nearest terminal station beyond their residence and/or workplace. The terminal stations being (Borivli, Goregaon, Andheri, Dadar, Churchgate, Kurla, Mulund and V.T.). This is done for several reasons, the three principal being:

1. The difficulty of boarding the train let alone finding seating accommodation at any place other than at the originating stations.

2. Benefits of fast 'express' trains are available only at terminal stations.

3. Due to the graduated block structure of fares on the railways, commuters buy season passes to the last station of the block rather than intermediate stations at a marginal additional cost. There is a tendency to purchase passes up to the CBD termini with the added advantage of greater flexibility of travel.

Correlation co-efficients were calculated between line volume and distance from CBD. It was found by using Pearson's correlation co-efficient test that when line volume and distance are co-related using data for the whole of Greater Bombay along the Western Railway a very weak negative co-relation of \(-0.276\) exists. This implies that the number of commuters, does not decrease markedly with an increase in distance from CBD. This is because most of the commuters come into the city from Salsette Island.

When the co-relation test is carried out using data for only Bombay Island a very strong positive co-relation of \(0.984\) is observed. This implies that as the distance from the CBD termini increases so does the number of commuters, again
reflecting the residential nature of the northern areas and the employment oriented character of Bombay south. Co-relation coefficients using C.R. data produced similar trends as those found when using W.R. data. A weak negative of \(-0.294\) is produced for Greater Bombay. On the other hand, a strong positive co-relation of \(0.964\) for data is produced when Bombay Island alone is envisaged, again indicating that most of the commuters come from the suburbs. A questionnaire survey undertaken by the author confirmed these findings. Table 3.4 shows the results obtained.

As the distance of residence from work place increases so does the number of commuters up to 15-20 km distance range. Note that this is in effect the northern limit of Bombay Island. A slight decrease in the number of commuters is observed between 20-30 km distance. However, an increase in the number of commuters living more than 30 km from their work place is observed with no clear linear distance decay function. It is also a confirmation of the point made earlier than the average commuting distance is relatively long.

The railways, therefore, serve the line-haul function of the transport system from the low density residential areas in the north to the high employment activity zones in the south. The high intensity of downtown oriented travel is apparent. This indicates that the many-to-one nature of journey-to-work is still predominant with destinations of commuters concentrated in the CBD.
Table 3.4

**Frequency Distribution of Distance of Residence From Workplace of Commuters**

<table>
<thead>
<tr>
<th>Distance Residence From Workplace (in km)</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>10.2</td>
</tr>
<tr>
<td>5 – 10</td>
<td>12.5</td>
</tr>
<tr>
<td>10 – 15</td>
<td>14.2</td>
</tr>
<tr>
<td>15 – 20</td>
<td>15.2</td>
</tr>
<tr>
<td>20 – 25</td>
<td>12.2</td>
</tr>
<tr>
<td>25 – 30</td>
<td>9.6</td>
</tr>
<tr>
<td>30 – 35</td>
<td>12.7</td>
</tr>
<tr>
<td>35+</td>
<td>13.4</td>
</tr>
<tr>
<td></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

**Source:** Field Survey, July 1982.
Bus Commuter Flows:
The nature of bus transport demand and the pattern of its traffic is also worth analysing at this stage. Bus density maps (Figs. 3.2 and 3.3) provide a good indication of the present overall pattern of movement. Fig. 3.2 shows that the buses along the north-south arterial roads carry the heaviest density of traffic. The central arterial route, which virtually bisects the Island, has the heaviest flow of traffic. On average, 120 buses per hour ply along this route, that is, with two buses a minute. The bus density increases to 155 buses per hour south of V.T. It is important to note that the main north-south route passes through the middle and low income residential areas. Furthermore, it connects the CBD with the eastern half of the indigenous core area links industrial areas of central Bombay traverses the centre of Bombay Island between the bus rail corridors. The location of the rail CBD termini is such that the majority of commuters have to depend on road transport for completing their journey-to-work, especially to the new commercial complexes at Nariman Point and Backbay. This results in heavy traffic in the vicinity of the two rail termini, especially along D. N. Road and N.C. Road. Bus routes south of S.V.P. Road all converge on the CBD. Bombay Electric Supply and Transport undertaking (BEST) also runs a number of special buses during the rush hour in the CBD and other parts of Bombay Island to clear the overlaps of commuters at the bus stops. The other major bus route with high densities and therefore, high passenger flows is found on the western arterial route extending from Mahim causeway to V.T. The highest density on this route is found along Maharashi Karve Road which connects two important traffic generating areas, Opera House and the CBD. An average of 79 buses per hour ply along this route, which is important because it connects the residential colonies in the north-west part of Bombay Island, areas not well served by the W.R., to the business area of the indigenous core and CBD. Elsewhere along the western seafront a much lower passenger flow is observed. This is a high class residential area and the people residing here make wider use of the private car and taxis rather than public transport services.
BUS DENSITY CHART
OF BOMBAY ISLAND

Number of buses per hour on arterial roads in each direction.
Nov. 1980

SOURCE: CENTRAL PLANNING SERVICES, IN BOMBAY
JAN 1981
A third major routeway with heavy passenger flows occurs from Mahim to CBD via Godhale Road, N.N. Joshi and Byculla Bridge, then joining the major stream of traffic along J.J. Road and Mohammed Ali Road to Hutatma Chowk. This route connects the north-west part of Bombay Island with the south-east and has an average of 93 buses plying per hour, with the number increasing as the CBD is approached.

Given the alignment of the railways it is not surprising that several east-west bus routes provide important connections and have high density flows. These routes serve through traffic as well as internal movement within the high density residential areas of Girgaum, Thakurdwar, Masjid and Dongri. Flows along the east-west routes are densest in the CBD and indigenous core areas, and decrease as one proceeds northwards. These dense east-west traffic flows in the CBD are due to the fact that passengers alighting at Churchgate station but having their final destinations in the east near Ballard Estate need to use the bus for the final leg of their journey. Similarly, passengers alighting at V.T. but with destinations near Churchgate also have to use buses. For example, 88 buses per hour ply on Veer Nariman Road which links the two CBD termini. From V.T. to Hutatma Chowk along D.N. Road, 155 bus per hour, that is, 2.6 buses a minute, ply to cater to the heavy demand. Bus densities thin out at the two causeways because most of the bus routes originate and terminate at Sion and Mahim.

Travel patterns reflect the importance of the CBD as a focal point for traffic movement. Buses are used predominantly for trips within the CBD and for radial trips parallel to the railways. Bus traffic is of essentially short leads. White (1980, 53) estimated that about 70% of bus passenger travel is less than 5 km and therefore, long distance passengers do not make up a large proportion of passengers, in contrast with rail commuting. The structure of the services would, however, allow travel for over 40 km within Greater Bombay but buses cater mainly for short distance trips of individuals throughout the day. They are not a popular mode for daily long distance commuting mainly
because of congestion problems from which they suffer and the consequent longer journey times in comparison with railways. For radial trips along principal arteries the rail service offers a quicker and more efficient service especially journeys over 8 km.

In the suburbs, a different type of flow pattern is observed. Since most of the suburbs have developed around the railway stations, the feeder role of the buses to railway stations is apparent. In the suburbs, the two arterial routes, Bombay-Agra Road in the east and S.V.P. Road in the west have high density traffic flows, especially in the southern part (Fig. 3.3). Bus flows along these routes do decrease with increasing distance from the two causeways. Pednekar (1980) gives a good account of the development of the bus network on Salsette Island. He notes that the bus routes further accentuate the dominance of the major axial roads. The heaviest bus passenger flows in the suburbs occur on the vital routes that connect the east and west suburbs such as Nathurdas Vasanji Road connecting Andheri to the central portion of Salsette Island which has 65 buses per hour plying along it, and also Sion-Trombay Road which is an important bus route.

In the western suburbs, west of the railway tracks, the bus routes have developed in response to the needs of high and middle income groups. The bus routes link the residential colonies along the seaface to the nearest railway station. In contrast to the western suburbs, residential colonies in the eastern suburbs such as Cheeta camp and Anushakti Nagar have direct bus connections to Sion and the city rather than to the nearest railhead like Mankhurd. This may be due partly to the poor rail service offered on the Central Railway. High density flows occur in residential areas around the railway stations where there are a large number of feeder routes. Denser flow patterns are noticeable in the inner suburbs possibly due to the fact that until 1957 the boundary of Greater Bombay was at the northern margin of the inner suburbs, namely Andheri on the west and Ghatkopar in the east. The relative absence of road
links in the northern part of Salsette Island is due to the presence of physical barriers which have curtailed the demand for east-west travel. Travel from the eastern to the western suburbs as a consequence is confined to a limited number of routes south of Andheri and Ghatkopar. The density flows along these routes are relatively high. Bus flows in the suburbs are routed so as to provide linkages between the railheads and residential areas that are not within walking distance and for providing inter-suburbs travel. The buses do not make extensive use of the two Express Highways although they do offer potential for faster travel. BEST's policy of providing feeder services rather than a line haul service, so as not to be in competition with the railways, may perhaps be a reason for not making use of them fully, since they are advantageous only when long distances need to be traversed. BEST buses ply through large traffic generating zones in both the city and the suburbs.

Travel patterns of bus commuters indicate the importance of the CBD as the focal point where traffic converges. Heaviest movement is along the north-south axis although there are prominent east-west movements in the vicinity of Parel and Mauplans Shaukhatali Road. The higher demand and denser flow on Bombay Island in comparison with the suburbs is because of the overall higher population densities as well as the fact that buses provide a superior service for passengers whose trip origins and trip destinations occur on Bombay Island. Analysis of the spatial pattern of demand on the railways showed that the trains arrive full by the time they reach the northern margins of Bombay Island. Capacity limitations and the difficulty of boarding the trains as well as the greater flexibility of bus services accounts for intra-city Island bus use. Buses, therefore, service a line haul function mainly for those who live and work on Bombay Island as well as serving as downtown collectors and distributors from the railway stations.
In the suburbs the buses serve mainly as residential collectors and distributors to the line haul system provided by the railways. The proliferation of services that has occurred in certain areas of the city highlights the very direct links between land use and transport, urban form and the distribution of activities within it. From this analysis of bus services the significance of the CBD once again emerges as does the role of the bus in association with the railways in providing for long distance commuters.
3.3 TEMPORAL ASPECTS OF DEMAND

It has been shown that the demand for transport is not uniform spatially, nor is it constant over time. It varies seasonally, weekly and diurnally. Daniels and Warnes (1980) noted that temporal variations in demand occur not only in terms of total volume but also in direction of movement. The changes in demand throughout a given weekday will be of concern here as the daily movement characteristics cause a concentration of movement at particular times and in a particular direction which results in the development of pressure points in the transport infrastructure. This in turn is a main cause of the urban transport problem. Such aspatial aspects are especially important with regard to the design, capacity and efficiency of a transport system.

Extreme variation takes place during the day. High demand for passenger transport facilities occurs at the beginning and end of the working day. This peak in traffic demand arises from obligatory trips, including journey-to-work and school. An important characteristic of such trips is that they are highly inflexible both in direction and timing. Journey-to-work is a time consuming activity for urban workers since it involves overcoming the friction of space between residential location and job location. An important aspect of the journey-to-work is spatial and consequently of interest to Geographers. The problem of the peaking in travel demand is made worse by the gradual increase in the number of commuters. However, it is often seen as a necessary evil in order that urban activities can function properly. Each city will have its own peculiar pattern of traffic peaking. Meyer (1967) notes that there are wide varieties of peaks ranging from the short and sharp peak usually associated with the CBD to the long peak affecting suburban areas.

The characteristics of the peak in Bombay will now be discussed.
Rail Travel

For the average middle class Bombayites, the public transport facilities are part and parcel of their existence in the urban setting. It is for this reason that in addition to the 'office peak' which is discernible in every large city, Bombay has other peaks that are present and which need to be appreciated. Tables 3.5 and 3.6 show the different types of demand which can be identified and the temporal nature of demand on the railways. It emphasizes the diverse nature of daily trip types taken by different sections of the population, with each creating their own 'peaks' in the demand for rail services. Most of the users are captive riders who have no other alternative in terms of modal choice. Railways serve more than just the CBD oriented trips. A distinguishing factor of Bombay suburban services, especially in comparison with those in DC's, is that goods are carried along with the passengers throughout the year whether it be milk, fresh fruits, vegetables or any other merchandise. There is no clear differentiation which exists between passenger and freight transport.

Ketkar (1981, 4) states appropriately that, 'there no longer exists a peak hour crowd on the Bombay suburban trains. Each hour is a peak hour and there is no respite on the railways either in the afternoon or at midnight'. It can, therefore, be seen that the railways play a vital role in the transport needs of Bombayites. There is always a great demand for accessibility to and from city to suburban areas. However, the dominant peak is provided by the journey-to-work and most transport studies have to date concerned themselves with the 'office peak' and have neglected the other types of peaks that are present in Bombay. Acute traffic problems do, nevertheless, coincide with the office peak. The problems of the peak are worsened by the spatial concentration of employment. Given that the land use policies in Bombay south are tending to attract more rather than less people into the Fort area, the present problems are likely to be accentuated. Bombay's major transport problem is basically a peak hour problem and this uni-directional peak hour
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0330 - 0500 hours</td>
<td>With petty trading and peddling being a widespread phenomenon in Bombay, daily supplies of agricultural produce such as milk, vegetables, eggs and fruit is brought in by the vendors from the extended suburbs. Passengers travelling with heavy luggage.</td>
</tr>
<tr>
<td>0500 - 0700 hours</td>
<td>Mill and factory workers residing in the suburbs commute to Bombay Island for start of morning shift. In addition to the blue-collar workers, self-employed and students commute south.</td>
</tr>
<tr>
<td>0700 - 1100 hours</td>
<td>White collar workers commute from the dormitory suburbs in the north to their work places in the extreme south. City bound Office goers.</td>
</tr>
<tr>
<td>1100 - 1300 hours</td>
<td>Businessmen and entrepreneurs who live in the north and travel to the business/bazaar area. Demand also by errand boys locally known as 'dubbawallas' (around 3,000 in Bombay) who carry heavy pallets stacked with lunch-boxes from homes of workers to their offices. Also demand by women shoppers and miscellaneous traffic.</td>
</tr>
<tr>
<td>Time</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1300 – 1600 hours</td>
<td>Second shift of mill and factory workers commuting to central part of Bombay Island. Also serving miscellaneous traffic including shoppers.</td>
</tr>
<tr>
<td>1600 – 2000 hours</td>
<td>Evening delivery of milk by milk vendors, school and college children returning home from their institutions in the north. Intercity passengers come down to Bombay Central and V.T. Businessmen whose work commences in evening such as diamond merchants and other precious stone dealers.</td>
</tr>
<tr>
<td>2000 – 2200 hours</td>
<td>Catering to miscellaneous traffic including social travel e.g. Cinema goers.</td>
</tr>
<tr>
<td>2200 – 0030 hours</td>
<td>Third shift of blue collar workers from northern and central suburbs to industrial area.</td>
</tr>
</tbody>
</table>

**Source:** Author's Research.
Table 3.6

**Analysis of the temporal nature of peak demand**

On Suburban Railways

(Northbound)

<table>
<thead>
<tr>
<th>Anti-peak Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>04:30 - 06:00 hours</strong> (Low density peak)</td>
</tr>
<tr>
<td>Intercity trains arriving at Bombay Central and V.T. where the passengers' ultimate destination is in the suburbs. Serving miscellaneous traffic</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>06:00 - 08:00 hours</strong> (Workers peak)</td>
</tr>
<tr>
<td>Industrial workers and students who live in the south but have workplaces in north. Third shift of mill workers returning home</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>08:00 - 12:00 hours</strong> (Students peak)</td>
</tr>
<tr>
<td>Students and Office workers going to their institutions and work places in the north.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>12:00 - 15:00 hours</strong> (Low density period)</td>
</tr>
<tr>
<td>Dubbawallas returning tiffins of workers to their homes. Agricultural vendors going back to the countryside.</td>
</tr>
</tbody>
</table>
### Table 3.6 (Contd.)

#### PEAK DIRECTION

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 - 1700 hours (Workers peak)</td>
<td>First shift of mill and industrial workers returning home. CBD shoppers who want to avoid the office peak returning to the suburbs early.</td>
</tr>
<tr>
<td>1700 - 2100 hours (Office peak)</td>
<td>White-collar workers and businessmen returning to the dormitory suburbs in the north.</td>
</tr>
<tr>
<td>2100 - 2300 hours (Low density period)</td>
<td>Businessmen and late office workers returning to the suburbs. Second shift of blue-collar workers returning home. Miscellaneous traffic.</td>
</tr>
</tbody>
</table>

**Source:** Author's Research.
traffic is generated by the heavy concentration of office employment in the south. There is a definite directional and temporal bias in the demand for transport services. The transport system proves to be grossly inadequate during the peak hours in spite of fast speeds, reliability and high frequencies. On the existing suburban network, the directional movement in the peak is north to south in the morning peak and south to north in the evening. The north-to-north traffic, that is, commuters from the western to eastern suburbs and vice versa merges with the directional flow as far as Dadar and at this interchange, traffic moves in the non-peak direction during the peak periods. Capacity problems are basically related to peak hour demand. BMRDA (1981, 2) estimated that 8% of the daily trips are being carried by the railways per peak hour in the peak direction, however sections south of Byculla and Grant Road still carry 10% of the total daily trips. The rated capacity of the nine-car electric multiple unit (EMU) is 1750 passengers, that is, its 'crush load capacity' with twice the seating capacity. It has been estimated by the railways for planning purposes that an average loading of 2600 passengers per rake can be used as the dense crush load capacity. This is adopted for peak period capacity calculations. MTP (Rly.) (1972, 99) estimated that this theoretically provides a floor space of 1.43 sq.ft. per standing passenger which is considered reasonable accommodation for suburban travel. However, what happens in practice is very different. The actual numbers carried on some sections is well over 5,000 passengers per train, that is, the trains are carrying twice their dense crush load capacity. Congestion and overcrowding are difficult to quantify. One can see these problems and even personally experience it, however, in order to get an indication of the degree of overcrowding on the railways the density of passengers per train can be calculated. A good indicator of the degree of overcrowding can be illustrated by the passenger density on the suburban trains during the 'office peak period'. Given that the percentage of passengers carried during the office peak is 8% of the total 24-hour volume (MTP (Rly.) 1981) and knowing
the number of trains run per peak hour, the passenger density per train can be calculated. (Appendix V and VI). In the peak hours, the trains from the suburbs are packed well beyond their dense crush load capacity. The density of traffic varies over each section (Fig. 3.4). Analysis of overcrowding on both railways shows that by the time the trains reach the northern boundary of Bombay Island at Mahim and Sion, trains are already 100% or more overcrowded over the dense crush load capacity, of 2600 on the C.R. and nearly 90% overcrowded on the W.R.

More overcrowding is evident on the C.R. than W.R. despite the fact that the former has a much lower line volume. (Appendix IV). This is mainly because of the less frequent service offered on C.R. which has only 17 trains per peak hour as opposed to 27 trains per peak hour on W.R. There has been a steady increase in the number of trains originating from Virar and Borivli since 1960. This has given some relief to the commuters but not to the extent demanded.

The densest passenger volumes on the C.R. main line occur on the section between Ghatkoper and Dadar. More than 100% overcrowding over the dense crush load capacity is observed. On the W.R. such dense overcrowding occurs between Dahisar and Borivli, and Goregaon and Andheri. Augmenting of capacity by additional trains originating at Borivli and Andheri gives some relief to the passengers, although the trains are still filled far in excess of their theoretical capacity. The average percentage overcrowding from Andheri to Dadar is 80.97%. The trains on both the railways are uncomfortably overcrowded upto Dadar. Stations south of Dadar have less overcrowding and this is because commuters start detraining to get to their work places on Bombay Island. It must be noted, however, that the trains are still full over their crush load capacity. For the volume of demand generated there is too little capacity to permit comfortable journeys.

The peak hour overcrowding has caused some degree of spreading to occur. This is manifested by the relatively long 'office peak' which lasts for three hours in the morning and three hours
Percentage overcrowding over the crush load capacity on the suburban network - 1978/79.

Fig. 3.4

Source: Based on personal calculations using Appendix V & VI.
in the evening. It has also resulted in considerable supressing of the demand by other users during these hours. Suburban rail services in Bombay have failed to expand in capacity to meet the demand requirements and this has caused considerable overcrowding and inconvenience to the commuters, with trains unsafely loaded far in excess of their design capacities. All indications point to the fact that an augmentation in service is both desired and necessary. Table 3.7 shows the number of trains required to be in service to avoid such inhuman overcrowding. The peak hour requirements on Andheri-Bandra section comes to 47 trains per hour using the railways index of 2600 commuters per train. At present 24 trains run on this section per hour. An additional 23 trains are required. The same level of capacity deficiency occurs on most of the sections south of Borivli and Thana. The number of trains running on the suburban section is not sufficient to deal with the present needs of the suburban commuter traffic during the peak hours. Despite having a very efficient electric railway system, it is still insufficient for today's needs. This discrepancy between the demand for transport services and the supply for it has created problems of unmanageable dimensions for the railways.

Clearly, the large number of trains needed to adequately satisfy the peak demand raises the question of the line capacity (MTP (Rly.), 1978, 97).

On the C.R., there is no scope for increasing the frequency of service in the northern suburban area due to track limitations. As a result, it seems as if the dense overcrowding will continue and become worse as demand increases. On the W.R., a similar situation prevails. The available capacity has been increased to facilitate 29 trains per peak hour coming in to Grant - Churchgate section with 27 trains already running the extra capacity allows for only two more trains in the peak hour. This compares with the required capacity of 19 additional trains. The uni-directional pattern of traffic flow causes a great deal of strain on the transport system. Such transport problems cannot be solved merely by providing additional capacity. The increase in the frequency of the train service will not end the race
Table 3.7

Gap between supply and demand
For rail transport capacity

<table>
<thead>
<tr>
<th>SECTION</th>
<th>Number of trains run during peak hour</th>
<th>Number of trains required to be run during peak hour</th>
<th>Additional trains required</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENTRAL RAILWAY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kalyan - Thane</td>
<td>8</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Thane - Kurla</td>
<td>15</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Kurla - V.T.</td>
<td>17</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>WESTERN RAILWAY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virar - Borivli</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Borivli - Andheri</td>
<td>14</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>Andheri - Bandra</td>
<td>24</td>
<td>47</td>
<td>23</td>
</tr>
<tr>
<td>Bandra - Churchgate</td>
<td>27</td>
<td>46</td>
<td>19</td>
</tr>
</tbody>
</table>

Source: METROPOLITAN Transport Projects (Railways)
between demand and supply. Although the waiting time to board the train is not very long, Table 3.8 shows that 43.2% of commuters wait between 5-10 minutes and 61.1% wait between 5-15 minutes. This can be explained by the large capacity of trains in comparison with buses. Also, and a more important reason, is the degree of overcrowding that is allowed on the railways and which occurs during the peak hours. Taking into consideration the fact that the W.R. runs a two minute frequency service during the rush hours and the C.R. a five minute service, the waiting time proves that the commuters are unable to board the first train that comes. Voorhees (1930) undertook a survey to calculate the hourly inflow of rail commuters into the two CBD termini. The highly peaked nature of office workers arriving into the fort area is shown in Figs. 3.5 and 3.6. Passenger arrivals at Churchgate and V.T. reach a sharp peak between 9.30 and 10.30 a.m. At V.T. a sharp midday peak is discernible. This could be due to the arrival of inter-city trains. The evening peak at V.T. is not as sharp as at Churchgate. The large tertiary sector concentration produces the high, closely concentrated daily 'office peak' which is maintained and worsened by the growth of office complexes and the set work hours. Great demands are placed on the railways particularly since many activity generators are located in a small area in the south. (Chapter 3.2). Plate I depicts the daily scene on V.T. platforms during the peak hours. Two commuter trains arriving simultaneously at the terminus shows the haphazard and disorganized system of alighting and existing methods. London Transport Executive (1972, 26) estimated that it takes at least three minutes to disperse the crowd from one train. This problem is not confined only to inside the terminus.

Excess demand at peak hours manifests itself through overcrowding and passengers not being able to alight from or board the train. Westwood (1974, 12) describes vividly the conditions prevalent on Bombay's railways. 'At any one time of the day, they could not be assured a seat .... during the (acute) peak hours which lasted six hours a day they could not be even sure of boarding
### Table 3.8

**Waiting Time for Railway Commuters to board train**

<table>
<thead>
<tr>
<th>Time (in min.)</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>21.4</td>
</tr>
<tr>
<td>5 - 10</td>
<td>43.2</td>
</tr>
<tr>
<td>10 - 15</td>
<td>17.9</td>
</tr>
<tr>
<td>15 - 20</td>
<td>8.9</td>
</tr>
<tr>
<td>20 - 25</td>
<td>5.7</td>
</tr>
<tr>
<td>25 - 30</td>
<td>1.8</td>
</tr>
<tr>
<td>30+</td>
<td>1.1</td>
</tr>
</tbody>
</table>

100.00%

**Source:** Field Survey, July 1982.
HOURLY DISTRIBUTION OF ARRIVAL OF RAIL COMMUTERS AT
CHURCHGATE TERMINUS

Bombay 1980.
HOURLY DISTRIBUTION OF ARRIVAL OF RAIL COMMUTERS AT VICTORIA TERMINUS


112
Plate I: Daily peak hour scene at Victoria Terminus.

Plate II: Overcrowding on Central Railway
the train except at the originating stations. Intermediate stations train after train may halt without offering a foothold either inside or outside. The degree of overcrowding is so great that it has been estimated only 12% of the commuters get a seat while travelling by train.

Plate II depicts the plight of the Bombay commuter which is part of the daily experience for a majority of the city's inhabitants. Inadequate capacity due to the high demand forces commuters to stand on the footboard or cling to the doors. For commuters not fortunate enough to board the train at the terminus, travelling is a gamble with death. Thousands daily travel hanging on steel bars of the doorway and on average Jha (1981, 12) estimated that fourteen persons fall to their death everyday. Travelling on the footboards is illegal but for the commuters it is unavoidable. This is not so much an indication of the paucity of trains as of the plentitude of people. IBRD (1971) estimated that during the peak hours about twice as many commuters use railways compared with buses as the main mode of transport.

Rail transport cannot provide a door-to-door service. Walking serves as an important adjunct to rail transport. Severe pedestrian congestion occurs on the roads in the vicinity of many stations. This is especially pronounced outside the two main CBD termini in the Fort area. It is estimated that during the peak hour 26,000 pedestrians walk between the two CBD termini and to the commercial districts in the south and west. Proposals to connect W.R. and C.R. CBD termini by an underground loop which would allow commuters to be taken directly to their workplaces and hence avoiding the large pedestrian spill over onto the carriageways have not yet been sanctioned. Plates III and IV depict the overflow of commuters outside V.T. Adequate dispersal facilities have not been provided on the approach roads of the station. This creates conflict between pedestrians and vehicles and as a result safety hazards and lengthy delays for all. This is further aggravated by the fact that heavy vehicular flow coincides
Plate III: Overflow of commuters outside V.T. - Morning peak

Plate IV: Overflow of commuters outside V.T. - Evening peak
with high pedestrian flows giving rise to an unmanageable congestion situation. Recommendations for a pedestrian precinct from V.T. to Hutatma Chowk along D.N. Road by Voorhees (1980) have not been implemented. Meanwhile a pedestrian lane comparable to a bus lane has been compromise for a pedestrian precinct. Modak (1981, 21) in an important study undertook a walking experiment along D.N. Road. The result showed a speed decline with an increase in walking time by 26% during the peak hours. In the vicinity of Churchgate station the overflow of pedestrians onto the carriageway is not as severe because of the availability of a foot-overbridge. This space separation of pedestrian and vehicle facilities has become a boon to the pedestrians as they are able to reach the termini without dodging their way through heavy vehicular traffic. Voorhees (1980) survey revealed that on average 23,000 pedestrians per hour use the foot-over-bridge across Veer Nariman Road while 2,100 vehicles (including 80 buses) per hour pass under it. Ironically, however, IERD in 1980 requested the local Government to abandon the foot-over-bridge in favour of a zebra crossing. The main reason given for abandonment of the facility was that delays of over four minutes were experienced by pedestrians using the foot bridges during the peak hours and many as a result avoided it thus conflicting with vehicular traffic. In retrospect, however, it seems as if it would have been wiser to keep the foot bridge in use as well as provide a zebra crossing, thereby not only giving a choice to the pedestrians but also increasing the capacity available for pedestrians.

From the authors questionnaire survey, it was found that 80.4% of those surveyed were using the footbridge or underpass provided. This is a high percentage considering the low level of road discipline of users. However, the 19.6% who said they did not use the facilities explained that they were time consuming and not convenient to use, and that they were overcrowded most of the time by unwanted elements such as beggars and hawkers who cause such structures to be dirty and unhygienic.
A third terminal at Ballard Estate was proposed and a survey by MTP (Rly.) in 1970 was undertaken. It was found in the report that since a large number of commuters disgorged at Churchgate and V.T. during the office peak period to reach their destination in the Fort Market area of the CBD, construction of another CBD terminal would considerably reduce the congestion not only on the present two terminals but also on the approach roads. However, the proposal was not considered justified by itself because it would not have served as additional corridor to syphon traffic directly from north of Bandra and Kurla. There was, the authority felt, a need to simultaneously increase capacity of the line haul portion of the existing system.

Analysis of the travel patterns indicates that the geographical constraint exercised by the location of CBD at the southern tip of the narrow peninsular has caused tremendous pressure on the existing transport system.

The tendency toward further concentration in the CBD must be effectively restricted. Traffic cannot be minimised as long as work centres are centralized and land use in the CBD is intensified. It is urgently necessary to regulate demand for transport through better control over land use, the pattern of land use being the dominant factor influencing the demand placed on the public transport system.

**Bus Travel**

Stage bus services are provided exclusively by BEST who also face the problem of meeting the peak hour demand of the commuters. They are obliged to maintain a large fleet of buses to cope with the peak hour demand which causes idle capacity during the off-peak hours. With well planned land use, unwanted concentration of traffic at a certain few times of the day and in a particular direction can be prevented to some degree. Fig. 3.7 shows the volume and direction of the flow of commuters during a typical workday. The two morning and evening peaks are discernible. In contrast with the railways, however, the peak —
Fig 3.7

LEGEND

- NORTHBOUND (to suburbs)
- SOUTHBOUND (to city)

antipeak directional volumes are not as varied. In the morning the predominant flow of traffic is north to south whilst during the evening the flow is reversed. During midday the flows are more or less even in both directions.

0600 - 0800 hours: Workers peak: Nearly 1½ more passengers travelling northbound. This is due to the blue collar workers who live in the south and commute to central or north Bombay.

0800 - 1000 hours: Office peak: A higher percentage of passengers travelling southbound. White collar workers who reside in the northern part of Bombay Island commute to the city centre.

1000 - 1600 hours: Miscellaneous peak: All these hours show reasonably balanced flows of passengers in both directions. As the buses serve a variety of trip types on Bombay Island as well as in the suburbs this causes the buses to be evenly occupied both north and southbound. Therefore, unlike the railways, buses do not suffer from such acute peak - antipeak differences in demand.

1600 - 2000 hours: Office peak: Northbound demand is higher as office workers return home. 31.4% of the total passengers carried northbound occur at this time and give the buses their maximum demand.

2000 - 2400 hours: There is a dramatic drop in demand from 8.9% dropping to 2.3% of total passengers carried. Southbound demand is higher and this can be accounted for by blue collar workers returning home from industries in the central and north parts of Bombay.

In general, the buses carry high densities of traffic throughout the working day from 0800 to 2000 hours. In some places the demand is suppressed for want of more services and thus the peak demand is not fully catered for. The peak demand is flattened and like the railways it is spread over a greater time period. The 'extended' and 'flattened' peak period is shown by the fact that the BEST authorities classify the period of high demand in the following way:-
CITY: 0800 - 1200 and 1600 - 2000 hours

SUBURBS: 0600 - 1000 and 1700 - 2100 hours

Note the earlier start of morning peak period in the suburbs and later start of evening peak period.

Mott (1972, 74) estimated that 250 buses are used as 'extras' during the peak hours. The characteristics of temporal demand are such that the buses are required to be run more intensively at times outside what would normally be considered the peak. An advantage the buses therefore have over the railways is that the demand structure does not create long periods when the buses ply empty in only one direction at different times of the day. During what would normally be considered 'off-peak hours' the demand is still relatively high. The load factor on BEST today is 77%. BLRDA (1981, 49). Such a high occupancy level cannot be attained without substantial peak hour overcrowding and high loadings at most times of the day.

Another feature of bus operation is the high vehicle utilization. White (1980, 142) notes that 2,000 passenger trips per day and 75,000 passengers per day can be attributed to the high demand throughout the day and the high load factor.

The high load factor also suggests discomfort being faced by passengers because of insufficient number of vehicles to meet the demand. The repercussions of this are similar to that faced by rail commuters. The bus commuters find it extremely difficult to get accommodation either seating or standing other than at the terminals. Even at the originating points, long winding queues are proof of the fact that demand is far greater than the capacity available.

Conditions for bus passengers are variable and certainly undesirable during peak periods when delays give way to lengthened headways, reduced service frequencies and long queues of waiting passengers.

BEST authorities do not allow levels of overcrowding on their buses comparable with that on the railways. Conductors are fined if they carry more passengers than allowed.
Plate V shows that BEST also has its share of footboard travellers. This photo was taken during one of the railway strikes. It shows how commuters made their journey home. Such overcrowding of buses is a daily scene in other large cities of India including Delhi and Calcutta but BEST authorities are normally extremely stringent on such overloading of buses. It does occur, however, when the railways, a major component of Bombay's transit system, are not for any reason operating fully. The longer waiting times experienced by bus passengers is shown in Table 3.9. The survey shows that bus commuters do wait a relatively long time to catch a bus. 31.3% of commuters waited between 10-15 minutes while 22.5% waited between 15-20 minutes and over 5% waited more than 30 minutes. Bus commuters generally wait for a longer time than train commuters. Since buses do not have their own right of way - exclusive track, they are subject to vehicle congestion in addition to person congestion which tends to characterize road use especially in large cities in LDCs. Road congestion problems are further aggravated by the heterogeneous nature of road traffic. The low speeds and poor utilization of road space causes hazardous conditions for bus operators, so much so that the buses move at an average speed as slow as 6 km per hour on some routes (Illustrated Weekly, 1981, 29). In some places, especially in the Bazar area extremely low speeds are maintained throughout the day. The often quoted flexibility of the bus has been increasingly undermined by the incidence of traffic congestion and its impact on service regularity and time keeping.

Bhardwaj (1974, 210) describes the road traffic situation in Bombay and he notes that 'The roads and city streets of today have become a battlefield of cars, buses, handcarts, pedestrians, stray cattle etc. Such a traffic mixture has caused problems to become more complex and difficult'. Such a situation creates particularly difficult conditions for the bus operator.

In order to increase the operational efficiency of buses, a bus priority scheme in the form of a bus lane was introduced. A bus lane from J.J. Hospital to Crawford Market in the Bazar area along the heavily used Mohammedali Road and Rahintulla Road
Plate V: Footboard travellers on BEST
Table 3.9

Frequency Distribution of Waiting Times for bus

<table>
<thead>
<tr>
<th>Time Waiting For bus (in min.)</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>3.1</td>
</tr>
<tr>
<td>5 - 10</td>
<td>28.6</td>
</tr>
<tr>
<td>10 - 15</td>
<td>31.3</td>
</tr>
<tr>
<td>15 - 20</td>
<td>22.5</td>
</tr>
<tr>
<td>20 - 25</td>
<td>6.5</td>
</tr>
<tr>
<td>25 - 30</td>
<td>2.7</td>
</tr>
<tr>
<td>30+</td>
<td>5.3</td>
</tr>
</tbody>
</table>

100.00%

was implemented in 1977. The bus lane was a failure because the road users neglected the measures to be adopted and violation remained high. Bus lanes provide an inexpensive way of relieving the bus of peak hour congestion problems. Successful implementation did not occur because of the inadequate road network capacity and the heterogeneous vehicular type plying Bombay roads. The nature of the problems are such that they cannot be solved using readily available western traffic management techniques. The scope for traffic engineering methods proposed in Bombay is discussed in more detail in Chapter 5.3.
3.4 COMMUTER TRAVEL CHARACTERISTICS

Travel characteristics of people in a given city depend to a large extent upon the transport facilities, available to them. As a result of the extensive public transport network, Bombayites greatly rely on the public transport system for access to and from the city and suburbs. For the vast majority of them there is no choice between taking the car or using public transport.

The Indian Institute of Management (1978, 22) in their study of household and travel characteristics found that the per capita trip by all modes was 1.23 per day in 1978. The per capita trip by mechanical modes was 0.83 per day and by public transport it was 0.75 per day. They calculated that the per capita trip by public transport had increased from 0.68 to 0.78 over the decade 1968-1978. This shows that more people have opted to travel by public transport and hence there has been an increase in public transport patronage, in clear contrast with the situation in many large cities of the developed economies.

In Bombay it is found that modal split characteristics for journey-to-work and other obligatory trips is such that public transport is the most frequently used mode. Table 3.10 shows the distribution of trips amongst the different modes. Buses and trains carry the maximum traffic load. The majority of the commuters use suburban trains followed by BEST buses. By virtue of their larger capacity, speedier travel and cheap fares, travel by train has been increasing over the years at the expense of other modes. In 1968 the modal split between rail and bus was 50:50, today in view of the development of new residential areas further north, without the matching job opportunities, the share of rail commuter traffic has increased to 53:47 (Central Planning Organization, 1981).

Changes in modal split characteristics from 1968 to 1981 show that more people are using public transport, commuters are using cars less and that the buses have lost out to the railways. The very low levels of motorcycle/bicycle usage
Table 3.10

MODAL SPLIT CHARACTERISTICS OF COMMUTERS

<table>
<thead>
<tr>
<th>MODE</th>
<th>1968 PERCENTAGE</th>
<th>1981 PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban</td>
<td>39</td>
<td>44.0</td>
</tr>
<tr>
<td>Railways</td>
<td>39</td>
<td>37.0</td>
</tr>
<tr>
<td>Buses</td>
<td>10.6</td>
<td>9.0</td>
</tr>
<tr>
<td>Cars</td>
<td>9.3</td>
<td>7.9</td>
</tr>
<tr>
<td>Taxis</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>School buses</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Motorcycles/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

100.00%  100.00%

Source: CENTRAL Planning Organization, Lok Sabha Committee on visit to Bombay, Commuter Services in Bombay, Bombay, January 1981.
comparative to other LDC cities is due to the long average distances that have to be traversed in Bombay and also because of the availability of cheap mass public transport.

Today, cars account for only 9% of the total trips and not surprisingly, are used mostly by the higher income groups. Rail and bus modes together account for a significant 81% of passenger movement, with 4.5 million people using the trains and 4 million using the buses daily. The vital role of railways is highlighted here and is explained by their comparative advantage in the transport of large numbers of passengers at low cost. Buses form the next most important element in the transport system, moving the second largest proportion of passengers.

Travel expenditure is closely related to income IIM(1978) found that on average 6% of total income is spent on transport, the average monthly per capita expenditure being Rs.35.00. Table 3.11 shows the results of the IIM survey. It was found that 23% of the commuters earning below Rs.300.00 spend less than Rs.10.00 a month on travel. In contrast, 28% of those in the income brackets 'D' and 'E' spend more than Rs.90.00. Of those in income bracket 'B', nearly 50% spend between Rs.11.00 - Rs.20.00 while those in group 'C', over 50% spend between Rs.41.00 - Rs.60.00. 54% of those in income group 'A' spent below Rs.20.00, the same percentage of those in income group 'E' spend over Rs.90.00.

The level of expenditure on transport, demonstrates that there is a clear tendency for commuters to spend more on transport as income increases. Modal choice and income also show a direct relationship. Table 3.12 shows the percentage of each modal type by persons in different income groups.

It can be seen that 66.2% of all trips by walk mode were undertaken by people in the lower two income groups whereas only 5.8% were undertaken by those in the highest two groups. Over half (53%) of trips on private car was undertaken by people in the highest income group and no one in the lowest group.
Table 3.11

PERCENTAGE OF COMMUTERS BY TRAVEL EXPENDITURE AND INCOME

<table>
<thead>
<tr>
<th>Group</th>
<th>Income Class (Indian Rupees)</th>
<th>Less than 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>11-20</td>
</tr>
<tr>
<td>A</td>
<td>Less than 300</td>
<td>22.6 (8.0)</td>
</tr>
<tr>
<td>B</td>
<td>301 - 500</td>
<td>53.9 (6.5)</td>
</tr>
<tr>
<td>C</td>
<td>501 - 1000</td>
<td>20.0 (2.9)</td>
</tr>
<tr>
<td>D</td>
<td>1001 - 1500</td>
<td>2.5 (1.7)</td>
</tr>
<tr>
<td>E</td>
<td>1501 and above</td>
<td>1.0 (1.4)</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Source: INDIAN Institute of Management, Centre for Transportation Studies, Travel demand and social cost benefit analysis of East-West Corridor - BMR, Bombay, 1978, p. 31.
<table>
<thead>
<tr>
<th>Monthly Income (Rs.)</th>
<th>Train</th>
<th>Bus</th>
<th>Car</th>
<th>Walk</th>
<th>Taxi</th>
<th>Scooters/Motorcycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Less than 300</td>
<td>15.1</td>
<td>12.5</td>
<td>-</td>
<td>22.0</td>
<td>2.7</td>
<td>9.3</td>
</tr>
<tr>
<td>B 301 - 500</td>
<td>42.1</td>
<td>39.2</td>
<td>10.9</td>
<td>44.2</td>
<td>22.2</td>
<td>10.9</td>
</tr>
<tr>
<td>C 501 - 1000</td>
<td>34.5</td>
<td>36.6</td>
<td>22.1</td>
<td>28.0</td>
<td>31.0</td>
<td>28.7</td>
</tr>
<tr>
<td>D 1001 - 1500</td>
<td>6.4</td>
<td>8.6</td>
<td>14.1</td>
<td>4.0</td>
<td>18.4</td>
<td>30.2</td>
</tr>
<tr>
<td>E 1500 +</td>
<td>1.8</td>
<td>3.1</td>
<td>52.9</td>
<td>1.8</td>
<td>25.7</td>
<td>20.9</td>
</tr>
</tbody>
</table>

**Source:** Indian Institute of Management Centre for Transportation Studies, *Travel Demand and Social Cost benefit analysis of East-West Corridor in B.M.R.*, Bombay, 1978, p. 46.
It is also worthwhile to note that over three-quarters of all trips by public transport modes were undertaken by people in the two middle income groups (B and C). 31% of all trips by taxi was undertaken by people in income group (C) and nearly 26% by those in the highest income group. However, this percentage decreases to under 3% for those in the lowest income group. The lower levels of car usage by those in income group (C) accounts for the greater number of taxi trips by them. A relationship also exists between duration of a trip and the transport mode used. A pattern of usage of different modes with trip length can be identified. Table 3.13 shows that 61% of the walk mode trips are completed within 19 minutes. Walk trips are seen to decline steeply with an increase in travel time up to one hour. In a city like Bombay, walking is used mainly for short trips. Given the relative speeds of the different modes, the long average journey time for the railways confirms that mode's importance for long distance commuters, 19% of the train trips are of a duration of more than one hour and over 47% are in excess of 40 minutes. In the case of the slower bus mode, the percentage of journeys of above 60 minutes duration is 12% and only 30.6% above 40 minutes. 69.4% of the bus trips fall below 40 minute duration and 53% of the train journeys. In the 'other' category, which includes cars, taxis, scooters/motorcycles, 83.5% of all journeys are completed within 40 minutes.

Expressed graphically Fig. 3.8 shows the overwhelming importance of walking for shorter time journeys with a rapid decline after 19 minutes and gradual decline between about 30 minutes and one hour. The percentage of journeys made by bus rises to a peak at about 39 minutes but then declines markedly while the percentage of journeys by train clearly dominates in the 39 minutes to one hour range of time.

In the questionnaire survey carried out by the author, respondents were asked to rank the reasons why they used the different public transport modes. Table 3.14 shows the results of the ranking and weighted averages of respondents answers to
Table 3.13

PERCENTAGE OF TRIPS
BY MODE AND TRAVEL TIME

<table>
<thead>
<tr>
<th>Time period</th>
<th>TRAIN</th>
<th>BUS</th>
<th>WALK</th>
<th>OTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 9</td>
<td>0.9</td>
<td>0.7</td>
<td>8.8</td>
<td>1.9</td>
</tr>
<tr>
<td>10 - 19</td>
<td>11.1</td>
<td>15.0</td>
<td>52.7</td>
<td>32.2</td>
</tr>
<tr>
<td>20 - 29</td>
<td>14.3</td>
<td>18.7</td>
<td>19.0</td>
<td>19.7</td>
</tr>
<tr>
<td>30 - 39</td>
<td>26.6</td>
<td>35.0</td>
<td>16.2</td>
<td>29.7</td>
</tr>
<tr>
<td>40 - 59</td>
<td>27.8</td>
<td>18.3</td>
<td>2.1</td>
<td>8.6</td>
</tr>
<tr>
<td>60+</td>
<td>19.3</td>
<td>12.3</td>
<td>1.2</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Source: INDIAN Institute of Management, Centre for Transportation Studies, Travel demand and Social cost benefit analysis, Chapter two, p. 33.
Graph to show trips by mode and journey time

Source: IIM, Travel Demand and Social cost-benefit of E-W Railway corridor in BMR, 1976, p.35
Table 3.14

<table>
<thead>
<tr>
<th>REASONS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total weighted averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable</td>
<td>11.4%</td>
<td>8.2%</td>
<td>12.1%</td>
<td>18.6%</td>
<td>23.2%</td>
<td>26.4%</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>(68)</td>
<td>(41)</td>
<td>(48)</td>
<td>(56)</td>
<td>(47)</td>
<td>(26)</td>
<td></td>
</tr>
<tr>
<td>Cheap</td>
<td>9.6%</td>
<td>22.9%</td>
<td>17.1%</td>
<td>15.7%</td>
<td>20.7%</td>
<td>13.9%</td>
<td>396</td>
</tr>
<tr>
<td></td>
<td>(58)</td>
<td>(115)</td>
<td>(68)</td>
<td>(47)</td>
<td>(94)</td>
<td>(14)</td>
<td></td>
</tr>
<tr>
<td>Quick</td>
<td>14.6%</td>
<td>17.5%</td>
<td>21.1%</td>
<td>16.8%</td>
<td>17.5%</td>
<td>12.5%</td>
<td>358</td>
</tr>
<tr>
<td></td>
<td>(88)</td>
<td>(88)</td>
<td>(84)</td>
<td>(50)</td>
<td>(35)</td>
<td>(13)</td>
<td></td>
</tr>
<tr>
<td>Convenient</td>
<td>22.5%</td>
<td>20.7%</td>
<td>21.1%</td>
<td>18.2%</td>
<td>12.5%</td>
<td>5.0%</td>
<td>408</td>
</tr>
<tr>
<td></td>
<td>(135)</td>
<td>(104)</td>
<td>(84)</td>
<td>(55)</td>
<td>(25)</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>Readily available</td>
<td>6.8%</td>
<td>19.3%</td>
<td>22.9%</td>
<td>22.9%</td>
<td>17.9%</td>
<td>10.4%</td>
<td>345</td>
</tr>
<tr>
<td></td>
<td>(41)</td>
<td>(97)</td>
<td>(92)</td>
<td>(69)</td>
<td>(36)</td>
<td>(10)</td>
<td></td>
</tr>
<tr>
<td>No Other alternative</td>
<td>35.1%</td>
<td>11.4%</td>
<td>6.1%</td>
<td>7.5%</td>
<td>8.6%</td>
<td>31.4%</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td>(211)</td>
<td>(57)</td>
<td>(24)</td>
<td>(23)</td>
<td>(17)</td>
<td>(31)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey, July 1982
reason for travelling by train. It was found that 'convenient' and 'cheap' were the most important reasons why commuters travelled by train. Middle ranking was given to 'quickness' and 'no other alternative', while reliability was ranked relatively low by most people. Weighted averages of reasons for travelling by bus more or less followed the same trends as reasons for travelling by train (Table 3.15). 'Convenient' was ranked as the most important reason why commuters travelled by bus. However, 'no other alternative' was ranked the second highest. Confirming the importance of the bus for commuting from areas not served by the railways, while 'reliable' had a higher ranking than trains. This is quite surprising when one takes into consideration the fact that buses are open to road congestion causing irregular services. 'Cheap' had a lower ranking in comparison with trains, understandable in view of the fact that buses are more expensive than trains especially in the absence of season passes for bus travel.

'Quick' had a middle range ranking and 'readily available' had a higher ranking in comparison to trains.

Having discussed in some detail the nature of commuter travel in Bombay, each mode of transport will now be looked at in the next chapter.
### Table 3.15

**Ranking of reasons why commuters travel by bus**

<table>
<thead>
<tr>
<th>REASONS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total weighted average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable</td>
<td>6.8</td>
<td>15.8</td>
<td>20.4</td>
<td>19.6</td>
<td>20.8</td>
<td>16.6</td>
<td>339</td>
</tr>
<tr>
<td></td>
<td>(41)</td>
<td>(79)</td>
<td>(82)</td>
<td>(78)</td>
<td>(42)</td>
<td>(17)</td>
<td></td>
</tr>
<tr>
<td>Cheap</td>
<td>6.0</td>
<td>10.2</td>
<td>13.6</td>
<td>16.2</td>
<td>26.4</td>
<td>27.5</td>
<td>271</td>
</tr>
<tr>
<td></td>
<td>(36)</td>
<td>(51)</td>
<td>(54)</td>
<td>(49)</td>
<td>(53)</td>
<td>(28)</td>
<td></td>
</tr>
<tr>
<td>Quick</td>
<td>3.0</td>
<td>6.8</td>
<td>21.5</td>
<td>21.1</td>
<td>28.3</td>
<td>19.2</td>
<td>277</td>
</tr>
<tr>
<td></td>
<td>(18)</td>
<td>(34)</td>
<td>(86)</td>
<td>(63)</td>
<td>(57)</td>
<td>(19)</td>
<td></td>
</tr>
<tr>
<td>Convenient</td>
<td>38.5</td>
<td>27.9</td>
<td>14.0</td>
<td>13.2</td>
<td>3.8</td>
<td>2.6</td>
<td>478</td>
</tr>
<tr>
<td></td>
<td>(231)</td>
<td>(140)</td>
<td>(56)</td>
<td>(40)</td>
<td>(8)</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Readily available</td>
<td>6.0</td>
<td>26.4</td>
<td>21.5</td>
<td>20.8</td>
<td>13.6</td>
<td>11.7</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>(36)</td>
<td>(132)</td>
<td>(86)</td>
<td>(62)</td>
<td>(27)</td>
<td>(12)</td>
<td></td>
</tr>
<tr>
<td>No other alternative</td>
<td>39.6</td>
<td>14.3</td>
<td>8.7</td>
<td>7.9</td>
<td>7.2</td>
<td>22.3</td>
<td>405</td>
</tr>
<tr>
<td></td>
<td>(238)</td>
<td>(72)</td>
<td>(35)</td>
<td>(24)</td>
<td>(14)</td>
<td>(22)</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Field Survey, July 1982
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CHAPTER FOUR

TRANSPORT PROVISION IN

GREATER BOMBAY

General Railways

1. One pair of tracks of local trains from Kalyan to VT, a distance of 53 km, used for running local suburban trains.

2. One pair of tracks from Kalyan to VT, used for running local line trains and during peak hours for fast express suburban trains.

3. One pair of tracks between Kalyan and VT, a distance of 15 km, used for running suburban trains.

Suburban trains run along the suburban and main line tracks from Kalyan to Kurla and between Kurla and Bombay Docks of 27 km and 66 km respectively (All India Planning Organization, 1971). Bombay is an excellent example of a city that is...
THE SUBURBAN RAILWAYS:

Greater Bombay is served by two railways, namely, the Western Railway and the Central Railway which are now two divisions of Indian Railways and were formerly the B.B. and C.I. Railway and G.I.P. Railway respectively. Both these railways offer commuter suburban rail services as an adjunct to their main line passenger and freight services. The suburban railway traffic at present accounts for 4.5 million passengers daily. This is quite substantial when one considers the fact that this makes up over one third of the total daily number of passengers carried on all Indian Railways (Central Planning Organization, 1981). The existing suburban railway network in Bombay consists of five corridors, two on the W.R. and three on the C.R.

**Western Railway:**
1. One pair of tracks of local lines from Borivli to Churchgate, a distance of 34 km used for running slow suburban trains.
2. One pair of tracks of main lines from Virar to Bombay Central, a distance of 50 km used for inter-city trains and during peak hours used for fast 'express' suburban trains.

**Central Railway:**
1. One pair of tracks of local lines from Kalyan to V.T., a distance of 53 km used for running slow suburban trains.
2. One pair of tracks from Kalyan to V.T. used for main line trains and during peak hours for fast 'express' suburban trains.
3. One pair of tracks between Bandra/Kurla to V.T. a distance of 14/15 km used for running suburban trains.

Suburban trains are also run sharing the main line tracks from Kalyan to Kasara and Kalyan to Karjat distances of 67 km and 46 km respectively (Central Planning Organization, 1981). Bombay is an excellent example of a world city that is
not able to effectively segregate its main line inter-city traffic from intra-urban transport movement. This inevitably gives rise to inordinate delays when the goods and mail trains are delayed or occupying the tracks. It constitutes a hindrance to the regular flow of commuter traffic and prevents a regular operation of the suburban services. Efforts have been made to reschedule the inter-city trains so that they arrive in Bombay before and after the 'office peak'. Nevertheless, such a mixture of inter- and intra-urban trains does constitute a severe problem for the railways.

The advantages and disadvantages of rail transport for urban movement revolve around its fixed track. Railways by their very nature lack flexibility, due to this characteristic, journeys have frequently to begin and end by road. The main advantage, however, is that under suitable operating conditions they are able to maintain speed and are not affected by traffic congestion in the way that road transport is. In Bombay, the railways constitute the most popular, effective and low cost means of mass transport. The coverage and catchment area of the railways as estimated by the railway authorities is within a radius of 1 km from stations on Bombay Island and 1.5 km in the suburbs. Fig. 4.1 shows that excellent coverage is provided on Bombay Island except for the extreme eastern and western flanks of the island and the area south of the two CBD termini. The average distance between stations on Bombay Island is 1.35 km. In the suburbs in contrast, stations are 2.83 km apart on average (Patankar, 1978, 135) and coverage is fairly satisfactory except in the centre of the island where physical barriers prevent transport links. The survey carried out by the author shows that 53% of those questioned live within 2 km of the railway station (Table 4.1). Beyond a distance of 3 km the number of commuters tapers off rapidly. The railways inflexibility, therefore, does not act as a deterrent in the demand for rail transport. This, together with the linear development of the city has enabled conventional rail transport to provide a good intra-city

Table 4.1

Frequency Distribution of Distance of Residence From Railway Station

<table>
<thead>
<tr>
<th>Distance in (km)</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.0</td>
</tr>
<tr>
<td>2</td>
<td>28.7</td>
</tr>
<tr>
<td>3</td>
<td>23.3</td>
</tr>
<tr>
<td>4</td>
<td>10.0</td>
</tr>
<tr>
<td>5</td>
<td>3.2</td>
</tr>
<tr>
<td>6</td>
<td>5.4</td>
</tr>
<tr>
<td>7</td>
<td>5.4</td>
</tr>
</tbody>
</table>

100.00%

service resembling that of a rapid transit system both in terms of frequency and inter-station distance, especially on Bombay Island.

On average 2.2 million commuters use the W.R. services. In order to cope with this demand, the railway runs 715 trains daily. The structure of the services between various terminals is given in Table 4.2. Examination of the timetable shows that all the 'fast' trains serve the long distance commuters. There are no express services provided for commuters who live south of Bandra. In the morning peak, nine trains from Virar, twenty-six trains from Borivli to Churchgate offer speedy travel for those who commute from the extended suburbs. An equal number are also provided during the evening peak period. The speed on average is in the order of 32 km/hr to 38 km/hr. This compares favourably with the average speed of rapid transit corridors in other cities of the world which range between 25 km/hr to 40 km/hr. (MTP (Rly.), 1972). During the morning period, there is a frequency of service of 2.25 minutes into Churchgate and in the evening peak the service is maintained at 2.27 minute intervals.

The Central Railway on the other hand, runs the highest density of trains on Indian Railways with a route length of 192 km and serving 55 suburban stations. It carries commuters over distances of 100 km to the city every day. This suburban system is perhaps the largest in the world in terms of route length and the number of passengers carried (Central Planning Organization, 1981). Due to the continued use of old equipment it has been estimated (Illustrated Weekly, 1980, 29) that 31% of the rakes on C.R. are dilapidated resulting in disruptions to regular service and as a consequence causing hardship for millions of commuters. The problem of insufficient capacity would be made less formidable simply by dealing with necessary replacement of obsolete rolling stock. For example, Deshpande (1973, 362) estimates that C.R. had 459 dilapidated coaches in 1970, 104 of which were of 1928 vintage and were due for replacement. The difficulties in getting replacement
### Table 4.2

**WESTERN RAILWAY SERVICE STRUCTURE**  
**OCTOBER 1979**

Total number of trains a day: 715

<table>
<thead>
<tr>
<th>Break-up as under</th>
<th>Number of trains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Churchgate - Virar</td>
<td>98</td>
</tr>
<tr>
<td>Virar</td>
<td></td>
</tr>
<tr>
<td>Borivli</td>
<td>398</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>Goregaon</td>
<td>4</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>Andheri</td>
<td>174</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>Bandra</td>
<td>39</td>
</tr>
<tr>
<td>Bombay Central</td>
<td>1</td>
</tr>
<tr>
<td>Andheri</td>
<td></td>
</tr>
<tr>
<td>Dadar Andheri</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stations</th>
<th>Morning Peak (8.30 to 11.30 hrs.)</th>
<th>Evening Peak (17.00 to 20.00 hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virar</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Borivli</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Slow</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Goregaon Fast</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Andheri</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Slow</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Bandra</td>
<td>9</td>
<td>5</td>
</tr>
</tbody>
</table>

and the continued use of the obsolete coaches have been responsible for frequent breakdowns and cancellations.

The structure of the train schedule on C.R. is shown in Table 4.3. This suburban section at present carries 2.3 million passengers daily. The frequency of service on C.R. is not as regular as that of W.R. The average headway during the peak period is 6.3 minutes in the morning and 6.7 minutes in the evening. Commuters from stations such as Dombivli and Ghatkopar have been asking for trains to originate and terminate at their stations in the hope of getting accommodation at the originating stations during peak hours. As an additional complication, climatic conditions also cause hazardous travel during the monsoon season when torrential rain and high water levels create severe, prolonged delays and disruptions to the suburban commuter services and the daily routine of millions of commuters. Plate VI depicts how the vagaries of nature can create problems for the railway services. It shows the C.R. commuter trains abandoned midway between Kurla and Vidhya Vihar stations due to the monsoon rains.

It may seem paradoxical that a service which is in such high demand cannot meet its costs. The commuter lines suffer from rising deficits. Fares, hardly if ever are raised since they become political and emotive issues. The authorities also feel that as there is no alternative to mass transport. It is their social obligation to provide a transport service at a cost which most people can afford. On account of this the Government of India have heavily subsidized the fare structure by encouraging the use of monthly and season passes.

Table 4.4 shows that 75% of all second class passengers on Bombay suburban section travel on season passes. The price of a monthly second class pass is equivalent to fourteen single fare tickets, the cost is very low and greatly tapered for long distances. Fig. 4.2 and 4.3 show the graduated fare structure on the railways.

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### Table 4.3

**Central Railway Service Structure**  
**October 1979**

#### Main Line

<table>
<thead>
<tr>
<th>Destination</th>
<th>No. of trains</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dn.</td>
<td>Up</td>
</tr>
<tr>
<td>Karjat</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Badlapur</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Ambernath</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Kasara</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Asangaon</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Titvala</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Kalyan</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Thana</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Ghatkopar</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Kurla</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>250</td>
<td>250</td>
</tr>
</tbody>
</table>

#### Harbour Branch

<table>
<thead>
<tr>
<th>Destination</th>
<th>No. of trains</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dn.</td>
<td>Up</td>
</tr>
<tr>
<td>Thana</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Mankhurd</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Chembur</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Kurla</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Bandra</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>157</td>
<td>157</td>
</tr>
</tbody>
</table>

#### Kurla-Kalyan

<table>
<thead>
<tr>
<th>Destination</th>
<th>No. of trains</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dn.</td>
<td>Up</td>
</tr>
<tr>
<td>Kurla-Thana</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Kurla-Kalyan</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Kurla-Mankhurd

<table>
<thead>
<tr>
<th>Destination</th>
<th>No. of trains</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dn.</td>
<td>Up</td>
</tr>
<tr>
<td>Mankhurd</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Chembur</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>20</td>
</tr>
</tbody>
</table>

**Grand Total**  
433 431 864
Table 4.3 (Contd.)

Number of trains on the three corridors during morning and evening peaks are given below:

<table>
<thead>
<tr>
<th></th>
<th>Morning peak (Arriving VT)</th>
<th>Evening peak (Leaving VT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0830 to 1100</td>
<td>1700 to 2000</td>
</tr>
<tr>
<td>Up local</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Up through</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Harbour Branch</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>81</td>
</tr>
</tbody>
</table>

Average head-way during peak hours:

<table>
<thead>
<tr>
<th></th>
<th>Morning peak</th>
<th>Evening peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up local line</td>
<td>5.5 mts.</td>
<td>6.7 mts.</td>
</tr>
<tr>
<td>Up thro' main line</td>
<td>7.5 &quot;</td>
<td>7.5 &quot;</td>
</tr>
<tr>
<td>Up Harbour Branch</td>
<td>5.8 &quot;</td>
<td>6.0 &quot;</td>
</tr>
<tr>
<td>Total average frequency</td>
<td>6.3 &quot;</td>
<td>6.7 &quot;</td>
</tr>
</tbody>
</table>

Plate VI: Trains stranded inter-station on Central Railway
Table 4.4

NUMBER OF PASSENGERS CARRIED ON
SUBURBAN RAILWAYS CLASS-WISE

<table>
<thead>
<tr>
<th>NUMBER OF PASSENGERS (in '000)</th>
<th>CENTRAL RAILWAY</th>
<th>WESTERN RAILWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st class</td>
<td>2nd class</td>
</tr>
<tr>
<td>Daily Tickets</td>
<td>117</td>
<td>200,870</td>
</tr>
<tr>
<td>Season Passes</td>
<td>54,170</td>
<td>557,630</td>
</tr>
<tr>
<td>Total</td>
<td>54,287</td>
<td>758,500</td>
</tr>
</tbody>
</table>

Suburban Railway Fare Structure - Season Passes

Fig: 4.2

Source: BMRDA, Transport and Communications Statistics For BMR, March 1981
Suburban Railway Fare Structure - Single Journeys

Fig. 4.3

First class travel is four times as expensive as second class travel when calculated using cost of a seasonal pass. The differences in cost are greater if calculated on the price of a daily ticket. The cost of a first class ticket varies from 20 times the price of a second class ticket for distances shorter than six kilometers down to ten times as expensive for distances longer than 35 km. This may be a reason why 99% of those travelling first class use seasonal passes.

Second class passes are the most popular and the cheapest way to travel. The cheap fares available compound the transport problems since provision of truncated long distance fares encourages more from the low middle income groups to live outside the city where housing and rents are much lower. Fares are divorced from the real operational costs, the uneconomic fare structure being mainly related to what the traffic will bear, the paying capacity of the commuters. As a result, long distance commuting occurs at public cost.

The vast gap between the demand for rail transport and the capacity available was analysed in the previous chapter. The necessity for expansion of the system needs no emphasis. As a result of the inadequate capacity, the railways in 1971 were seeking to optimize the existing system. The capacity of the railways can be increased by lengthening the trains or increasing the frequency by better signalling. Along with financing problems, actual implementation seems equally problematic. The plans to increase the length of rakes from nine to twelve coaches requires extension of platforms and remodelling of terminals and other ancillary facilities. It was estimated by Mott (1972) that the introduction of twelve-car rakes would give an additional 33% increase in capacity.

The argument against such augmentation in capacity is that the increase in the number of commuters per train will cause further spill-over of pedestrians onto the roads and congestion outside the rail termini. The scope for additional trains through better signalling, on the other hand, could only increase rail capacity by 15-20%.
When first proposed in early 1970s, increasing the frequency of service was seen as a long term solution. It soon became obvious that there was a need to provide extra rail corridors to meet the demand of the north-south flow of commuters. In view of the limitations of line capacity, the Town Planning and Valuation Department in 1968 recommended a study for the development of extra line capacity. A double track sixth corridor, known as the Port Market line was proposed by MTP (Rly) in 1972 (Fig. 4.4). The main object of this corridor was to augment the capacity on W.R. and C.R. beyond what could be obtained by the optimization schemes on existing lines. The corridor was planned to comprise an additional pair of lines between Goregaon and Bandra on W.R. and between Bhandup and Kurla on C.R. The additional pair of lines on W.R. were planned so as to be connected via Mahim Chord to a pair of lines between Raovli Junction to Fort Market opening up a new dispersal point in the CBD. In total then, the sixth corridor was planned to include the following lines:—

1. Raovli Junction - Fort Market - 10.62 km (partly underground)
2. Bandra - Goregaon - 12.74 km
3. Kurla - Bhandup - 11.17 km

It was hoped that this line apart from increasing the line capacity would provide:

1. A more direct and faster service for commuters whose origins are in the suburbs and with destinations in the vicinity of Port Market in the CBD.
2. To give commuters a direct service and relieve pressure on the two existing CBD terminals.

MTP (Rly.) (1974, Ch. 8,6) calculated that even after an outlay of Rs.160 crores on existing track the requirements for trains would be 37 as against the available capacity of 35 on the W.R., C.R. requirements would be 40 between Dadar-Kurla section as against the available capacity of 28. This clearly established the need for an additional corridor. London Transport Executive (1972) recommended the construction of the sixth corridor and in addition proposed a seventh corridor for providing intra-city movements and to take care of the spill
Present and Proposed Railway Corridors in Bombay.

LEGEND

☐ Existing Suburban Lines
☐ Sixth Corridor
☐ Seventh Corridor
☐ Major Interchanges


Fig 4.4


154
over of traffic from the sixth corridor. The techno-economic feasibility survey undertaken in 1974-75 proposed the seventh corridor to provide a dispersal function and to link by rail those areas not at present covered by the railway network such as the Airport, Worli, Bazar area and Colaba (Fig. 4.4). In addition, several other dispersal points in the CBD would be provided. The seventh corridor is planned to comprise of the following sections: (MTP Rly., 1974)

1. Colaba to Bandra 17.38 km (underground)
2. East-West from Bandra to Kurla 4.90 km (elevated)
3. Kurla to Airport 4.11 km

This corridor would serve by rail the congested indigenous core area as well as the Worli and Mahalaxmi areas which have considerable commercial, industrial and residential developments and which are now solely dependent on bus transport. The provision of railway facilities would be a great boon to these areas. The commuter stream at present has necessarily to merge with the heavy intra-island traffic in the narrow and heavily congested strip of Bombay Island in order to reach the CBD. The project would make use of the existing but underused railway alignments of the harbour branch and Bombay Port Trust lines and provide better interchange with the present network at many points, thus increasing the accessibility and connectivity.

There is a prima facie need for rapid transit facilities which would not only make a contribution towards meeting demand for greater rail capacity but also provide rapid transit facilities for carrying the heavy volume of inner urban traffic and free it from the encumbrances of road congestion. Neither corridor VI nor VII can satisfy the requirements of rail transport with demand increasing as it is but each is complementary to the other and the rest of the system.
Chopra (1979, 22) estimated that the total cost of the seventh corridor would be Rs.3800 million at 1976 prices, three times that for the sixth corridor and the additional lines have not been sanctioned in view of the prohibitive costs and paucity of funds available. As a result, commuters have to face the consequences of insufficient rail capacity. Progress of rapid transit projects are slow not only in Bombay but also in many other LDC cities mainly because of the vast capital involved and the relatively small area of impact and benefit. The railway projects which were proposed and are under consideration are not a luxury or comfort oriented to wean the commuter from other modes of transport. They are the minimum necessary requirements to meet the demand for transport and to maintain the viability of the city if growth continues in the manner and direction it now is. What has been sanctioned by the Planning Commission and is now being implemented is a small portion of Corridor VI. Construction of the Bandra Flyover which will connect the local W.R. lines to C.R. harbour branch line will enhance the capacity of the latter by increasing frequency of peak period trains from nine to twelve an hour and will give relief to those who commute on the Khar Road-Bandra section of W.R. It will provide commuters on W.R. with a direct link to V.T. The cost of this flyover was estimated at Rs.6.92 crores according to Indian Railways (1979, 20). At the present time, commuters who reside in the western suburbs but have their work places in the vicinity of V.T. have to terminate their journey at Churchgate station and either walk or catch a bus to their destination causing problems of the types discussed at some length in Chapter 3.3.
User perception of rail services:

Table 4.5 shows the results of the survey undertaken by the author on the way in which the commuters view the existing train service. It was found that 20% of the commuters thought the train service was extremely poor, an equal number said 'poor', therefore, nearly 41% found the train service to be poor–extremely poor. 49% said the services were satisfactory and under 11% thought they were good–excellent. The reason for the low rating of train service can be found by analysing the ways commuters think improvements in service can be brought about and Table 4.6 shows the frequency distribution of results, overcrowding of the trains is a main factor influencing the perception of poor services offered by railways. Nearly 29% asked for more frequent services. Another 25% are in favour of extra 'fast' trains, the popularity of this improvement mainly deriving from the limited stops, speedier journeys and inability to board except at the terminal. The poor conditions of trains is reflected in the findings. 22% of the respondents think that much could be done to improve train standards.

Lower fares, better passenger behaviour and improved stations facilities were not seen as important factors in improving train service. The lower rating given to these three factors reflects the far greater significance of them related to overall service frequency and journey comfort. Fares are given low importance because commuters are well aware that the fares are cheap by all standards.

The overall conclusion from the questionnaire responses is that overcrowding on the railway is the paramount problem for commuters because the respondents were strongly in favour of any means of increasing the capacity of the system whether by extra fast trains or more frequent services.
<table>
<thead>
<tr>
<th>SERVICE</th>
<th>PERCENTAGE OF SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely poor</td>
<td>19.9</td>
</tr>
<tr>
<td>Poor</td>
<td>20.9</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>48.9</td>
</tr>
<tr>
<td>Good</td>
<td>9.6</td>
</tr>
<tr>
<td>Excellent</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 4.6

User perception of rail service improvement

<table>
<thead>
<tr>
<th>Improvements</th>
<th>Percentage of commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower fares</td>
<td>9.5</td>
</tr>
<tr>
<td>Improve train standards</td>
<td>21.8</td>
</tr>
<tr>
<td>Better passenger behaviour</td>
<td>7.4</td>
</tr>
<tr>
<td>Extra 'fast' trains</td>
<td>25.0</td>
</tr>
<tr>
<td>More frequent service</td>
<td>28.5</td>
</tr>
<tr>
<td>Better station facilities</td>
<td>7.8</td>
</tr>
</tbody>
</table>

4.2 ROAD PUBLIC TRANSPORT

Buses also play an important, if different role from the railways. BEST services account for 70% of the road borne passengers.

The first bus service in Bombay began to operate in July 1926, prior to that Bombay was served by tramways. For several years buses were looked upon as a transport mode for the upper and middle class as they were more expensive than the trams. In 1937, double-decker buses were introduced to cope with the growing traffic (BEST, 1981, 2). The trams were slow, obtaining speeds of 8 km/hr and proved to be a hindrance to the free and fast movement of other traffic and as a result they were abolished.

In 1947, the bus company was municipalized and as a result it became necessary to provide bus services to the entire Greater Bombay area. In October 1949, suburban bus services started operating in the western suburbs. The eastern suburbs were provided with bus services in January 1955 (BEST, 1981, 3). Prior to that the suburbs had been served by private bus companies. With the development of the suburbs, bus services assumed increasing importance because of their flexibility. Once the north-south bus routes were established attention was focussed on strengthening the links between east and west suburbs.

Present route planning is on an ad hoc basis and dictated more by demands made by people. Planning has been dominated by the policy of connecting important localities to each other, this has resulted in operation of a large number of bus services in a zig-zag pattern (Hussain, 1980). As a result it has been estimated that 62% of BEST routes are uneconomic (Planning Commission, 1970, 58). Route planning for buses should be carried out on basis of the overall traffic demand so that demand points can be served in an optimal way. Pednekar (1980) in a study relating to accessibility of bus network in the suburbs demonstrated that access to bus termini is highest for Andheri.
This results in large numbers of passengers embarking on and disembarking from the buses near railway stations causing inordinate delays to schedules. Buses are not generally available for passengers between many of the interchange points and as a consequence heavy pedestrian traffic occurs near such points.

There may not be any scope left for improvement of bus services by additions to the fleet but a still untapped improvement would be the better integration of modes. The real potential of public transport can be realized only within the context of properly co-ordinated policies of integration between different modes, and Bombay lags far behind in this respect.

The two transit systems offer un-coordinated services causing losses to both commuters and operators. This is manifest in the insufficient feeder bus service to railway stations and overlap between transit routes. BMUDA (1981) attributed the difficulty of integration of modes (despite all its advantages) to the multiplicity of authorities involved and the absence of single transport authority. An additional problem is that the fare structures are at present vastly different on bus and railways while the latter offers massive concessions. This is absent for bus travellers. A unified metropolitan transport authority is a necessary pre-condition to coordinate all the transport modes. BEST's present fare structure is a finely graduated scale. It charges 25 paise for 3 km then 5 paise per km beyond giving a small degree of tapering in fare scale (Fig. 4.5). There are no concessionary fares and seasonal passes or transfer tickets. 'Limited' buses charge a slightly higher fare.

BEST has not been able to cover costs due to the politically imposed restriction on fare increases which have not been raised since December 1975.

BEST's fare structure is such that it is cheaper for short journeys. As regards long distance movements suburban rail travel is much cheaper on account of the comparatively low fares for season passes.
Fare structure on BEST Buses - 1979

Fig. 4.5

Source: BMRDA, Transport and Communications Statistics for BMR, March 1981
Stations upto Goregaon on W.R. have maximum connectivity beyond which, due to lack of east-west road links, connectivity declines rapidly. In the eastern suburbs, Chatkopar was seen to be the only station well connected. There is a more ubiquitous coverage of bus services on Bombay Island than in the suburbs. This can be shown by the fact that of the daily bus Kilometres, 64% occurs within Bombay Island and only 36% is in the suburbs. With the dense network provided on Bombay Island only marginal increases in service have been contemplated by the BEST authorities. They feel that a stage has been reached where further increases in the number of buses to serve the demand will only add to congestion and reduce further the speed of traffic. On account of the congested conditions on the roads the authorities do not propose to introduce any new north-south routes between the city centre and suburbs. Their policy is now to provide feeder services to rail heads from the interior residential and industrial zones.

Although there has been more emphasis on buses serving as feeders to the north-south oriented rail routes this has not been exploited to the fullest. There does not appear to be any close relationship between the railway stations and bus operations. Fig. 4.6 shows the location of bus stations vis-a-vis railway stations. Bus services do not focus obviously on the railway stations, although BEST authorities are ready to point out that all stations are in fact served by a bus route. In fact, an examination of the timetables and route map revealed that 120 of the 205 bus routes (59%) make direct connections with the railway stations. If buses are to serve as collectors, feeders and distributors it is surprising that not more emphasis has been put on direct connections to railheads as in many large North American cities. To site an example, the Toronto Transit Commission (TTC) has 123 bus routes of which 111 (90%) make 167 connections with the subway. (TTC, 1982).

In addition, very few bus routes in Bombay originate at railway stations especially in the central area. It was found that only 23% of bus routes making connections with railheads are on Bombay Island.
Location of Bus Termini vis-a-vis Railway Stations

Fig. 4.6

LEGEND
Rail station ●
Bus station ○
BEST depot ▲

Buchanan (1980, 167) calculated the fare and service elasticities on BEST buses. It was found that fare elasticities varied from -0.28 to -0.75. This inelasticity shows that patronage is not much affected by changes in fares, however, Buchanan found that elasticities were higher for residents in low income areas and where rail service is an alternative. Service elasticities varied from 0.30 to 0.45 which also shows that patronage is not very responsive to changes in service levels. The transport undertaking has been finding it difficult to keep pace with growing demands for commuter trips not only because of lack of funds but, equally important, the operational environment under which it has to provide the services. Buses operate under less than ideal conditions. Additional buses alone are inadequate as a solution and must be accompanied by improved vehicular speed. This involves large scale traffic management.

Roads should be looked at not only as areas of vehicle movement for motorized traffic but also as corridors of activities of different kinds. Much of the life in the traditional city takes place in the street. Voorhees (1980, 30) identified correctly that the widths on some Bombay streets appear to be more than adequate, however, they are forced to provide more than a route for transport, they also function as parking space for vehicles access to buildings, sites for hawkers, commercial activities, as footpaths and other uses which severely limit their vehicular carrying capacity and which in turn contributes to a reduction of their throughput capacity. All these elements, singly or in combination, contribute to the congestion on roads of Bombay.

The continuous and complex interaction of these activities leads to a chaotic operating environment for the bus operators. It is difficult to quantify exactly the contribution of each but the survey by the author shows the commuters perceive that pedestrians are one of the major causes of bus delay. Although cars and lorries were found to have the highest weighted averages of all, 38.3% ranked pedestrians first. This is due to the multiplicity of pavement uses (hawkers, sleepers, vagrants, housing) and the spill over of pedestrians onto the outside lane of the carriageway,
where in fact the buses should be plying (Table 4.7(a) (b)).

The high ranking given to cars and lorries definitely calls for spatial separation between buses and private modes of transport.

Rickshaws also had high weighted averages, where 32.2% thought them either the first or second most important problem. This is a very high ranking for rickshaws considering the fact that they do not ply in Bombay south.

Taxis were also given high weighted averages, with 51% having second or third ranking.

Buses were also seen as causing delay to other buses and given middle range ranking with 45% ranking them third and fifth most important cause of bus delay. Scooters and motorcycles were also given middle range ranking with 62% placing them fourth to sixth. Cycles and tongas were ranked very low and had low weighted averages. They were not seen as contributing significantly to bus delays. 66.7% ranked them between sixth and eighth. Tongas were ranked the lowest with 42% placing them in the last position. A reason for such low ranking for tongas is that they are allowed to ply only in certain areas and at certain times of the day. This temporal and spatial separation helps to overcome the problems of slow moving vehicles on congested roads. Twelve different modes of transport are operating and competing for limited space on Bombay's road system.

1. Cars 7. Tempos
2. Taxis 8. Rickshaws
4. Trucks 10. Pedal Cycles
5. Handcarts 11. Bullock Carts

There is no effective segregation through traffic management of these modes. This results in disorganized plying of vehicles.

It is against this background that bus operators have to provide a service to their increasing number of patrons. The BEST authority maintain in operation 94% of its fleet (BMRDA, 1981) which is a high performance rate for any large city bus operator. London Transport Executive (1972, 26) comments that 'Efforts by BEST to keep the buses on the roads are strenuous and ingenious in relation to the operating environment.'
## Table 4.7 (a)

<table>
<thead>
<tr>
<th>COMMUTER PERCEPTION OF CAUSES</th>
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</thead>
<tbody>
<tr>
<td><strong>BUS DELAY</strong></td>
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</tr>
<tr>
<td><strong>HIGH RANKING</strong></td>
<td></td>
</tr>
<tr>
<td>1 - Cars and lorries</td>
<td></td>
</tr>
<tr>
<td><strong>UPPER MIDDLE RANKING</strong></td>
<td></td>
</tr>
<tr>
<td>2 - Taxis</td>
<td></td>
</tr>
<tr>
<td>3 - Pedestrians</td>
<td></td>
</tr>
<tr>
<td>4 - Rickshaws</td>
<td></td>
</tr>
<tr>
<td><strong>LOWER MIDDLE RANKING</strong></td>
<td></td>
</tr>
<tr>
<td>5 - Buses</td>
<td></td>
</tr>
<tr>
<td>6 - Scooters/Motorcycles</td>
<td></td>
</tr>
<tr>
<td>7 - Cycles</td>
<td></td>
</tr>
<tr>
<td><strong>LOW RANKING</strong></td>
<td></td>
</tr>
<tr>
<td>8 - Tongas</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.7 (b)

Commuter perception of causes of bus delay in Greater Bombay

<table>
<thead>
<tr>
<th>Causes</th>
<th>1 (8)</th>
<th>2 (7)</th>
<th>3 (6)</th>
<th>4 (5)</th>
<th>5 (4)</th>
<th>6 (3)</th>
<th>7 (2)</th>
<th>8 (1)</th>
<th>Weighted Averages</th>
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<td>Pedestrians</td>
<td>38.3</td>
<td>9.5</td>
<td>8.7</td>
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<td>12.9</td>
<td>7.2</td>
<td>8.3</td>
<td>4.9</td>
<td>572</td>
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<td>(306)</td>
<td>(67)</td>
<td>(52)</td>
<td>(53)</td>
<td>(50)</td>
<td>(22)</td>
<td>(17)</td>
<td>(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclists</td>
<td>1.1</td>
<td>4.2</td>
<td>6.8</td>
<td>8.7</td>
<td>12.5</td>
<td>24.6</td>
<td>22.0</td>
<td>20.1</td>
<td>364</td>
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<td>(20)</td>
<td>(44)</td>
<td>(50)</td>
<td>(148)</td>
<td>(44)</td>
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<tr>
<td>Rickshaws</td>
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<td>16.7</td>
<td>12.9</td>
<td>12.5</td>
<td>10.6</td>
<td>11.7</td>
<td>14.4</td>
<td>5.7</td>
<td>493</td>
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<tr>
<td>(124)</td>
<td>(117)</td>
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<td>(63)</td>
<td>(42)</td>
<td>(35)</td>
<td>(29)</td>
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<tr>
<td>Buses</td>
<td>5.3</td>
<td>9.5</td>
<td>15.9</td>
<td>15.9</td>
<td>13.3</td>
<td>9.8</td>
<td>15.2</td>
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<td>(42)</td>
<td>(67)</td>
<td>(95)</td>
<td>(80)</td>
<td>(53)</td>
<td>(29)</td>
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<td>10.2</td>
<td>20.5</td>
<td>22.0</td>
<td>19.7</td>
<td>14.0</td>
<td>7.6</td>
<td>390</td>
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<td>(61)</td>
<td>(103)</td>
<td>(88)</td>
<td>(59)</td>
<td>(28)</td>
<td>(8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tongas</td>
<td>2.3</td>
<td>3.8</td>
<td>3.0</td>
<td>9.5</td>
<td>12.2</td>
<td>11.8</td>
<td>15.6</td>
<td>41.8</td>
<td>268</td>
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<tr>
<td>(18)</td>
<td>(27)</td>
<td>(18)</td>
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<td>(49)</td>
<td>(35)</td>
<td>(31)</td>
<td>(42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxis</td>
<td>8.7</td>
<td>28.1</td>
<td>23.6</td>
<td>13.7</td>
<td>10.3</td>
<td>8.7</td>
<td>4.9</td>
<td>1.9</td>
<td>574</td>
</tr>
<tr>
<td>(70)</td>
<td>(197)</td>
<td>(142)</td>
<td>(69)</td>
<td>(41)</td>
<td>(26)</td>
<td>(10)</td>
<td>(19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cars and Lorries</td>
<td>28.2</td>
<td>22.1</td>
<td>19.5</td>
<td>11.1</td>
<td>7.3</td>
<td>6.1</td>
<td>3.8</td>
<td>1.9</td>
<td>611</td>
</tr>
<tr>
<td>(226)</td>
<td>(155)</td>
<td>(117)</td>
<td>(56)</td>
<td>(29)</td>
<td>(18)</td>
<td>(8)</td>
<td>(2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

( ) = Weighted averages

(Source: Field Survey, July 1982)
Road capacity has become highly inadequate to accommodate the traffic that has built up over the years. With the absence of traffic segregation the road network cannot provide for high capacity movement. The World Bank in 1976 undertook an Urban Transport Project for developing the bus transport in Bombay. A number of measures were proposed with the aim of:

1. Augmenting capacity by increasing fleet size.
2. Ensuring optimization of bus operation by increasing the utilization of buses through remodelling of street junctions
3. Improving the hourly carrying capacity of the bus system

Increasing the fleet size alone would have only reduced the present crawl speed of traffic and added to the bottlenecks. BEST accepted that other measures are essential if any improvements in bus service are to be achieved.

It is significant that IBRD had been willing to loan a substantial sum of $25 million for investment in conventional public transport modes when in other cities it has opted for smaller capacity modes like mini-buses in Kuala Lumpur. This basically reflects the nature and characteristics of demand for transport in Bombay. The long term problems of bus transport provision lies in the extended suburbs as the population trends indicate. Failure of BEST to expand bus services where demand warrants will result in supply being filled in by rickshaws or other informal modes. The pre-requisite for supplying bus services is the need for roads. East-west road links in the suburbs are extremely poor. BMC has planned four east-west connectors in the suburbs but none have been completed to date. The proposed connectors are:

1. Santa Cruz - Chembur link
2. Andheri - Ghatkopar link
3. Jogeshwari - Vikhroli link
4. Goregaon - Mulund link

The availability of these routes will greatly increase the accessibility and connectivity of the suburbs which is at present extremely poor. This is reflected in the results of the survey, that is analysed next.
User Perception of bus service

Analysis of commuter's perception of the existing bus service is shown in Table 4.8. It can be seen that nearly 50% of those surveyed said that the bus service was 'satisfactory' and 32% thought it was 'poor'. Over 10% of the respondents claimed that services were extremely 'poor' and an equal percentage said 'good'. It is interesting to note that only 0.8% claimed the bus service to be 'excellent'. The reasons for the majority of commuters (78.6%) saying the services were poor-satisfactory can be better appreciated if we analyse how they think the bus services can be improved. The long waiting time for boarding a bus is reflected in the fact that nearly 30% of commuters felt that bus services could be improved by more frequent services (Table 4.9). Top priority for commuters seems to be for more frequent service followed by more bus routes which 21% stated as being important for contributing to improved bus service. 16% said bus-train connections were needed and 14% said bus lanes would help to improve bus services. 13% thought that low bus fares were needed despite the fares being well below operational costs. In the absence of concessional monthly passes a higher percentage of bus user regarded fares as an important factor.

The problem with the bus service is not only inadequate coverage in the suburbs and hence lack of accessibility but also the overcrowding and congestion evidenced by the long waiting times experienced.

On the question of how bus services could be improved, the written answers to the authors questionnaire fall into four major groups.

1. Commuters asked for the introduction of more express 'limited stop' buses. This indicates the poor travel conditions on the railway as well as the overcrowded state of buses. Express buses can only be conveniently run on long distance routes. This, however, conflicts with the bus operating policy of acting predominantly as feeders to the railways. Introduction of express buses where rail transport is available will result in unnecessary competition between modes when in fact they are supposed to be
### User Perception of Existing Bus Service

<table>
<thead>
<tr>
<th>Service</th>
<th>Percentage of Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely poor</td>
<td>10.5%</td>
</tr>
<tr>
<td>Poor</td>
<td>32.0%</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>46.6%</td>
</tr>
<tr>
<td>Good</td>
<td>10.2%</td>
</tr>
<tr>
<td>Excellent</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

### Table 4.9

**User perception of possible bus service improvement**

<table>
<thead>
<tr>
<th>Improvements</th>
<th>Percentage of commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower fares</td>
<td>13.3%</td>
</tr>
<tr>
<td>Extra bus stops</td>
<td>6.5%</td>
</tr>
<tr>
<td>More bus routes</td>
<td>20.8%</td>
</tr>
<tr>
<td>Better bus train connections</td>
<td>15.9%</td>
</tr>
<tr>
<td>More frequent Service</td>
<td>29.7%</td>
</tr>
<tr>
<td>Separate bus lanes</td>
<td>13.8%</td>
</tr>
</tbody>
</table>

complementary to each other.

2. Enforcement of a stricter queue system by supervision at bus stops. In the absence of such supervision passengers collect on carriageways and this creates serious obstruction to the free flow of traffic. As a consequence, buses are detained and running time is adversely affected. Pedestrians were ranked as one of the major causes for bus delay on roads. This reflects the poor waiting/loading condition. All this is to the disadvantage of the commuters themselves. Orderliness in bus queues can improve bus operation without any additional cost.

3. Commuters also thought that services could be improved by improvements in staff behaviour and by the latter giving a more courteous service to its passengers.

4. The problem of 'bunching' of buses is also important. Many commuters complained of waiting times of over 20 minutes during the peak period when in fact the scheduled headway was 5 minutes. A typical complaint was that buses came three at a time followed by a gap of as much as half an hour. Passengers as a result suffer from a temporal imbalance of supply and demand of bus transport.

In fact, the BEST authorities penalize the drivers for either being behind schedule or ahead of it and the drivers are encouraged to keep to timetable. However, road traffic conditions override the ability of drivers to maintain timing.

When asked to categorize how respondents viewed the public transport services in Greater Bombay as a whole, the problem areas were highlighted (Table 4.10).

69% of those surveyed said that transport services between Churchgate and Virar are satisfactory and 21.5% said they were good. 89% said that services between V.T. and Kalyan were poor, 9.6% said satisfactory and only 1% said good. Opinions expressed were strong and this reflects the irregular and unreliable services on C.R.
<table>
<thead>
<tr>
<th>PUBLIC TRANSPORT SERVICES IN GREATER BOMBAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVICES BETWEEN</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Between Churchgate and Virar</td>
</tr>
<tr>
<td>Between V.T. and Kalyan</td>
</tr>
<tr>
<td>Between East and West Suburbs</td>
</tr>
<tr>
<td>Within Bombay South</td>
</tr>
</tbody>
</table>

Source: Field Survey, July 1982
66.2% said that the services were poor between East and West suburbs. Due to the absence of rail connections, the burden of providing transport between these areas falls totally on buses and with the lack of suitable road links providing any type of service is impossible.

64.2% of the respondents said that services within Bombay south were satisfactory, 17.5% said the services were poor and nearly an equal number said they were good.

Most strongly critical views were in the cases of commuters having to use the seriously inadequate C.R. and those having to travel between east and west suburbs.
Informal Modes of Transport

A means of urban transport that is widespread in LDC cities comprises what may variously be termed as 'informal', 'spontaneous', 'non-conventional' or paratransit. Modes such as the cycle rickshaws of Calcutta and Surabaya, Indonesia, auto-rickshaws of Bombay, jeepneys of Manila and the Silor of Northern Thailand fall into this category. These informal modes are both labour-intensive and low on capital and their importance in many LDC cities has been described by Grava (1978), Fouracre (1979), Chand (1981) and Silcock (1981). These are personalized modes of transport offering a service which is intermediate in terms of cost, comfort and convenience between that provided by the conventional bus service and the private car.

At the outset it may seem that there is a large variety of modes that falls into this category, this is primarily because of the variations in 'hardware'. The types of services that these modes offer can be divided into two groups.

1. Those that offer a bus-like service with fixed routes e.g. Mini-buses and jeepneys.
2. Those that offer a taxi-like service with flexible routes e.g. cycle and auto-rickshaws.

These modes generally ply by inducement and their almost complete route flexibility provides patrons with a door-to-door service.

Informal modes have been open to widespread criticism and have been looked on with censure. Britton (1977, 42) notes that 'the attitude of transport authorities and traffic advisors in LDC cities is by and large one of impatience if not nearly embarrassment with such services...they are often looked at as being somewhat symptomatic of their underdevelopment'. In India, the growth of Intermediate public transport indicates not only the inadequacy of conventional public transport facilities but also reflects the inherited road system of urban settlements where larger and faster modes cannot operate efficiently (Transport Policy Committee, 1980).
These modes are seen by transport planners as being of debateable value especially with regard to use of road space. They are blamed for being the major contributor to congestion and traffic accidents as a consequence of their irregular and ill-disciplined operating patterns.

Informal modes do, nevertheless, play an important role in the personal mobility of LDC inhabitants. Convenience of access to places is the most important factor for the users. What mode they use is of minor concern.

Greater Bombay does not have as varied a range of informal transport modes as some other Indian cities or for that matter other LDC cities.

This is mainly because of the well developed services provided by the conventional modes with relatively good rail and bus networks. In addition, the urban form is such that long north-south distances cannot be traversed efficiently or service supplied adequately by low capacity informal modes.

In Bombay, mass transport is found to be more economical and I.P.T., therefore, plays a supporting role. Buchanan (1980, 165) points out that taxis and rickshaws are not very significant as they account for only 5% of all person trips. Pouracre (1979, 10) found that 'the differences in the role and level of supply of I.P.T. can be traced more to land use constraints rather than any underlying technical or economic factors'. Just outside Greater Bombay, but within the Bombay Metropolitan Region, a wider variety of I.P.T. modes flourish, including tempo, cycle-rickshaws, auto-rickshaws, tongas and taxis. This is because in the absence of an efficient and reliable mass transport system commuters are forced to depend upon these forms of transport (BMRDA, 1981, 12).

The three principal types of informal transport services in Bombay are auto-rickshaws, tongas and the saloon car taxi. Auto-rickshaws are a combination of rickshaw and the motorcycle. They offer a taxi-like service with flexible schedules and operational patterns.
Rickshaws are not allowed to ply on the two Express Highways of Salsette Island nor on the roads south of Mahim Creek. They have been restricted to the lower density areas of the suburbs. The stringent ban on rickshaws is advantageous to all transport users and operators as the roads on Bombay Island are heavily congested and the presence of rickshaws would make the situation more chaotic than it is at present. Even with such restrictions on the area of operation it was noted in Chapter 4.2 that commuters perceive rickshaws as being a major cause of bus delay and a significant contributor to traffic problems.

As a result of their confined area of operation, rickshaws tend to act as feeders to regular bus and rail operations and local distributors as well as serving intra-suburb movement and short distance inter-suburb movement. They cater for the unstructured and irregular journeys of passengers as they are particularly good for short distance journeys, and tariffs are well below those of regular taxi-cabs. They are locally known as 'mini-taxis for the poor'. The price is set by the local authorities. As of January 1st 1983, the cost of travelling by rickshaw is Rs.2.00 for the first 1.61 km and an additional Rs.0.80 for every additional kilometre after.

The reason for the widespread popularity of rickshaws in the suburbs include:
1. The inadequacy of bus services. This has undoubtedly encouraged their use and increase in numbers.
2. High area accessibility - they can penetrate inside narrow convoluted busy streets and can negotiate narrow tortuous lanes and thereby serve more readily a diffuse pattern of demand.
3. Lower operating costs when compared to the conventional bus. The operational pattern of rickshaws is that they have flexibility in routeing and scheduling and in spite of picking up and dropping off passengers at any place, the efficiency of large scale operation is maintained.

Although this mode is demand responsive to customer need, the
drivers are in no way obliged to provide the service they offer. The drivers are always on the look out for return journey customers. They commonly refuse to offer the service because of the uncertainty of a return fare. Fig. 4.7 shows the rapid increase in the number of auto-rickshaws on Salsette Island. There were only 142 rickshaws in 1975-76 and today there are over 1,600. The increasing numbers which are in use shows their importance in filling a gap in the overall transport system of Bombay.

Rickshaws and buses cater for essentially different types of demand and different groups of people and as a result are not competitive to a large extent. The cost of a rickshaw is six times the cost of an equivalent bus journey and so for many inhabitants in Bombay it is far beyond their means.

Saloon-car taxis provide the archetype taxi service. They are allowed to ply all over Greater Bombay (Pouracre, 1981, 26). They are a popular means of transport where distances that have to be covered are fairly long. They prove to be very convenient and efficient for those who can afford them. The fare structure as of January 1st 1983 is Rs.3.00 for the first 1.61 km. and Rs.1.80 for every additional kilometre. This is relatively expensive when compared with other modes. Tariffs per passenger kilometre for taxis are ten times that of those charged by the conventional bus service for an equal journey length.

For short journeys with four people travelling together a taxi works out to be cheaper and also better in terms of time, cost, comfort and convenience. For longer journey lengths, the taxi becomes very expensive and beyond the means of the masses. Taxis and buses compete for different markets. While bus and train services are characterized by regular passenger trips with buses constantly crowded taxi trips serve the irregular and spontaneous demand of middle and high income travellers who make maximum use of them as a direct substitute for the personal car.
Fig 4.7
Number of Auto-rickshaws in Greater Bombay
1975-1981

Fig 4.8
Number of Taxi-Cabs in Greater Bombay
1975-1981

Source BMRDA, Transport and Communications Statistics For BMR, March 1981
With the introduction of rickshaws and their widespread availability in the suburbs over the past decade there has been increasing competition between auto-rickshaws and taxis to attract passengers. Rickshaws provide a similar fast, though less comfortable service at a much lower cost.

Fig. 4.8 shows the increase in the number of taxi-cabs in Greater Bombay with 1,500 taxis in 1951-52, there are over 30,000 taxis plying today in Greater Bombay. According to the Deputy Police Commissioner, Mr. Paaricha, Bombay has the highest number of taxis in the world for a city of its size. There is one taxi to every 250 people. This is an exceptionally high figure considering the socio-economic status of the majority of inhabitants. This has two implications for Bombay.

1. Taxis wait/passengers on carriageways, thereby decreasing road capacity.
2. An efficient service is not provided to all passengers since many taxi drivers refuse short distance passengers as they are constantly in search of long distance ones.

Despite this, there is still a great demand for taxis and it is a growth area in spite of the two drawbacks mentioned above.

There is scope to further the advantages of rickshaws and taxi-cabs in Bombay, through integration with the public transport modes.

Tongas (horse-drawn carriage) in Bombay are more remnants of a past era than a vital mode in the present transport system. The number in operation is on the decline and the attitude of the authorities is to regulate them out of existence and to this end no more licences are now issued. Their numbers have dropped drastically from 1,600 in 1970 to only 315 today (BMUDA, 1981). They are restricted to ply only in certain areas and at certain times. Tongas are allowed in the area south of Marine Lines station to Nariman Point and in the indigenous core area. With their limited capacity and slow speeds they are used predominantly for casual travel where time is not an important factor. The slowness of this mode is used to its advantage as cost may sometimes be more than that.
of a taxi ride for the same journey length.

The cost of travel on tongas is not regulated by the local authority but at the discretion of the owner who can charge what he desires and what the traffic will bear.

Hack Victorias were not perceived as a major cause of traffic problems or bus delays. This may be due to their limited use both temporally and spatially and their low numbers or perhaps because of the nostalgic feeling Bombayites have towards this mode.

By their very nature it is almost impossible to quantify the overall contribution of such modes as they have been little studied and their role is not fully understood and is even in dispute. Some think they have a positive role to play while others believe that they are an impediment to progress (Jain, 1969, Ch. 12). Nevertheless, whatever school of thought one may belong to, it cannot be doubted that they perform a very important function in filling 'gaps' which conventional modes either do not or cannot provide for adequately. Each mode has useful characteristics and capabilities.

In Bombay, the different modes of transport, both conventional and informal are generally complementary to rather than fiercely competitive with each other as they tend to cater for different groups of people and different journey lengths. The question is not, therefore, whether or not to have such informal modes but identifying their precise role, the places where they are needed and the best technology to adopt.

Walking is the most convenient and flexible method of covering short distances and it is of prime importance in most LDC cities. Hillman (1980) calls walking 'the most neglected form of transport' and this is very correct. Surveys carried out by Ramachandran (1977) show that for most activities Bombayites would prefer to walk.

It is evident from Table 4.11 that for six of the eight activities the present and preferred mode was walking. It is primarily with regard to travel to work place that different
Table 4.11

Percentage frequency distribution of walking as a mode of travel to various activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Present (%)</th>
<th>Preferred (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To work</td>
<td>36</td>
<td>43</td>
</tr>
<tr>
<td>To school</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>To market</td>
<td>94</td>
<td>90</td>
</tr>
<tr>
<td>Shopping</td>
<td>84</td>
<td>85</td>
</tr>
<tr>
<td>Medical</td>
<td>86</td>
<td>88</td>
</tr>
<tr>
<td>Recreation</td>
<td>69</td>
<td>74</td>
</tr>
<tr>
<td>To rail station</td>
<td>82</td>
<td>82</td>
</tr>
<tr>
<td>To bus stop</td>
<td>95</td>
<td>93</td>
</tr>
</tbody>
</table>

modes were used. This is primarily because of the distances involved. This has or should have considerable implications with regard to land use and transport planning. Bombayites show their preference for having activities located within walking distance of their residence. However, in view of the distances which can be conveniently covered on foot access by walking involves proximity to the activities one wishes to reach.

Walking is the accepted mode of transport for a wide variety of principle trips generated. For many of the inhabitants for much of the time there may be no other alternative.

In Bombay, due to the long distances involved in many essential journeys the number which can be walked is reduced. Nevertheless, many citizens do depend upon walking for their personal transport.

While in small and medium sized urban areas, walking is the prime mode of transport, in large metropolitan areas it additionally forms an important interface between different transport modes (Kodak, 1980, 20). A large number of commuters choose to do many of their short trips by walking rather than wait in long queues at bus stops. The walk mode has been deprived of its share of 'road' space due to the bias in transport planning in favour of motorized vehicles.

The Wilbur Smiths Report of 1963 was a case in point, in which road expansion and improvement schemes were envisaged with no attention at all given to the plight of the pedestrian.

Walking is fraught with its own problems of inadequate conditions. Pedestrians are seldom free from noise, congestion, fumes and intimidation by vehicles with real danger of injury. Pedestrian's own routes, the pavements, are frequently filled by other activities which slow their progress or force them on to the roads. This will be discussed at some length in Chapter 5.1 as will the plans for pedestrianization of some routes to make walking both more convenient and safer.
Large third world cities are plagued not only with rapid increase in population, but over the past decade and a half, by a huge growth in car ownership levels (IBRD, 1976, 1). Car ownership is by no means as ubiquitous as in DCs, especially North America, and in LDCs car ownership tends to be concentrated in a few large cities. For example, Owen (1973, 6) estimated that Bombay has 1.1% of the Indian National population but had 14.5% of the cars. In Bombay, car ownership levels are increasing but so is the public transport patronage. The increase in car ownership has affected little the population dependent on public transport (IBRD, 1975). This is in sharp contrast with DC cities, where growth in car ownership invariably results in a simultaneous and often dramatic decline in public transport demand. The difference in LDC cities (Owen, 1973) is that there is a very large and usually rapidly growing reservoir of demand for public transport from the poor members of the urban community who currently walk or use other modes.

Fig. 4.9 shows the steady but rapid increase after 1966 in the number of private cars. Given the inadequacy of the road system even small absolute increases in car numbers can add greatly to the levels of congestion experienced throughout the day. Today, there are 1.3 cars to 100 people in Bombay. Ownership is, not surprisingly, confined to higher income level groups. The importance of the motor car in LDCs as a contributor to congestion is possibly less obvious but may in fact be just as great as in DCs. IBRD (1975, 17) stated correctly that 'even where private automobiles are only a small part of traffic it cannot be assumed that their role in congestion is small'. From the modal split characteristics analysed in Chapter 3.4, it was found that the car is used for only 10% of all trips. There are no firm figures on what activity types the car is used for, but overall it is a small fraction as compared to those carried by bus and train.
Number of Motor-Cars in Greater Bombay.

1951 - 1981

Voorhees (1980) undertook a survey on motor car usage and its problems in Bombay as part of a Transport Systems Management (TSM) study. The findings showed that it is in the central area - CBD, where car usage causes the most problems. It was found that during the peak hours, the number of cars entering the CBD is more or less constant. The very flat peak for journey-to-work by car and for other purposes is evident from the proportion of total car borne journeys entering the CBD. Table 4.12 shows that there is a gradual increase in the number of cars entering the CBD rather than a sudden peaked pattern. However, the highest flow does occur between 1000 - 1100 hours. Table 4.13 shows the distribution of car trips within the central area, wards A to D. It can be seen that CBD oriented car trips are destined for ward A. Large parts of wards 'B' and 'C' attract very little traffic. This is because, these two wards are unattractive to motorists. The knowledge of the local inhabitants that this area is constantly congested by traffic, both motorized and non-motorized modes, deters car owners from entering the area if they can avoid it. Despite the poor conditions on the roads within this area, 45% of car trips originate from the north and without an alternative route they have to use the arterial roads that traverse through wards 'B', 'C' and 'D'. It was found in the study that a major problem is caused by stationary and parked cars. Voorhees (1980, 227) estimated that on-street parking is used by 51% of vehicles in the central area. In ward 'A', 46% of parking was long term parking implying that these cars were used for journey-to-work purposes. It was estimated that only 5% were short-term parking which was used mainly by shoppers. In an earlier study carried out by BMC, 66% of work trip by cars to the central area parked on-street. In ward 'A' alone, this figure rises to 85%. When parking space demand and supply are seen together, the disparity becomes apparent. Fig. 4.10 shows the parking supply in the central area. The number of parking spaces in district 3 of ward A is only 3-4 spaces per 1000 sq. metres. In district 4, over 6 spaces per 1000 sq. metres are available and in district 5, there are less than 3 spaces per
Table 4.12

Number of cars entering CBD by time of day as proportion of all such cars for period 0600-1900 hours

<table>
<thead>
<tr>
<th>Time of entering CBD</th>
<th>% of work trips entering CBD 0600 - 1900</th>
<th>% of all trips entering CBD 0600 - 1900 by car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 0900</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>0900 - 1000</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>1000 - 1100</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>1100 - 1200</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>1200 - 1300</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core of CBD Destination</th>
<th>Origins %</th>
<th>Origins %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South of CBD</td>
<td>North of CBD</td>
<td></td>
</tr>
<tr>
<td>Ward A (part)</td>
<td>23</td>
<td>45</td>
<td>68</td>
</tr>
<tr>
<td>Ward B</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Ward C</td>
<td>4</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Ward D (part)</td>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Parking Supply Density in Central Area of Bombay.

Fig 4.10

LEGEND (spaces per 1000 sq. metres)

- more than 6.0
- 5.0 - 6.0
- 3.0 - 4.0
- less than 3.0

12 DISTRICTS

1000 sq. metres. The available space is much less than the demand resulting consequently in a high percentage of on-street parking. The availability of free on-street parking in the central area accounts for the high percentage of on-street parking. Whereas in other large cities a charge is made for parking which discourages long term parking; the absence of any type of fee by meters or otherwise has led to the proliferation of on-street parking. The simplest remedy appears to be the banning of free parking which is a heavy burden on the city especially in the central area. Ruth (1967) and Owen (1973) both agree that parking charges should reflect the cost of parking and costs incurred by peak hour driving. Districts 9, 10, 11 and 12 all have over six spaces per 1000 sq. metres. The remaining districts have between three to five spaces excepting district 16 which has less than three spaces per 1000 sq. metres. Voorhees (1980) points out that a redress in the imbalance between location of supply and demand is needed. In ward A, there is a clear deficit in off-street parking. Multi-storey car parks have been proposed in ward 'A' at Horniman Circle and at Nariman Point, but they have been opposed by local councillors and the scheme has been shelved. As a result, car commuters continue to use on-street parking, thereby, reducing overall road space and creating innumerable problems. Road space is particularly badly used where on-street parking and street trading are allowed to develop in proximity. Many carriageways have their vehicle carrying capacity reduced by 30-70% (Voorhees, 1980, 116), due to the presence of illegally parked vehicles and other obstructions. While carriageways display adequate width of four lanes, only two are, in practice, available for moving traffic including buses which have to stop for passengers. A comprehensive parking programme is needed which must include parking areas in the central district.

Under the development control rules set by BMC, definite numbers of parking spaces are insisted upon for all new commercial and industrial establishments and high income
residential zones in order to provide as much off-street parking as possible.

Voorhees (1980) conclude in their report that 'management of traffic levels must be concentrated on the private car'. The number of motor cars on roads is rapidly growing and without any modal priority schemes, cars today are getting a grossly disproportionate share of available road space in relation to passengers moved.

Restraint on some of the trips through parking controls would reduce traffic levels on busy arterials especially the congested wards of 'B' and 'C'. Traffic restraint through parking controls was more desirable for Bombay's conditions than traffic restrictions. Parking control is a valuable restraint measure since authorities can control the amount of parking supply by duration and time of day (for other measures, ref. Thomson, 1972, Roth, 1967). Owen (1973, 24) points out that given the present state of transport technology it must be concluded that the automotive revolution is irreversible and the question posed for LDCs is how to achieve the most advantages from the car while reducing its unwanted side effects.

A proposal put forward by Bhattachajee (1973, 6) went to the extent of advocating a car free zone from Colaba to Mahim, that is, the whole of Bombay Island. He felt that the car had no usefulness in crowded congested city areas and that this mode could be put to better use in the suburbs. There are advantages to be gained from the motor car, but the conflict between cities and cars create major problems. Cars seem to be concentrated in the city where the density is also high. More recently, Adams (1981) has implied that it would be unwise for LDCs to follow the precedent of DCs in which the car gradually becomes the controlling factor.

LDC cities, especially Bombay, are not in a position to cater for the car either environmentally or economically. It is no doubt a status symbol and a sign of prestige of those who belong to the upper echelons of society, but in Bombay, rail transport is a much more efficient mode from all points of view except self interest for the few.
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The problems that the transit system has been facing are not only geographic and physical, but also socio-economic. The growth of the city and its transportation problems have been exacerbated by uncontrolled growth in traffic which has taken place since independence. This has led to chronic problems on the roads and the creation of serious bottlenecks all around the city. There is a strong need to increase the supply of vehicles and invest in the utilization of existing capacity. However, existing overpasses and building roads will not bring immediately viable and cost-effective solutions to the problems which in fact arise from uncontrolled conditions resulting from competing modes and the uncontrolled presence of pedestrians. The occupation of narrow streets by parked vehicles, hawker and pedicab stands may use of only a fraction of the existing road space. Table 5.1 shows the results of the survey in which the pedestrian's view of the condition, standard and maintenance of footpaths in their city were examined. Nearly 50% of the respondents said that the conditions were extremely bad, 26% said they were medium and only 16% said good. Therefore, it can be seen that an overwhelming majority of those surveyed, 84% perceived footpath conditions as being bad – extremely bad. These issues need to be addressed to ensure safe and adequate transport.
5.1 THE GENERAL PROBLEMS

The transport problems of Bombay are inherent in the very geography and physical characteristics of the city. The problems that suburban rail operators and users faced were examined in detail in previous chapters. This section will concentrate on the causes of the road traffic problems in Bombay.

The road network, especially on Bombay Island is unable to cope with the unplanned and unanticipated growth in traffic which has taken place since independence. This has led to chronic problems on the roads and the creation of serious bottlenecks all around the city. There is a strong temptation to think of solutions in terms of additions to existing capacity rather than improvements in the utilization of existing capacity. Moreover widening carriageways and building roads will not necessarily solve and could aggravate problems which in fact arise from confused conditions resulting from competing modes and the uncontrolled pressure of pedestrians. The occupation of carriageways by parked vehicles, hawkers and pedestrians compels the use of only a fraction of the existing road space is an example of wrongly used and not inadequate capacity.

Pedestrians are a major component of the transport system in Bombay. They predominate, yet the conditions for them are appalling. Walking is hazardous and clearly difficult. Footpath conditions are not uniform throughout the city. Table 5.1 shows the results of the survey in which the pedestrians' views of the condition, standard and maintenance of footpaths in their city were examined. Nearly 50% of the respondents said that the conditions were extremely bad, 33% said bad, 15% said they were satisfactory and only 1.6% said good. Therefore, it can be seen that an overwhelming majority of those surveyed, 83% perceived footpath conditions as being bad - extremely bad. Where footpaths are provided they are occupied by hawkers and squatters.
Table 5.1

Pedestrians' Views
Of the condition standard and maintenance
Of footpaths

<table>
<thead>
<tr>
<th>Condition standard and maintenance of footpaths</th>
<th>Percentage of Commuters-adjusted frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely bad</td>
<td>49.7</td>
</tr>
<tr>
<td>Bad</td>
<td>33.7</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>15.0</td>
</tr>
<tr>
<td>Good</td>
<td>1.6</td>
</tr>
<tr>
<td>Excellent</td>
<td>-</td>
</tr>
</tbody>
</table>

100%

Source: Field Survey, July 1982
Inadequate footpath space due to obstruction and encroachment of various kinds forces the pedestrian to walk on the carriageway. The survey carried out by the author substantiates this as 63% of the pedestrians admitted to walking on the carriageway. Table 5.2 shows the reasons given by the pedestrians in order of importance for not using footpaths using weighted averages. Hawkers and pedlers are seen to be the major reason why pedestrians do not use the footpaths, over 77% of the respondents ranked this factor either first or second. Squatters and poor condition of the footpath were given middle range ranking. On the other hand, narrowness of footpath and overcrowding by pedestrians was ranked low. The low ranking given to pedestrians is not surprising when one considers that only 37% of the pedestrians claimed to use the footpath anyway.

From the written answers to this question three categories of impediments to pedestrians emerged, namely,

1. Parts of the footpath (and also roads) were encroached upon by hawkers and vendors with unauthorized stalls, thereby depriving pedestrians of their legitimate rights to use the footpaths.

2. Unauthorized construction of hutments by squatters in their ceaseless quest for a place to live.

3. Footpaths are extremely dirty and unhygienic to walk on.

Modak (1981, 21) observed that footpaths function as dumping grounds for everything that cannot be taken on to the carriageway: an observation confirmed by the author's field work. The written answers to the question on 'How could footpaths be improved' can be grouped in three major categories, namely,

1. The unauthorized occupation of footpaths by hawkers, vendors and footpath dwellers must be stopped. Such unsocial elements must be curbed by patrolling and enforcement control.

2. Reorganize regulation of traffic to confine stationary vehicles to certain sections of the road and keep hawkers in systematic archways.
<table>
<thead>
<tr>
<th>REASONS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Weighted</th>
<th>Totals Order of Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow</td>
<td>(86.5)</td>
<td>(47.2)</td>
<td>(51)</td>
<td>(58.2)</td>
<td>(24.9)</td>
<td>(268)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>17.3</td>
<td>11.8</td>
<td>17.0</td>
<td>29.1</td>
<td>24.9</td>
<td>119.6</td>
<td></td>
</tr>
<tr>
<td>Poor Condition</td>
<td>(62.5)</td>
<td>(94)</td>
<td>(89.4)</td>
<td>(48.4)</td>
<td>(10.0)</td>
<td>(304)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12.5</td>
<td>23.5</td>
<td>29.8</td>
<td>24.2</td>
<td>10.0</td>
<td>96.6</td>
<td></td>
</tr>
<tr>
<td>Hawker/Pedlar</td>
<td>(27.4)</td>
<td>(89.6)</td>
<td>(39.3)</td>
<td>(11)</td>
<td>(4.1)</td>
<td>(418)</td>
<td>1</td>
</tr>
<tr>
<td>Hindrance</td>
<td>54.8</td>
<td>22.4</td>
<td>13.1</td>
<td>5.5</td>
<td>4.1</td>
<td>94.8</td>
<td></td>
</tr>
<tr>
<td>Squatters/Hutment</td>
<td>(57)</td>
<td>(119.2)</td>
<td>(58.2)</td>
<td>(39.4)</td>
<td>(19.7)</td>
<td>(294)</td>
<td>3</td>
</tr>
<tr>
<td>Dwellers</td>
<td>11.4</td>
<td>29.8</td>
<td>19.4</td>
<td>19.7</td>
<td>19.7</td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td>Pedestrian</td>
<td>(21)</td>
<td>(524)</td>
<td>(60.3)</td>
<td>(66)</td>
<td>(41.2)</td>
<td>(261)</td>
<td>5</td>
</tr>
<tr>
<td>Over-crowding</td>
<td>4.2</td>
<td>13.1</td>
<td>20.1</td>
<td>21.5</td>
<td>41.2</td>
<td>94.2</td>
<td></td>
</tr>
</tbody>
</table>

(3) Widen footpaths and more important maintain them by keeping them clean and convenient to walk on.

In view of the inadequate facilities provided for pedestrians, it is not surprising that 90% of the respondents were in favour of pedestrian precincts, yet there is no such facility reserved for them. The results are substantiated by the findings of BMC which carried out a survey to gain an insight into problems faced by pedestrians in which over 61% listed hawkers as the major problem for pedestrians (Voorhees, 1980, 120), 95% favoured more control over hawkers from blocking footpath and carriageway space and 70% felt that the authorities could do more to provide safe pedestrian movements. Detailed surveys undertaken by Modak (1981, 23) revealed that Kalbadevi district in the indigenous area is the core of the chaotic situation that prevails on the footpaths. They found that footpaths were wholly occupied by hawkers and so was a part of the carriageway and 15% of the carriageway space was utilised by pedestrians. The approach roads to Santa Cruz station in the Western Suburbs was seen to have the highest encroachment, with 94% of the footpath occupied by a variety of impediments.

89% of the footpath from V.T. to the General Post Office in the CBD along D. N. Road was used by persons other than pedestrians. BMC has given licences to 132 hawkers to trade along D. N. Road, however, calculations show that 850 hawkers trade there daily. Although the policy of the authorities concerned is to discourage hawkers along arterial roads it has been extremely difficult to curb their presence. Illustrated Weekly (1981, 28) estimated that successfully dealing with the hawker menace will by itself go to the easing by half the traffic problem. Hawkers tend to concentrate along the major arterial routes with high pedestrian flows in the vicinity of railway stations and bus stops which severely disrupts transport operations.

When commuters were asked to rank in order of importance the causes of traffic problems, an interesting trend is observed.
Table 5.3 shows the finding of the survey. Hawkers and pedestrians are perceived as being the major cause of road traffic problems. This is followed by cars, lorries and taxis. Rickshaws are given middle range ranking while scooters/motorcycles, cyclists and tongas are all ranked low.

Fig. 5.1 shows the cause-effect diagram employed to illustrate the results of the survey into the factors influencing the road transport problems in Bombay. Itinerant hawkers and squatter settlements are a major cause of traffic problems in Bombay. As a result the capacity of the carriageway for vehicles and footpath space for pedestrians is reduced. Pedestrians are forced to walk on the roads which in turn leads to common occupancy of carriageway by pedestrians and vehicles causing an inevitable pedestrian/vehicle conflict and thereby increasing the likelihood of accidents (Gore, 1976, 415; Adams, 1981, 48). Gore (1976) noted that on average 40-50 fatal accidents and 400-500 road injury cases are registered every month in Bombay. Some of these may be due to careless driving and street crossing by pedestrians but many are the direct and indirect consequence of the strain and tension of walking and driving through overcrowded streets. The conflict between pedestrians and vehicles leads to congestion and delay in transit. Indiscriminate on-street parking by private cars and taxis using streets as 'garages' further reduces carriageway space. The heterogeneous modes of transport using the carriageway leads to overall low average speed of vehicles. Inefficiency of modal mix is all too apparent, widespread traffic conflicts occur throughout the city where modes use inappropriate channels of movement and where traditional modes conflict with modern ones. Hay (1972) notes that in a road network with heterogeneous speeds, each vehicle tends to reduce the average speed for other vehicles. A complex relationship exists between vehicle densities, speeds and route capacity. There is a decline in speed with increase in traffic density and this is made worse when the composition of traffic is heterogeneous. The speeds of modes on Bombay streets vary enormously from 5 km per hour of the bullock cart to 80 km per hour of the private car.
Relative Importance of the causes of traffic problems in Bombay

**High Ranking**
1. Hawkers/pedlers
2. Pedestrians
3. Cars and Lorries
4. Taxis

**Middle range Ranking**
5. Rickshaws

**Low Ranking**
6. Scooters/Motorcycles
7. Cyclists
8. Tongas

IDENTIFICATION OF ROAD TRANSPORT PROBLEMS

Fig. 5.1

Hawkers and Squatters using footpaths
→
No full utilization of footpath by pedestrians
→
Conflicts between pedestrian and vehicles
→
Traffic accidents

No full utilization of carriageway by buses
→
Reduced carriageway for vehicles
→
Congestion
→
Delays in transit
→
Transport problems

Parking on sidewalks by vehicles
→
Communal use of road by fast and slow moving vehicles
→
Slow Speed
→
Reduced road capacity
→
Increased transport deficiency

Can be overcome by:
- Traffic Management
- Law enforcement
- Land use and transport planning
Congestion caused by such intermixing of modes is apparent when one finds that the average speed is as little as 6 km per hour during the peak hour in the central area. Harris (1978) quite appropriately states with reference to the CBD that 'the peak of accessibility is now the sink of congestion'. In the absence of proper segregation of motorized/non-motorized vehicles, hazardous situations arise for all users. Handcarts and bullock carts are allowed in theory to ply only in a restricted area of the city, namely, in the indigenous core area of wards 'B' and 'C', but they are also found outside this zone.

The inability of the bus to fully utilize the roadway because of the many obstructions causes a decrease in access to bus transport by passengers. This lack of accessibility is seen by the bus users as a reduction in the utility of the service. The delay in transit increases the operating costs of vehicles which leads to an increase in transport costs and loss in productivity in public transport causes a loss to the urban economy. With the socio-economic condition currently prevailing in Bombay, total elimination of hawkers and squatters from the footpaths and roads is not possible. A total ban would be both socially and politically unacceptable. However, steps can and should be taken by the authorities to confine hawkers to selected areas. These areas should be away from major arterials but near to high pedestrian flows. This will leave more space for footpaths and give an opportunity for pedestrians to use them and in turn have the desirable effects of reducing pedestrian/vehicle conflict and allow undisturbed flow of traffic.

Squatter settlements are the most difficult to deal with. Until work opportunities get suitably dispersed over a wider geographic area, the hutment dwellers will continue to proliferate in close proximity to their work places. Law enforcement can also be used effectively as a deterrent for illegally parked vehicles on the carriageway. Stricter parking controls are required otherwise carriageway space is turned
into 'expensive parking lots', especially when seen in terms of reduced capacity. As with hawkers, special areas can be allocated with taxi-stands near high traffic generating areas. Long distance taxi hire stands are already used in Bombay, proving that Bombayites respond well to such designated areas.

The communal use of roads by both fast and slow moving vehicles and its associated problems can be tackled by using some indigenous form of traffic management. Segregation of a rudimentary kind does exist in that handcarts, bullockcarts and pedestrians generally monopolize the nearside lane. This is to the severe disadvantage of buses which are in theory required to use this lane. The variety of modes most impairs mobility of the buses.

Table 5.4 shows the results of the survey on how commuters ranked transport problems. Among the complaints, overloading of public transport facilities, congestion and irregularity and inconvenience of those services that were publicly provided were ranked high.

For the individual city dweller the contemporary transport problem remains in large measure a congestion problem, both 'person congestion' and 'vehicle congestion'. Middle range ranking was given to pedestrian/vehicle conflict, poor road user behaviour and vehicle conflict. It is interesting to note that both high accident rates and air/noise pollution were given extremely low ranking. They are not perceived as being major transport problems, although to an outsider these two problems make their presence felt in no uncertain terms. It is clear that in the mind of the commuters these are not problems of great concern.

The questionnaire responses indicate four major groups of problems:

(1) Roads and footpaths overcrowded by hawkers was again emphasized. The presence of hawkers stems basically from the dualistic socio-economic structure.
Table 5.4

RANKING OF TRANSPORT PROBLEMS IN BOMBAY

**HIGH RANKING**
(1) Overcrowded buses and trains

**UPPER MIDDLE RANKING**
(2) Road traffic congestion
(3) Poor services

**LOWER MIDDLE RANKING**
(4) Pedestrian vehicle conflict
(5) Poor Road user behaviour
(6) Vehicle conflict

**LOW RANKING**
(7) High accident rates
(8) Air/Noise pollution

*Source: Questionnaire Survey, July 1982*
(2) The dearth of police personnel on roads to regulate traffic enforcement.

(3) High population growth and centralization of employment establishments results in high transport demand for which adequate capacity is not available.

(4) Squatter settlements and hutment dwellers create hazardous conditions for traffic, both road and rail.

It would be worth expanding on the squatter problem at this stage. Locally known as 'Zopadpattis', these unauthorized settlements align themselves adjacent to railway tracts, on either side of the road and anywhere there is vacant land. They are significant in the urban scene when we consider that 20% of Bombay residents are squatters (Deshpande, 1981, 195). Plate VII illustrates the all too frequent situation in Bombay in which high density squatter settlements is dangerously close to and parallels the railway tracks.

It has been estimated by the railway authorities that ten people die each day, especially children by straying onto the path of a suburban train. This sort of scene is painfully repeated along the major arterial roads creating severe traffic congestion of the type unknown in DC cities. This unfortunate state of affairs needs to be rectified as such dwellers are found in every ward of Greater Bombay. Even high class areas are not exempt from their presence. The proliferation of Zopadpattis is the Bombayites abject surrender to immediacy. Much of this slum development is linked directly with the 'journey-to-work' problem.
Plate VII: Squatter settlements burgeoning parallel to the busy railway lines
5.2 Commuter Perception Survey

Several hypotheses concerning the respondents' attitudes and perception towards their city and its transport system were developed. The choice of statistical test is dependent on several factors (Seigel, 1956, 18). Non-parametric statistical tests were found to be appropriate for the type of data in this survey. The frequency distributions of the variables were analysed in previous chapters and although informative on the general trends in respondents' perception to transport problems, it is worthwhile now to focus attention on the interrelationships among variables and assess whether or not the relationships are statistically significant. As the sample size is relatively small, the following statistical tests were utilized most of the time to analyse the responses:

(a) Chi-square Test ($x^2$) was used to find the association between nominal and ordinal level variables.

(b) Kruskal-Wallis H Test was used to find the difference in medians between samples using the rank value of each case. The significance 'corrected for ties' was used in the analysis, as it makes the value of 'H' larger and so increases the chance of rejecting the null hypothesis (Ebdon, 1978, 69). The null hypotheses were rejected at either the 95% or 99% confidence level.

The questions in the survey can be divided up into two major types:

(1) Profile questions

(2) Substantive questions about the issues under consideration.
The substantive questions are further divided up as follows:

SUBSTANTIVE QUESTIONS

- BUSES
- TRAINS
- PEDESTRIANS
- CITY TRANSPORT

SERVICE INDICATORS AND SERVICE IMPROVEMENT

The research project posed questions aimed at determining the respondents' attitudes and opinions regarding:

1. Bus transport
2. Rail transport
3. Pedestrian facilities

Several hypotheses were generated prior to the formulation of the questionnaire. The hypotheses have been divided up by mode of transport and in the order in which they appear on the questionnaire.

Respondents' attitudes towards Bus - Service indicators and improvements

(1) It was hypothesized that those living in the Eastern suburbs will be more likely to perceive tongas as creating bus delays than those living in Bombay South due to the confined area of operation of tongas. The K-W test showed a significance value of 0.0387 (Table 5.5), indicating that the null hypothesis can be rejected at the 95% confidence level.

(2) In connection with this, it was also hypothesized that rickshaws would be ranked higher as a cause of bus delay for those living in the suburbs than in the city, because of the absence of rickshaws in Bombay South. Results of the K-W test shows that this is indeed true. Those commuters living in the suburbs do rank rickshaws higher as a problem than those living in Bombay South. A significance value of 0.00 (Table 5.6) shows that the null hypothesis of
Table 5.5

K - W Test results between residence and ranking of Tongas

<table>
<thead>
<tr>
<th>Tongas</th>
<th>Bombay City</th>
<th>Western Suburbs</th>
<th>Eastern Suburbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of responses</td>
<td>80</td>
<td>122</td>
<td>61</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>124.9</td>
<td>144.0</td>
<td>117.3</td>
</tr>
</tbody>
</table>

Total No. of responses = 263
Corrected for ties, Significance = 0.0387
Table 5.6

K - W Test results between residence and ranking of rickshaws

<table>
<thead>
<tr>
<th>Rickshaws</th>
<th>Bombay</th>
<th>Western Suburbs</th>
<th>Eastern Suburbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of responses</td>
<td>81</td>
<td>122</td>
<td>61</td>
</tr>
<tr>
<td>Mean rank</td>
<td>175.4</td>
<td>101.4</td>
<td>137.7</td>
</tr>
</tbody>
</table>

Total No. of responses = 264
Corrected for ties, Significance = 0.000
no relationship can be rejected at the 99% confidence level. No significant relationships were found between other perceived causes of bus delay and residential location of commuters. Analysis of the results does, nevertheless, show some interesting trends. For example, those living in Bombay South tend to rank pedestrians, cyclists, buses and cars higher as causes of the transport problem than those living in the suburbs.

(3) It was hypothesized that 'quick' and 'convenient' would be ranked higher by those who classified the bus service as being 'good - excellent', while no other alternative will be ranked higher by those who said the bus service is 'poor - extremely poor'. The K-W test showed that these relationships were statistically significant. Significance values were 'quick' 0.0527, 'convenient' 0.0012 and 'no other alternative' 0.0024. This indicates that the null hypotheses of 'no-relationship' can be rejected at the 95% and 99% confidence levels.

(4) It was further hypothesized that 'no other alternative' would be ranked higher by those who wait longer to board the bus. This is assumed because if there were another mode offering a faster service they would use it. The K-W test showed a significance value of 0.00. This indicates that there is in fact a statistically significant relationship between the variables. It can be said at the 99% confidence level that, as waiting time for bus increases the more likely commuters are to rank 'no other alternative' higher as a reason for travelling by bus.

The K-W test results show that there was a tendency for 'readily available', 'convenient' and 'reliable' to be ranked higher by those who did not have to wait a long time for the bus. However, the significance values were too high for the null hypothesis to be rejected.
(5) The supposition that those commuters residing on Bombay Island will demand more frequent service of buses than those commuters living on Salsette Island was tested on the assumption that:

(i) Buses are used more by short distance commuters and
(ii) Buses arrive at full capacity when approaching Bombay South. Chi-square ($x^2$) test was applied to discover whether an association existed. From Table 5.7 it can be seen that 78.2% of the respondents said that they wanted more frequent bus services, while 21.8% did not recognize this as a service improvement. Of those surveyed that did not see more frequent buses as a service improvement, 39.4% were from the 0-20 km work/home zone and 60.6% from the 20+ km zone. The results indicate that a significant relationship does exist as the significance value is 0.0234. This means that the null hypothesis of 'no relationship' can be rejected at the 99% confidence level.

(6) It was hypothesized that a relationship exists between demand for separate bus lanes and the time taken for commuters to board the bus. This was based on the assumption that the longer commuters wait to board the bus, the more likely they are to want separate bus lanes. The longer waiting period is often due to longer headways caused not only by less frequent service but also by bus delays in traffic congestion leading to irregularity in service. The $x^2$ test of association showed that a significant relationship existed with a significance value of 0.03. From the cross-tabulation results, it was found that while 36.6% of those who waited upto 10 minutes did not see bus lanes as a means of bus service improvement, the corresponding percentage for those who waited over 20 minutes was only 10.5%. Further, of those who did see bus lanes as a service improvement, 57.9% waited over 20 minutes.

(7) The supposition that 'lower fares' will be demanded more by those who are in the 'clerical' and 'industrial'
Table 5.7

Crosstabulation between distance residence from work-place and the demand for more frequent bus services

<table>
<thead>
<tr>
<th>DISTANCE</th>
<th>Frequent bus Services</th>
<th>Upto 20 km</th>
<th>Over 20 km</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>26</td>
<td>40</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.4</td>
<td>60.6</td>
<td>21.8</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>133</td>
<td>104</td>
<td>237</td>
<td></td>
</tr>
<tr>
<td></td>
<td>56.1</td>
<td>43.9</td>
<td>78.2</td>
<td></td>
</tr>
<tr>
<td>Column</td>
<td>159</td>
<td>144</td>
<td>303</td>
<td></td>
</tr>
<tr>
<td></td>
<td>52.5</td>
<td>47.5</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Significance = 0.0234
occupation category rather than those in the 'executive' and 'businessman' category is a fair assumption as the cost factor will be an important form of service improvement for the lower income groups. Although only 34.7% saw lower fares as a service improvement, it was found that 42.6% of the clerical workers and 34.0% of the industrial workers surveyed did see lower fares as a form of service improvement. In contrast, only 28.9% of the executives and 15.4% of businessmen indicated the same. Table 5.8 shows the $x^2$ test produced a significance value of 0.04. This allows the null hypothesis of 'no relationship' to be rejected at the 95% confidence level. Results of the cross-tabulation show no significant relationships between occupation and either the demand for more frequent service or more bus routes. It can therefore be concluded that such service improvements are favoured by all respondents and not influenced by socio-economic factors.

Respondents attitudes towards Train - Service indicators and improvements

(1) It was hypothesized that relationships exist between 'Reason for travelling by train' and the way in which respondents perceived the quality of train service.

(a) The supposition that 'cheap' and 'no other alternative' would be ranked higher by those who classified train service as being poor - extremely poor was based on the assumption that those who so perceived the train service would travel by train out of necessity and because it is cheap. The K-W test showed a significance value of 0.0049 and 0.0000 for 'cheap' and 'no other alternative' respectively (Table 5.9). This indicates that there is a significant relationship between the variables and that the null hypothesis of 'no relationship' can be rejected at the 99% confidence level.

(b) It was further hypothesized that 'quick', 'convenient' and 'readily available' would be ranked higher by those who considered the train service as
Table 5.8

Crosstabulation between
Occupation and Demand for lower bus fares

<table>
<thead>
<tr>
<th>Lower fares</th>
<th>Executive</th>
<th>Clerical</th>
<th>Industrial</th>
<th>Business</th>
<th>Other</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>54</td>
<td>81</td>
<td>31</td>
<td>11</td>
<td>21</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>71.1</td>
<td>57.4</td>
<td>66.0</td>
<td>84.6</td>
<td>80.8</td>
<td>65.3</td>
</tr>
<tr>
<td>Yes</td>
<td>22</td>
<td>60</td>
<td>16</td>
<td>2</td>
<td>5</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>28.9</td>
<td>42.6</td>
<td>34.0</td>
<td>15.4</td>
<td>19.2</td>
<td>34.7</td>
</tr>
<tr>
<td>Column</td>
<td>76</td>
<td>141</td>
<td>47</td>
<td>13</td>
<td>26</td>
<td>303</td>
</tr>
<tr>
<td>Total</td>
<td>25.1</td>
<td>46.5</td>
<td>15.5</td>
<td>4.3</td>
<td>8.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Significance = 0.0431
<table>
<thead>
<tr>
<th>Mean Rank</th>
<th>Excellent</th>
<th>Good</th>
<th>Satisfactory</th>
<th>Poor</th>
<th>Extremely poor</th>
<th>Significance corrected for ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheap</td>
<td>106.3</td>
<td>138.2</td>
<td>153.5</td>
<td>146.3</td>
<td>188.3</td>
<td>0.0049</td>
</tr>
<tr>
<td>No other alternative</td>
<td>95.8</td>
<td>122.1</td>
<td>165.8</td>
<td>142.5</td>
<td>157.8</td>
<td>0.0000</td>
</tr>
<tr>
<td>Quick</td>
<td>165.3</td>
<td>152.3</td>
<td>126.0</td>
<td>137.6</td>
<td>143.5</td>
<td>0.0235</td>
</tr>
<tr>
<td>Convenient</td>
<td>164.4</td>
<td>133.5</td>
<td>131.7</td>
<td>159.7</td>
<td>32.0</td>
<td>0.0142</td>
</tr>
<tr>
<td>Readily available</td>
<td>154.5</td>
<td>160.9</td>
<td>133.8</td>
<td>103.1</td>
<td>108.0</td>
<td>0.0130</td>
</tr>
<tr>
<td>No. of responses</td>
<td>56</td>
<td>58</td>
<td>138</td>
<td>26</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
good - excellent. This is assumed since respondents would be travelling by train not out of necessity but rather for reasons of speed, convenience and availability. A K-W test showed significant values of 0.0235, 0.0142 and 0.0130 respectively (Table 5.9). This indicates that null hypothesis of 'no relationship' can be rejected at the 95% and 99% confidence levels.

(2) The relationship between the distance of residence from work place and reason for travelling by train was then examined and the K-W test was applied to discover whether the means (rank scores) for responses from people from different residence work distances are significantly different from each other. The hypothesis that 'cheap' and 'no other alternative' would be ranked higher by those who live further than 20 km from their work place is based on the assumption that railways are cheaper than buses for such distances. In addition, those commuters do not have an alternative mode by which to travel. The K-W test showed a significance value of 0.021 for 'cheap' and 0.00 for 'no other alternative'. This indicates that a relationship between the variables does exist and that the null hypothesis can be rejected at the 95% and 99% level respectively.

(3) When 'reason for travelling by train' is analysed with respect to residential location, it was hypothesized that 'reliable', 'quick' and 'convenient' will be ranked lower by those living in the Eastern suburbs than elsewhere in Greater Bombay. This is a fair assumption given the quality of rail services in Eastern suburbs (Chapter 4.1). The K-W test showed significance values of 0.00, 0.00 and 0.01 respectively indicating that there is a statistically significant relationship between the lower ranking given to 'reliable', 'quick' and 'convenient' and the residential location of respondents. The null hypothesis of no relationship can be rejected at the 99% confidence level.

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(A) It was also hypothesized that those who have to wait but a short time to board the train are more likely to rank 'quick', 'convenient' higher as a reason for travelling by train.

(a) Quick: It was found from the crosstabulation results, that while 82.9% of those who rank it first waited 0-10 minutes this percentage decreases to 17.1% for those who wait 10-20 minutes. It was found that no one who waited over 20 minutes ranked 'quickness' first. Therefore, there is a steady decrease in the ranking of 'Quick' as the waiting time for train increases. The $x^2$ test with a significance value of 0.00 shows that the null hypothesis of no relationship can be rejected at the 99% confidence level.

(b) Convenient: It was found by crosstabulation analysis that while 71% of those who ranked convenience first waited up to 10 minutes, this dropped to 27.4% for those who waited 10-20 minutes and to only 1.6% for those who waited over 20 minutes. Again, a steady decrease in the percentage of respondents who rank convenient high is seen with an increase in waiting time. A significance value of 0.03 indicates that there is a statistically significant relationship between respondents perception of convenience and actual waiting time for a train. The null hypothesis of no relationship can be rejected at the 95% confidence level.

It was further hypothesized that 'no other alternative' will be ranked as a major reason for those waiting a long period for travelling by train. Crosstabulation results showed that while 87% of those that waited over 20 minutes ranked 'no other alternative' the highest it was found that 48% who waited 10-20 minutes ranked it the same and this percentage further decreases to 22.1% for those that wait the shortest time. There is a tendency for the ranking of 'no other alternative' to decrease with a decrease in waiting time for
train. A significance value of 0.00 indicates that the null hypothesis can be rejected at the 99% confidence level.

(5) It was hypothesized that those living farther away, that is, in the extended suburbs would be more likely to see more frequent service as a means of service improvement than those living elsewhere. This is a fair assumption because railways offer an inferior service (in terms of frequency) in comparison to services in the city area and inner suburbs. Table 5.10 shows the crosstabulation results. It was found that 78.9% of the respondents did say that more frequent service would be a means of service improvement. However, results indicate that as distance increases from Bombay South, the more likely it is that commuters will want 'more frequent service'. Thus, 67.4% of those from Bombay South want more frequent services. This rises to 96.6% of those living in the extended suburbs. The $x^2$ test showed a significance value of 0.0001, indicating that the null hypothesis of 'no relationship' can be rejected at the 99% confidence level.

(6) It was hypothesized that 'extra fast trains' (express) would be demanded more by those who live in the suburbs, than by those living on Bombay Island. This was based on the assumption that those commuting longer distances would prefer less steps en route so as to reach their destination in less time.

The $x^2$ test showed a significance value of 0.0008. (Table 5.11). The results show that 69.3% of all the respondents indicated 'extra fast trains' as a form of service improvement but responses varied from 82.8% of those living in the extended suburbs to 72.4% of those living in the inner suburbs and 55.1% of those living in Bombay South. From the data, then, it can be seen that there is a tendency for those who live farther away to want extra fast train services.
Crosstabulation between residence and demand for more frequent train services

<table>
<thead>
<tr>
<th>More Frequent Service</th>
<th>Bombay South</th>
<th>Inner Suburbs</th>
<th>Extended Suburbs</th>
<th>Raw Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>29</td>
<td>33</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>32.6</td>
<td>21.2</td>
<td>3.4</td>
<td>21.1</td>
</tr>
<tr>
<td>Yes</td>
<td>60</td>
<td>123</td>
<td>56</td>
<td>239</td>
</tr>
<tr>
<td></td>
<td>67.4</td>
<td>78.8</td>
<td>96.6</td>
<td>78.9</td>
</tr>
<tr>
<td>Column Total</td>
<td>89</td>
<td>156</td>
<td>58</td>
<td>303</td>
</tr>
<tr>
<td></td>
<td>29.4</td>
<td>51.5</td>
<td>19.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Significance = 0.0001
### Table 5.11

**Crosstabulation between residence and demand for express trains**

<table>
<thead>
<tr>
<th>Extra Fast Trains (Express)</th>
<th>RESIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bombay South</td>
</tr>
<tr>
<td>No</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>44.9</td>
</tr>
<tr>
<td>Yes</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>55.1</td>
</tr>
<tr>
<td>Column</td>
<td>89</td>
</tr>
<tr>
<td>Total</td>
<td>29.4</td>
</tr>
</tbody>
</table>

Significance = 0.0008
Respondents attitudes toward pedestrian facilities

(1) The supposition that 'executives' and 'clerical' workers are more likely to say that they walk on the footpath than on the road and that industrial workers are more likely to say that they walk on the road is based on the assumption that 'executives' and 'clerical' workers would think walking on the road was not the 'done thing' and are more aware of the consequences of walking on the road. From the crosstabulation results, Table 5.12, it can be seen that while 48.7% of the executives use the footpath, the percentage decreases to 4.3% for industrial workers. There is an increasing tendency for commuters to walk on the road as the occupational group changes from executives through clerical workers to industrial workers. A \( x^2 \) test on the sample data showed a significance value of 0.0000 and proved that a relationship does exist and the null hypothesis of 'no relationship' between occupation and whether they walk on the footpath or road can be rejected at the 99% confidence level.

(2) It was hypothesized that hawkers would be ranked as a major reason for executives and clerical workers not to walk on the footpath. The K-W test carried out showed a significance value of 0.00 indicating that this is the case and that the null hypothesis of 'no relationship' can be rejected at the 99% confidence level. Results showed that narrowness as a reason for not walking on the footpath was ranked high by the industrial workers and 'other' occupation category. The K-W test showed a significance of 0.0083. There was no observed significant relationship between 'poor condition', 'squatters' and 'pedestrian overcrowding' and the occupation of respondents. Although it was originally hypothesized that the poor condition of the footpath and presence of squatters would be a major reason for executives and clerical workers to be dissatisfied with the condition of the footpath and not use it. The sample data does not substantiate this. As a result, the null hypothesis cannot be rejected because the significance value is greater than 0.05 for all.
Table 5.12

Crosstabulation between occupation and use of footpath or road for walking on

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Footpath</th>
<th>Road</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive</td>
<td>37</td>
<td>39</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>48.7</td>
<td>51.3</td>
<td>25.3</td>
</tr>
<tr>
<td>Clerical</td>
<td>55</td>
<td>83</td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>39.9</td>
<td>60.1</td>
<td>46.0</td>
</tr>
<tr>
<td>Industrial</td>
<td>2</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>95.7</td>
<td>15.7</td>
</tr>
<tr>
<td>Businessmen</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>38.5</td>
<td>61.5</td>
<td>4.3</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>46.2</td>
<td>53.8</td>
<td>8.7</td>
</tr>
<tr>
<td>Column</td>
<td>111</td>
<td>189</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>37.0</td>
<td>63.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Significance: 0.0000
Respondents attitudes toward other traffic problems

(1) The supposition that a relationship exists between residential location and how respondents rank traffic problems was based on the assumption that those living closer to work (near the CBD) are more likely to rank taxis as the major cause of traffic problems. This was based on the fact that shorter distance commuting means that commuters are more likely to use road based transport and thereby will be affected to a greater degree by taxis. The K-W test produced a significance value of 0.0024. The medians for each distance category show that those living at a closer distance to work did rank taxis high as a cause of traffic problems. Table 5.13 shows that a significant relationship does exist and the null hypothesis of 'no relationship' can be rejected at the 99% confidence level.

(2) It was hypothesized that traffic congestion will be ranked higher by those living on Bombay Island than those living in the suburbs. This is assumed because of the greater amount of traffic on Bombay Island and also because of the inadequate road capacity. The K-W test showed a significance value of 0.0169. This means that the null hypothesis of 'no relationship' can be rejected at the 95% confidence level.

(3) It was further hypothesized that 'poor services' would be ranked as a major transport problem for those living in the Eastern suburbs. In fact 55.6% of those respondents who live in the Eastern suburbs ranked 'poor services' the highest compared with 37.0% of those who live in the Western suburbs and only a small percentage, 7.4% of those living on Bombay Island. It is evident from the responses that the percentage are more or less reversed when one analyzes ranking of poor services the lowest. It was found that 60.0% of those living on Bombay Island rank it eighth, which indicates that for them 'poor services' is the least important of all transport problems. This percentage decreases to 30.0% and 10.0% for those living in the Western and Eastern suburbs respectively. The $x^2$ test for association
Table 5.13

K-W Test Results between distance Residence from work-place and ranking of Taxis as a cause of traffic problem

<table>
<thead>
<tr>
<th>Taxis</th>
<th>0 - 10 km</th>
<th>10 - 20 km</th>
<th>Over 20 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Responses</td>
<td>89</td>
<td>90</td>
<td>144</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>135.2</td>
<td>178.1</td>
<td>143.7</td>
</tr>
</tbody>
</table>

Total number of responses = 303

Significance corrected for ties = 0.0024
showed a significance value of 0.00, indicating that a relationship between ranking of poor services and residence does exist and that the null hypothesis of 'no relationship' can be rejected at the 99% confidence level.

A number of other hypotheses were also developed using the profile variables of residence, occupation and distance of residence from work and crosstabulating them with ranking of the transport problems. The results however suggest that there is a lack of relationship between many of the transport problems and such profile variables. This means that these dependent variables can be regarded as insignificant or minor explanatory value for respondents ranking of the problems. It further suggests that commuters perceive the problems in a more or less similar way. Having identified some elements in the Bombay residents perception of their city's transport problems, it is now necessary to see how the transport system could be better managed.
The conventional, formalized approach to tackling urban transport problems and its drawback was discussed at some length in Chapter 1.4. The rapid erosion in the 'demand-oriented' approach of the urban transport planning process gave rise to the need for other more practical approaches. It became apparent that one can no longer assume that sufficient capacity could be supplied to meet unconstrained demand. Transport Systems Management (TSM) is now a more popular means of tackling transport problems. There is a growing acceptance that careful management of the transport network is essential in the short term to ameliorate the worst effects of congestion. TSM evolved from traffic engineering and as its name implies it is essentially management of the existing transport system, using integrated application of conventional techniques of traffic management and control to the area in order to influence movement through and access to it. The central purpose of TSM is to make it easier and safer for the movement of vehicles and pedestrians on their existing routes (Khan, 1980, Ch. 1).

An approach that makes best use of the existing infrastructure is of paramount importance for LDCs where resources are scarce and have to be husbanded carefully. TSM's short term time horizon and emphasis on dealing with localized problems rather than trying to deal with them at city scale has earned it widespread popularity. The TSM approach is advantageous since it has a great deal of flexibility and scope for altering the techniques in accordance with the local situation. It takes into account that no two cities are alike and nor are their transport problems. TSM is essentially a tool for resolving conflicts between different demands for movement.

Because of the deterioration in traffic movement and environmental conditions, emphasis is tending to be placed on management of traffic as a principal way of coping with the short term situation (Buchanan, 1968). OECD (1978, 9)
claimed that this new approach is capable of monitoring and regulating the flow of traffic throughout the entire urban area and has the ability of relieving traffic congestion and optimizing traffic flow. This approach is not without its critics. Thomson (1977) notes that in many LDC cities traffic management tends to give greatest priority to motorists leaving the pedestrians to manage as best they can. There are those who see bus priority lanes as unconstitutional and in some LDC cities (Wirasinghe, 1981) they are being denounced as a device to let private cars flow freely and so favour the car owner (Srinivasan, 1977).

In the exigencies of the situation prevailing in Bombay, immediate steps have to be taken to alleviate the chaotic scene on the roads. TSM offers tremendous scope for improving Bombay's traffic problem. The solutions this approach offers are certainly valuable, however, it must be borne in mind that it is still a western methodology and solutions offered can be applied only after adjustment and alteration so as to make them suitable to the local conditions. Road space in Bombay is chaotically shared between motorized traffic, slow moving vehicles and a multitude of non-transport uses. In a congestion situation, no mode of transport can operate efficiently (Daniels and Warnes, 1980; OECD, 1981). Some modes are worse affected than others. Buses are the most severely affected in road congestion, on the other hand, the car, at any given level of congestion is better off and retains certain advantages. The fundamental weakness of buses is the conflict with the private car because the car interferes with the effective operation of public transport on which the majority depend.

In Bombay there are 150,000 private cars as against 2054 buses (as of January 1983), the latter move 4.5 million passengers each day, yet it is the car which uses the greatest amount of road space and is the main contributor to traffic jams and delays. Voorhees (1978, 213) estimated that private cars and taxis comprise 84% of traffic but carry only 27% of road borne passengers.
A reorientation of modal priorities on Bombay's streets is necessary and preferential treatment needs to be given to High Occupancy Vehicles (HOV), namely, buses. Management of traffic levels must be concentrated on the private car so that emphasis can be placed on optimising movement of people rather than vehicles (Altshuler, 1979). In order that this can be put into practice, the Voorhees consultants recommended policies for supply and demand management, both of which were complementary to each other. Demand management curtails excess demand by using measures to control traffic growth and thereby reduces problems and complements supply management. These measures include staggering work hours, land use changes and extension of parking controls. In addition the consultants recommended strongly that the present traffic signal system needed updating (Voorhees, 1980, 40). They point out that if a new signalling system were implemented, journey times during the peak hours would be reduced by 37% as a result of better co-ordination and improved timing and phasing of signals. OECD (1972) also recognizes that improved signalling has great potential for reducing one of the most crucial problems affecting mobility in urban areas — congestion. The most serious failing of maximization of vehicular flow is that it disregards the composition, the mix of traffic. Mixture of heterogeneous modes should be avoided, especially on important arterials and major bus routes, although there are serious problems of enforcement. Purposeful reduction in conflicts and increase in road capacity can only come by segregating modes. Jain (1979) firmly establishes that the capacity of roads can be increased by as much as 20-40% through segregation of different traffic types and other traffic engineering measures. There are a variety of such measures for giving road public transport priority over other vehicles (OECD, 1977). Bus lanes are the most popular. At first they may seem ideal for LDC cities as they do not require a lot of investment but it must be remembered that if they are to be effective they do require continuous enforcement to prevent misuse by other vehicles. The success
of bus lanes depends on all other activities being totally eliminated from the designated lane. Voorhees (1980) state quite rightly that geometrically an adequate street width is available in Bombay but that socially and politically it is not. The aim of segregating fast and slow moving traffic assumes the existence of a hypothetical situation bearing little resemblance to the reality of present conditions. The most serious of all problems, as emerged from the author's survey, is that of the encroachment on footpaths and carriageway by hawkers and squatters.

First priority for carriageway use must be given to moving vehicles since this is its prime function and purpose. Second priority must be given to public transport vehicles so that they can ply freely.

Pedestrians are such an influence on traffic movement and congestion largely because in Bombay the provision for them is grossly inadequate and they are forced to spill over on to carriageways. To improve the conditions for the pedestrian many schemes can be used, including pedestrian precincts in heavy pedestrian flow areas (Bor, 1972; Gandhi, 1973, Ch. 24). Such vehicle free areas have developed to some extent notably in Bhuleshwar and Kalbadevi (Ward C) where the narrow lanes, heavy pedestrian flow, non-vehicular traffic and the consequent congestion deter any motorist from going into the area unless they have no option. Even in the absence of many cars the conditions for the pedestrian leave much to be desired. Paradoxically, rather than widen carriageways on local and collector streets (as conventional wisdom suggests) for vehicular movement, which space is often used for parking, a more efficient answer may be to reduce carriageway space and increase footpath space for pedestrians that is not blocked by hawkers and squatters. This will be advantageous to both pedestrians and vehicles (Parker, 1979).

There is a limit to the amount of traffic that can be handled given the existing road system, therefore, restraint policies will have to play an increasingly important role. Before any
TSM method can be applied and implemented effectively, it must be borne in mind that Bombay’s streets are markets for commerce and also where people live (Appleyard, 1980). Owen (1956) noted that 'half the transport problem is to supply the facilities for moving and the other half is to create an environment in which the system has a chance to work.' The removal of commercial activity and storage encroachments from arterial roads is a necessary prerequisite. Their elimination at critical locations is vital since they impair pedestrian and vehicular mobility.

There is also a need to manage the temporal distribution of travel demand using flexi-time and staggered work hours. These methods have been considered as a way of reducing the severe congestion during the peak hours on the public transport system. However, experience elsewhere suggests that this could only have a marginal overall effect. BMRDA (1981) undertook a workplace and public transport usage survey which helped to determine the commuter travel characteristics. The survey findings showed that out of 920,000 workers, 575,000 (63%) of demand for train services during peak hours in the peak direction (North-South) in the morning as compared with 150,000 travelling in the anti-peak direction (South-North). One of the recommendations of the research (BMRDA, 1981, 3) was that there was scope for staggering of office hours so as to smooth out the peaking loads. An optimal staggering plan was devised by using a linear programming model to minimize the loading during the peak hours thereby benefitting commuters who at present travel during peak hours. Results of the model indicated that there would be an appreciable reduction in train loadings between 8.30 a.m. - 10.00 a.m. in comparison with the existing loadings. Between 10.00 a.m. -11.00 a.m. there would be an increment in the loadings, but within available rail capacity. Despite success in theory, field testing is still remaining'.
One of the conclusions reached by Voorhees (1980, 166) is that in 'Bombay's case road transport problems are as much a result of social and political attitudes of the people as from some deficiency in engineering aspects of traffic management. . . . practical engineering solutions, they emphasized, do not exist for an essentially socio-political problem'. Many opportunities exist for making substantial improvements to the quality of urban transport. Pedestrian precincts, oneway streets, restrictions on slow moving vehicles in certain areas, bus lanes, limits on parking, loading and unloading restrictions, an improved signal system or any of the other standard engineering practices can only be effective if, and only if, non-conforming activities are strictly controlled. It is vital to eliminate such non-conforming elements as the hard core of the problem lies there. This is an important pre-condition because until this is carried out no amount of traffic engineering improvement methods will be successful.

Such management and engineering solutions no doubt provide piecemeal, short term solutions to some of the transport problems but in the longer term there would seem to be no real alternative to comprehensive land use – transport planning. Aspects of this will be considered in the next chapter.
REFERENCES


CHAPTER SIX

REMEDIES FOR

URBAN TRANSPORT PROBLEMS

In the attempt to analyse the underlying causes of transport problems, these are related to the excessive demand on the transport system. It is related that urban population is increasing at a fast rate. Consequently, the capability of the transport infrastructure is proving for the volume of movement generated.

Kempner (1961, 36) investigated the effects of land consumption and travel demand on population growth. He showed that traffic growth was closely associated with the increase in the number of residents. The results showed that if the demand for transport is not controlled, it can lead to spiraling land values. In addition, the constraint of increasing transport capacity on enhancing the existing system has been notified and projected in population increases.
6.1 THE NON-TRANSPORT ISSUES

The preceding chapters have illustrated the situation existing in the field of transport in Bombay. It is the contention that only a properly integrated land use and transport system which takes into account the local conditions would provide the basis for relieving Bombay of its present transport problems.

One of the conclusions to emerge from this research is that non-transport factors are by and large responsible for the transport problems created in Bombay. Fig. 6.1 outlines a proposed model of the non-transport issues involved in Bombay and the way in which they associate to contribute to the overall problem.

In the attempt to identify the underlying causes of transport problems, there can be little doubt that the root cause is the excessive number of people in Bombay. It can be posited that urban population is increasing at a rate far outstripping the capability of the transport infrastructure to provide for the volume of movement generated.

Levinson (1981, 56) empirically established that ‘urban land consumption and travel outpace population growth. As the city grows its traffic grows too, the latter increasing at a faster rate than the former’. The failure of government policy on population growth and inability to stem the flow of rural-urban migrants has had profound implications for service provision in the cities. Bhattacharya (1981, 139) estimated that 350 migrants are added everyday to the population of Bombay. There is need, therefore, for a policy not only in words alone but in actual practice that reduces the drift to large cities. This has led to the high demand for urban space. Such population pressure in cities has in turn caused a spiralling of land values. In addition, any attempt at increasing transport capacity or enhancing the existing system has been stifled and negated by population increase.
NON-TRANSPORT ISSUES INVOLVED
IN ALLEVIATING TRANSPORT PROBLEMS

Fig. 6.1

**Government Policy**

- Over-concentration of people
- Maldistribution of activities
- Mono-nucleated city. Heavy concentration of industries and white-collar employment in Bombay Island

**Population Control**

- One-way access to the city - unique geographical feature
- Spiralling land values
- Non-flexibility of land use
- Convergence of trip attractors

**Development Problem**

- Unbalanced movement of people
- Great home/work distances

**Restructure & restricting growth of the city**

**New development**

**Twin city and urbanization of existing cities**

- Well-planned land use
- Adequate population and employment density
- Minimum Transport problems

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**Legend**

- The goal
- Process/mechanism to achieve goal
The maldistribution of land use in Bombay described in Chapter 2.2 is also another cause of the extremely high land values. The inflexibility of land use and the problem of readily altering land use together with the severe physical and geographical constraints of the Bombay site all contribute to a developmental problem. It is indubitable that the heavy concentration of secondary, tertiary and quaternary activities has led to the convergence of trip attractors which in turn exaggerated the unilinear movement of commuters. Nissel (1977) concluded that the traffic conditions are mainly due to the discrepancy between the geographical centre of Greater Bombay and location of the CBD. The spatial and structural imbalance has emerged as the most crucial problem of the metropolis and its repercussions are most evident in the transport sector. The city structure has become incompatible with the transport capacity available. The development of Cuffe Parade and Mariman Point through the Backbay Reclamation Scheme has further aggravated the structural imbalance and reinforced the mono-centric city structure.

This will no doubt encourage more tertiary sector employment to concentrate there and as a consequence generate more traffic. Meier (1980) supported that by stating, 'It is easily demonstratable that transport of workers to the new high rise buildings at waters edge would be exceedingly expensive.' Bombay's transport problem lies in its unplanned and lop-sided spatial growth. Even today, development is proceeding to an undesirable extent and in an undesirable direction.

The imbalance in the spatial distribution of population and economic activity necessitates large scale intra city movement giving rise to serious problems in the movement of people, goods and vehicles. The tendency towards employment concentration must be effectively restricted as commuters are being forced to travel over ever increasing distances and on ever more congested routes. Traffic cannot be reduced so long as work centres are centralized and land use in the CBD continues to be intensified. Providing infrastructure for
cities that focus on a single high density urban centre is a colossal task and inevitably they face high transport infrastructure costs because of the convergence of many people into a single area. For Bombay, this factor is multiplied several times because the CBD is approachable only along a corridor subtended by 30° angle.

Owen (1973, 67) gets to the crux of the matter when he says 'alleviation of traffic congestion will require not only a transport strategy designed to move traffic but an urban design strategy aimed at altering the conditions under which traffic moves.' And, one might add, the conditions under which it is generated.

The obvious remedy for over-concentration is decentralization (Galantay, 1979; Rondinelli, 1979). More appropriate in Bombay's situation would be re-centralization of the city's economic activities, that is, re-locating economic activities to another centre. This is a fundamental pre-requisite for decongestion of Bombay's population.

Decentralization has proved ineffective in eliminating transport problems in cities. Although 'peakedness' in demand is reduced, decentralization leads to dispersed origins and destinations which in turn require more flexible modes of transport provision, of which the car has proved to be the most convenient.

Since this mode is highly unlikely to be available to the masses in Bombay, planned re-centralization holds the answer to Bombay's transport problems. The situation that has been reached in Bombay calls for a better balance between transport supply and demand. This can be attained by a re-centralization of activity that results in more systematic and therefore more easily satisfied travel demand. Restructuring of the city entails new development by reorganization of unbalanced development. This could take place either by creation of a new twin city and/or organized development of existing towns which at present are merely dormitory suburbs to Bombay.

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Traffic attractors and generators especially commercial establishments should be shifted to other areas in order to lessen the load and volume on the transport system.

Surface congestion has reached critical levels (Chapter 5) and railways have failed to develop sufficiently as an alternative to relieve congestion of road traffic.

Without appropriate land use controls congestion seems unavoidable. IBRD (1975, 48) identified that Bombay's problem is posed by the dominance of the CBD and lack of secondary centres. This is confirmed in the present study. Subsidiary centres with adequate transport links need to be carefully planned and promoted. This is all the more important because Bombay is a growing city and continuing to expand. Future growth needs to be guided in a proper way.

Meier (1980, 136) comments on the fact that Bombay has for long been extraordinarily overcrowded and in order to be more productive it needs more space. Future growth must be siphoned off to the east across the Thana Creek. Counter-magnets to the existing CBD are urgently needed so that future movement is not restricted to a N-S axis. Unless the pressure of urbanization is properly channelled and controlled it is obvious that the city will become increasingly congested and the cost of supporting infrastructure will rise. There is need for directing more attention to the neglected side of the problem - land use.

In a city with unplanned land uses, excessive resources have to be devoted merely to traffic relief. The challenge is to ensure that the location of housing, industry and community services produce convenient arrangements that reduce transport problems instead of creating them. Rice (1977, 448) identifies that a more favourable distribution of residential and employment, both in terms of their densities and proximities may result in as much as 30% reduction in travel. If land use patterns could be more favourably and logically established, many of the transport problems as they are known today may be
eliminated. The European Council of Ministers (1975) point out that transport becomes a lazy substitute for urban planning. In an energy constrained, capital deficient city, the solution lies not in building more transport but to lessen the need for it. In Bombay if the land use organization continues in the present way it will perpetuate and accentuate the transport problems, making them insuperable.

Owen (1972, 43) observed that 'Bombays situation illustrates in an exaggerated way the mistake of attempting to accommodate congestion rather than deal with the underlying factors that generate it'. It has become both necessary and vital to regulate demand for transport through better control of land use. Land use planning remains the most powerful tool for controlling and regulating traffic, yet its use for this purpose has been negligible. This may be attributed to the fact that land use planning can only help in the long run as the results are unlikely to bring immediate relief to the transport problems. However, such a powerful tool should not be ignored and attention must be paid to restructuring land use.

While transport has greatly influenced the way in which cities have developed (Chapter 1.2) it has had very little influence on the way in which they have been planned. The key to resolving the transport difficulties lies in spatial organization of the land use which generates demand -- getting at the cause rather than symptoms of the disease.

There is substantial merit in doing this otherwise large sums of money will be required for augmenting railway capacity, expanding roads and building flyovers and underpasses in Bombay which is a questionable priority for a resource poor country. It is even a misconception to believe that additional transport infrastructure will mitigate UTPs. In fact it may even result in further decay and perhaps annihilation of the city.

Railways are often seen as an answer to urban transport problems of large cities in rapidly growing LDC cities. Bombay is an example of a city in which this option has already been exploited.
In Bombay, it is not that the transport system in terms of the people moved is inefficient. The IBRD (1971) report claimed Bombay to have an efficient public transport system especially in contrast with other LDC cities. However, the system generates traffic far in excess of its design capacity and it is doubtful if there remains any possibility of increasing the capacity. Therefore, the alternatives are either vastly expensive new transport systems, ruled out by lack of resources, or alter the land use patterns and tackle the problem from the point of view of the non-transport factors. Even with a good transport system, unless land use is compatible with the transport capacity available, transport problems will remain. Bombay serves as a good example to other LDC cities that a good public transport system by itself is not adequate to remove the problems.

LDCs have to be frugal in their use of resources and therefore, they need to ensure a less transport intensive, less costly and more efficient and congenial urban pattern.

The proposed sixth and seventh railway corridors (Chapter 4.1) are not the final answer to Bombay's transport problems. They would entail massive commitment of resources and if traffic is encouraged to grow along the same axis this will worsen the existing problems and create new ones to a point where an impasse is reached.

The proposed north-south railway corridors will also become overcrowded and congested unless action is also taken to restrict building heights and densities and guide growth beyond the built up areas to communities where a combination of jobs and housing can reduce the volume of commuter trips.

There is some scope for road transport improvement provided that the Transport Systems Management schemes are successfully implemented. Despite this potential, the available capacity would still not be adequate to meet the demand at the present growth rate. It seems clear that transport solutions alone cannot solve the problems and could indeed add to them even in a city like Bombay with low levels of car ownership and relatively efficient transport system.
In the light of the growing problems in Bombay especially with regard to the scale of growth and spatial distribution of that growth, a stage has been reached where the existing pattern can be sustained only by colossal investments. Perpetuation of the existing monocentric pattern of development as against a polynucleated pattern would mean an additional cost of Rs.1,200 crores over the next 25 years in order to maintain the present standard of civic facilities. Every job added in Bombay south involves an additional cost of Rs.23,000 and if the southerly concentration continues beyond 1986 additional costs may rise to Rs.48,000 per job (BMEDA, 1981, 1). Many of the transport problems can be directly attributed to the failure to implement a proper and consistent land use planning policy. Patankar (1981) and Nissel (1977) both favour restructuring of the metropolis as they point out that the problems would be nearer solution, if the existing land use, that is, the city's spatial economic structure is altered. BMEDA (1981, 3) and OECD (1978) conclude that the answer to Bombay's problems lies in the direction of demand management and modification through integrated land use and transport planning.

If the consummation is to minimize transport problems, then controlling the non-transport factors can provide the only long-term answers. There is need for decongestion of people and re-centralization of economic activity. The problem, then remains as to the precise form that such a restructuring of urban activity might take. This will now be considered in more detail.
6.2 PLANNING FOR THE BOMBAY REGION

Efforts have been made since 1945 to prepare plans for an orderly development of Bombay. Although the Bombay Municipal Corporation (BMC) took over the liabilities and functions of the Bombay Improvement Trusts in 1937, it was the Maharashtra Town Planning Act (M.T.P.A.) of 1954, that came into force in 1957, which gave requisite powers to BMC to prepare a comprehensive plan for the city (Indian Institute of Public Administration, 1978, 97).

In 1964, BMC published its twenty-year development plan for Greater Bombay. It was drawn up with the long term objectives of achieving integrated development and giving the city a cohesive structural pattern. Instead of altering the north-south development pattern, the planning proposals further accentuated the north-south axis.

Sivaramakrishnan (1978, 123) is critical of the plan as he sees it essentially as a land use zoning exercise which reinforces the existing monocentric development with high F.S.I. in the south (Chapter 2.4). A committee in 1965 under the chairmanship of Dr Gadgil was called upon to formulate principles for regional planning for Bombay and Pune. The Gadgil committee attempted to delineate the Metropolitan Region of Bombay by considering:

1. The area over which activity of the urban core is already ultimately affecting the socio-economic life.

It was concluded that a regional planning approach was essential if the problems of Greater Bombay were to be tackled satisfactorily. The problems of Bombay could not be viewed in isolation and had to be related to the regional matrix of which it was part. The total area under BMRPE jurisdiction amounts to 4,400 sq. km. With the object of guiding future growth the
Gadgil committee recommended the setting up of Regional Planning Board to tackle the problems of the region and these were established in 1967 (Bombay Civic Trust, 1970). The BMRPE, demarcation for BMR includes Greater Bombay, Thana, Kalyan, Bhiwandi and Bassein Talukas of Thana District, and the Uran Taluka, portion of Panvel, Karjat, Khopoli and Talukas of Kolaba district.

BMRPE published a twenty-year development plan for the Bombay Metropolitan Region for 1971-1990 (BMRPE, 1974). One of the conclusions reached was that the growth of Bombay is due more to office than industrial employment. The Board suggested that unless offices were shifted the growth of Bombay could not be controlled. In addition to a job freeze and reduction in F.S.I. in the CBD and the abandonment of the Backbay Reclamation scheme, they strongly recommend the development of the twin city across the Thana Creek with the object of locating tertiary activity there. One of the findings of the report was that the central problem of the region was the crushing domination of Bombay.

BMRPE justified the twin city development of two million population by 1991 on the basis that tertiary and quaternary activities need a metropolitan setting to function efficiently (BMRPE, 1974, 104; Bombay Civic Trust, 1970, 74; Desai, 1970). Offices can not be dispersed in a piecemeal manner and the existing concentration in the Fort Area was an interdependent whole. A similar concentrated base would be needed for a new city of equal strength. In addition, to be effective, the new city must be located within a reasonable commuting distance from Bombay in order that it could share the advantages of external and agglomeration economies. The report notes further that the geographical constraint in Bombay exercised by the location of the downtown area at the southern tip of the narrow peninsular indicates the necessity of duplicating the core activities along a new axis of development. Changes in the spatial structure of the city appear essential (BMRPE, 1974, xxvii; MEDC, 1978, Ch. 7).
The BMRPB report outlines four possible options for a rational structure for the future pattern of development in the region (BMRPB, 1974, 103). These are:

1. An internal restructuring of the metropolis
2. The development of new satellite towns and expansion of existing ones outside Greater Bombay creating a multi-town structure.
3. Corridor development along the transport arteries.
4. The development of a twin city with its main function to check migration to Greater Bombay.

The study firmly establishes (BMRPB, 1974, 105) that no single solution by itself would be adequate to take care of the development problems of the metropolitan region. The need is for a physical reorganization of activities and regulation of growth and this requires a combination of all the above four options.

The City and Industrial Development Corporation (CIDCO) was created in 1970 and was appointed as the development authority for New Bombay. Its function is primarily to plan, execute and maintain development of the twin-city as recommended by the BMRPB.

The Bombay Metropolitan Region Development Authority was created in 1975 basically as a forum for coordinating the different agencies to ensure a systematic development of the BMR. However, it has no power to require the agencies involved to submit their plans and therefore, even today the plans of different agencies remain largely unco-ordinated. Datta (1981, Ch. 4) discusses in detail the role of the development authority. In practice, liaison and consultation with the appropriate authorities, either those affected by development or with those involved in development, are of a meagre kind. This is best highlighted by the effort in developing the twin city as unregulated growth and concentration of economic activity in Bombay South continues unabated. This is confirmed by Sivaramakrishnan (1978, 124) who notes that 'the Backbay Reclamation Scheme, with high density office and residential
complex at the tip of Bombay Island is gaining momentum and thus running counter to the regional plans chief objective of shifting as much commercial and office space to the twin city'.

Bombay planning is described in greater detail by Gandhi (1973), Sivaramakrishnan (1978, 122-130), Datta (1981).

It emerges that planning in Bombay seems to have paid more attention to the preparation of development plans than to their implementation. The proposals are by and large still in the form of paper planning, strict enforcement of zoning regulations and land use plans have not been properly administered and the present transport problems can be directly attributed to the failure of land use controls.

The failure to execute the proposals despite the apparent rationality of the recommendations is by itself notable. This suggests that drawing up the plans has become an end in itself and that Bombay, like most other LDC cities, has become a victim of the 'easy to plan and formulate, hard to achieve and implement' syndrome. This has been primarily because while the forces which create, reinforce and accelerate urban growth are predominantly regional and national, and controlled by the State Government, the remedies to urban problems have to be found and implemented at the local municipal level, where limited resources make plan enforcement ineffective (Bombay Civic Trust, 1970; Dube, 1979; Thakur, 1980; Bhargava, 1981, Ch. 3). In the transport sector this is further complicated as Patankar (1978, 36) argues, by the existence of a large number of organizations responsible for the transport sector in Bombay, each with its own specific responsibilities to fulfil. He illustrates this by stating that 'the bus operator has no control on the land use planning which is the most important factor in traffic generation and even between the rail and road transport authorities there is no form of coordination'. The growth problems of the city have been aggravated by the all too common administrative delays, confusion of responsibilities and absence of clear-cut coordinated development objectives. As a consequence, a great
deal of planning effort is wasted and the actual implementation has been of marginal impact. Policies that are developed need to be adopted and plans implemented. The real problem today is how to activate the plans. There is an increasingly urgent need to check and guide continuing undesirable urban growth into a desirable planned form. Bharagava (1981, 15) states that past planning has emphasized the need for industrial decentralization with the belief that transport problems could be 'solved' by the dispersal of industrial employment.

The Maharashtra Industrial Development Corporation (MIDC) in 1961 and State Industrial and Investment Corporation (SICON) in 1966 were set up to help alter the industrial location in the state, away from Greater Bombay to the rest of Maharashtra in order to achieve balanced regional development (Godbole, 1978; I.I.P.A., 1978, Ch. 6). MIDC and SICON efforts at dispersal have not been successful as far as integrated urban development is concerned.

The industrial estates initiated by them are located in isolated pockets and are not part and parcel of the development plan for the area. Even more critical is the fact that housing colonies are being established without any thought given to the transport of workers. For example, Illustrated Weekly (1981, 28) revealed that the workers who were housed in the new colony in Chembur had eventually to abandon their tenements because of poor transport facilities. Employers as a consequence are obligated to run their own uneconomic transport services. The unnecessary multiplicity of buses in turn creates problems of traffic congestion in built up areas. Despite policies for industrial dispersal, industries are still concentrated in a single belt from Bombay to Pune (Deshpande, 1973, 230). Even more impressive is the fact that 75% of all industries are still located on Bombay Island. Industrial development has been most rapid in areas contiguous to Greater Bombay, as for example, Thana-Belapur area industrial employment has increased from 16,000 jobs in 1971 to 28,000 in 1978 (KTP (R1y), 1980, p. 24; Harris, 1978, 19).
Godbole (1978, 87) recognizes that despite the recommendation by committees for restrictive location policy on industries in Greater Bombay since 1965, the policy has been stringent only as far as heavy industries are concerned and they have been liberal with respect to the location of labour intensive units in Greater Bombay. This has added to the already serious problems for transport. It has permitted small scale industries to locate freely within the city and has allowed expansion of those already present. This has opened doors for uncontrolled growth of industrial activity in Bombay.

MEDC (1978) and Lakdawala (1960) describe in detail the industrial policy and location in Bombay. Induced industrial dispersal by MIDC and 51 CCM have brought about employment activity in areas that would otherwise have remained underdeveloped, however, there has been no 'trickle-down', to use Hirschman's terminology. Although industries have been regulated and controlled to some extent, tertiary and quaternary activity continues to grow unabated in Bombay South. Side by side with industrial location attention needs to be paid to deconcentration of offices in Bombay South.

Decentralization of employment has not extended to tertiary/office employment which has by all measures remained obstinately tied to the city centre. The authorities have by and large been preoccupied with industrial dispersal and have neglected the fact that it is commercial activity which generates a higher number of trip ends (Chapter 3.2).

Bombay Civic Trust (1970, 58-60) identify that it is the commercial and office establishments in the Bombay Fort area which contribute to congestion to a much larger extent than industries.

An office does not depend for its working on the provision of raw materials nor does it produce goods which need to be distributed. In this sense, offices are more footloose than industries. Despite this, offices tend to group themselves even more than industries. No industrial area in Bombay has a concentration of factories as intensive as offices in the downtown area. There is a disproportionate and heavy...
concentration of commercial establishments in Bombay south.
Although the advantages of agglomeration are not always so
tangible as the diseconomies are, the advantages of external
and agglomeration economies enjoyed by offices located in
Bombay south should not be undermined. Deshpande (1973)
found that the tertiary sector of Bombay is growing at a
faster rate than industrial employment since 1962.

Harris (1972, 66-72) points out that evidence suggests migrant
streams are sensitive to changes in employment opportunity in
the destination area. Therefore, there is indication that
job opportunities should agglomerate away from large city
centres. The problem remains of how to coax and cojole
commercial activity to relocate away from Bombay south. The
location policy must work principally by influencing the
location of firms by persuading them to establish away from
Bombay. Correa (1965, 41) went to the extent of saying that
it would be worthwhile to consider shifting the capital of
Maharashtra from Bombay to the proposed twin city across
Thana Creek.

To forestall further concentration of tertiary activity in
Bombay south and to lighten the burden of traffic on the
existing transport arteries BM RDA's strategy involves the
setting up of new growth centres, without which they point out,
abnormal growth of Bombay south cannot be halted.

A polynucleated structure is needed to organize the present
amorphous structure. It will be based on developments at four
locations (BM RDA, 1978) (Fig. 6.3; p. 260).

1. Bandra-Kurla complex:
Located at the southern end of Salsette Island. This
area is proposed to provide for the relocation and expansion of
wholesale trade from Bombay south. In addition, to encourage
the development of offices directly linked to Greater Bombay,
which would have otherwise gone to Bombay south. A total of
150,000 jobs is proposed for this complex.
2. **Two district centres:**

These are planned to be located in North Bombay, in the East and West suburbs, to house semi wholesale and high order retail trade. A total of 20,000 - 25,000 jobs is proposed for these two centres.

3. **Kalyan complex:**

This area is located north-east of Greater Bombay on the mainland. At present the area enjoys high levels of accessibility to Greater Bombay. This has resulted in it being a large dormitory to Greater Bombay. Restrictions, therefore, need to be imposed on residential land use in the area and to encourage instead tertiary sector employment. A total of 30,000 jobs is proposed for this complex.

4. **Central Business District of New Bombay:**

This area covers parts of Uran, Panvel and Nava Sheva. Unlike the other three employment centres it is proposed that this growth pole should have a diversified employment base similar to Bombay south with an employment target of 120,000 jobs. BMRDA is careful to point out, however, that a critical target of 30,000 to 40,000 jobs needs to be located there initially in order to form a base for self-sustaining growth and to obtain the advantages of agglomeration economies needed for a large tertiary centre.

According to the plan Bombay would have three CBDs and two district centres. These areas would generate substantial interaction between themselves which would promote rational traffic flows resulting in better utilisation of transport infrastructure. BMRDA notes that the largest single impact would be on the spatial pattern of transport demand. Poly-nucleated development would relieve the pressure on the railways and roadways and open up new townships in lagging region of the B.M.R. It would go further in stimulating growth in the hinterland than would the elongated N-S development on the peninsula.

Only two areas of progress are discernible since the birth of CIDCO in 1970 and with Rs.1,060 crores of public and private
investment (MTP (Rly.), 1980, 15). First, the development of the Vashi Residential Complex (VRC) at the entrance of the mainland (Fig. 6.3) with 35,000 self-contained housing units has not been able to sustain itself as an independent area in the absence of local commercial and office employment. Residents here commute to Bombay city. Konkan Bhawan is at present the only administrative complex on the proposed development site. It is still in its infancy, housing only the CIDCO offices.

Secondly, the development of Agricultural Produce Market (APM) at Turbe has shown more promise. The shifting of wholesale markets from the congested city core has been successful in relieving one of the traffic problems of the city. Illustrated Weekly, (1981, 38) calculated that before APM was developed, 250 truckloads of produce came into the bazar area daily. The incoming traffic has now fallen to 40 truckloads. CIDCO plans to shift other wholesale markets from Bombay Island to mainland.

It has been estimated that (Illustrated Weekly, 1981, 38) if all the wholesale markets are shifted to New Bombay, 20,000 jobs will be removed from Bombay Island. The proposed iron and steel warehousing complex at Kalamboli near Panvel will shift 15,000 jobs from Greater Bombay (MTP (Rly.), 1980, 25).

In summary, from the viewpoint of wholesale and industrial relocation the progress has been slow but steady but as far as office relocation is concerned progress has been low-key and not at the pace anticipated (Bombay Civic Trust, 1970, 71). What has retarded New Bombay development has been the absence of good transport and communication links with Bombay itself. Northward expansion of Bombay was facilitated by the readily available transport links (Chapter 2.1) and there is no reason to believe that expansion cannot proceed eastwards if efficient and cheap transport is available in that direction,
6.3 THE TWIN CITY PROJECT

The BMRPB was not the pioneer of the twin city proposal. As early as 1958, the Barve Committee urged that priority be given to development across Thana Creek. In addition, the Communications and Traffic Panvel (Karg, 1965, 38) firmly established 'that the error of history must be corrected and the handicap of geography overcome by developing a city on the mainland side of the Bay.' Neier (1980, 135) is also of the opinion that the twin city development is a far more ambitious and thorough plan than anything that has preceded it, since it will involve deflecting the normal evolution of the city.

New Bombay is also a linear shaped city extending from Uran in the south to Panvel in the north for 35 km in a N-S direction and with an average width varying from 4-14 km in E-W direction. The total (Fig. 6.2) area of New Bombay is 343 sq. km. The area proposed for development cannot be expected to develop in the absence of cheap mass transport facilities. In Bombay as in other urban centres in India, the majority of inhabitants are dependent entirely upon public transport for distances greater than can be carried out by walking.

Transportation (1970) points out that when planning for future movement of man, it is often more important to reduce the amount of travel than just plan bigger and more complex transport infrastructure. With this in mind and to promote maximum use of walking the new city is structured as a series of twenty self sufficient modes, each of 100,000 inhabitants and with a balanced aggregation of residential, employment, shopping, social and entertainment areas within 1-2 km (walking distance) range. The transport plan also envisages provision of cycle tracks between residential and employment areas which fall within 10-12 km range. Once a balance between location of urban activities and population is achieved, it is expected that demands on the transport facility will reduce substantially.

Greater Bombay

Kalyan

To Kuria

Mankhurd Stn.

Nerul

Elephanta

Nhava

Sheva

Panvel Creek

Uran Town

Alibag

Land Use

- Residential
- Commercial
- Industrial
- Port Area
- Parks & Sewage
- Farming
- Fishing Activities
- Major Roads
- M.T.P.(Rly.)


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For distances greater than 10-12 km, the new city has been planned around a conventional mass transport system. On account of its capacity and energy efficiency, a railway system was chosen as the most desirable transport mode, and one which was also within the financial and technological capability of Bombay (Ajgaonkar, 1974, 267). The phased transport strategy comprises several distinct elements.

1. The primary transport system of rail corridors passing through the heart of the residential and employment nodes. These will bring within their catchment area (3 km) as much development as possible.

2. The Bus routes are seen as secondary feeder systems to rail.

3. Special bus lanes will be provided in such a way that they can be converted to rail when demand warrants.

The densities of activities will be kept at or near optimum levels for economic provision of services. For full details of the plan, see Bombay Civic Trust (1970, 86), Ajgaonkar (1974), Wilsher and Righter (1977). Such a plan allows for coordination between land use and transport planning.

The proposed CBD at Belapur is at the centre of the N-S city structure and commuter corridors are so arranged as to have maximum accessibility from all nodes within city. The Railway is also to act as efficient dispersal system by providing stations at closer intervals and having all points in the CBD within 1 km of railway station so as to do away with the need for a secondary bus system.

The main industrial areas are proposed to be located at the periphery of the new city.

It is essential to provide a wide range of infrastructure and also simultaneously secure progressive growth of jobs in all sectors, particularly the tertiary sector. If these attempts to recentralize activities in Bombay fail, office employment
will expand even more in Bombay south and the transport problems will be worsened. There is no doubt that Bombay's future lies in the economic forces that determine office location.
The development of a twin city in the trans-harbour area will require vastly improved transport and communication links between Greater Bombay and New Bombay. Without adequate transport links to the area, promoting growth and sustaining development will prove to be difficult as has already been evidenced by past experience. Illustrated Weekly, (1981, 37) remarked that despite a package of incentives for firms to relocate, very few have moved largely because Government has failed to provide the necessary supporting infrastructure. No amount of investment in other sectors of the economy will prove productive unless transport, a crucial element in development which provides accessibility, is first available. The twin city development seems to have got caught up in the vicious circle of transport infrastructure not being provided because activities have not located there and activities not locating there because there are not adequate transport links.

Since the population depends on location of work places and their access vis-a-vis residential areas, an efficient and cheap transport system plays a dominant role in influencing distribution of urban activities.

It has even been argued that construction of a suspension bridge (Marg, 1965, 56) or a tunnel between Gateway of India and Uran is a prerequisite for trans-harbour development. J. G. Bodhe in 1961 commented that 'Bombay is of all the world's Island cities, the one having the poorest communication links with its mainland'. Even today there is only one bridge, namely, Trans Thana Creek Bridge connecting the Eastern suburbs of Chembur to Panvel (Fig. 6.3). Gore and Sharma (1976, 406) are careful to point out that the bridge is located north-east beyond the central part of the city so that vehicular traffic from the warehouses and the business district has still to work its way north before moving onto the mainland. This bridge did provide some impetus for development of the mainland but the pace has been rather sluggish. N.E.D.C. (1978, 65) argue that the bridge by itself has been unable to
Proposed East-West Railway Corridor

Fig. 6.3

Legend

- Bandra-Kurla Complex
- E-W rail link
- Existing rail lines
- District Centres
- Kalyan Complex
- Highways
- CBD of New Bombay

initiate development and that further improvement in accessibility is required. The capacity of the bridge is 1,500 passenger car units (PCUs) per hour in one direction (MTP (Rly.), 1980, 42).

At present, the public transport links to and from the New Bombay area are supplied by CIDCO which operates buses on eight different routes between New Bombay and various points in Greater Bombay and the external areas (MTP (Rly.) 1978, 100). It has been estimated by MTP (Rly.) (1980, 16) that the total number of passengers carried between Greater Bombay and New Bombay is 73,000 per day. CIDCO buses are well patronized having load factors of 75% - 80% during the peak period.

Private buses also ply within the two areas, this being confined to industry owned transport services, particularly in the Thana-Belapur industrial belt, where 300 privately owned buses carry 30,000 passengers (two-way volume) daily.

The expected increase in job potential will increase commuter traffic to and from New Bombay, especially from the suburbs because of their large population base (Chapter 2.4).

The Indian Institute of Management (IIM, Bangalore) consultants, using computer mathematical modelling techniques, assessed the magnitude of passenger travel and the social cost benefits of an East-West railway corridor, (Fig. 6.3) under different development scenarios (IIM, 1978; MTP (Rly.), 1980, 33-35).

The conventional transport model was used to forecast traffic patterns and demand under varying population/employment stages of development. The model indicated that under different scenarios, accessibility to New Bombay plays a dominant role in its development.

The IIM model estimates that a total of 2,153 PCUs will be required by 1986 for travel to and from New Bombay (MTP (Rly.) 1980, 43).
With the existing capacity of 1,500 PCUs, this means a saturation of bridge capacity. Railways which initially created the problems of uni-linear movement will have to play a vital role in bringing about rational distribution of population and employment in the metropolitan area. It is hoped that the railway will act as a catalyst in inducing growth and development in the area and in re-centralizing the economic activities from Bombay South.

The genesis of the east-west corridor (EWC) from Bandra in the west to Panvel in the east is based on the concept of a poly-nucleated city structure and the three-phased development of the proposed EWC is outlined in Table 6.1. The priority has been given to augmenting accessibility between Greater Bombay and New Bombay that is, recommending the construction of the Nankhurd-Belapur line first. Unfortunately, though, this line was excluded from the sixth 5-year plan—1978-1982. The EWC plan has, however, been submitted to IBRD for US$400 million loan to assist in its construction (Meier, 1980). There is no doubt that railway building is capital-intensive and providing infrastructure of such magnitude is a considerable task. It is justified on the grounds that:

1. It is needed for accelerating development of New Bombay. In the absence of a railway link, growth and development will be severely retarded.
2. It is needed to reduce growth on the uni-directional N-S corridor beyond Borivli and Thana. Although the total cost of the EWC is Rs.644 crores, it is estimated that it will yield a benefit of Rs.1,800 crores. The social cost-benefit being a ratio 1:3. (Illustrated Weekly, 1980, 41).

In its absence, over Rs.1,000 crores will have to be spent on augmenting the existing north-south railway capacity to meet the rising traffic demand in that direction. In the long term the EWC will prove to be less expensive and a more desirable urban structure will result. Deshpande (1973, 370) notes that 'the need for a proper railway link is all too obvious as studies
Table 6.1

<table>
<thead>
<tr>
<th>Link</th>
<th>Planned to be completed by</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Mankhurd - Belapur</td>
<td>1986</td>
<td>20.00</td>
</tr>
<tr>
<td>3. Belapur - Panvel</td>
<td>2001</td>
<td>11.00</td>
</tr>
</tbody>
</table>


2. MTP (Rly.), Techno-Economic feasibility report on extension of railway line from Mankhurd to Belapur (Panvel Creek), Bombay, October 1980.

3. MTP (Rly.), Techno-Economic feasibility report on extension of railway line from Belapur (Panvel Creek) to Panvel, Bombay, January 1981.
and surveys estimate that three million commuters will travel daily between the two cities’ (MTP (Rly.), 1978, 1980, 1981). The railway corridor will also result in more intensive utilization of the existing Kurla–Mankhurd line. The location of stations has been suggested on the basis of land use development in the different areas. The railway alignment also provides connection to all the five existing railway corridors on the suburban network, thereby, greatly increasing its overall accessibility and connectivity. It is envisaged by (MTP (Rly.), 1981, 46) that the resultant rail commuter pattern will show a substantial increase in north-south trips north of EWC and less so to its south.

Serious measures must be taken to develop employment activity in New Bombay, otherwise there is likelihood (from past experience) that it might become another dormitory for Bombay. Critics of the New Bombay development (Noble and Dutt, 1978, 323) say that it will increase regional concentration and geographic extension of Bombay. Richardson (1981) also argues that the drawback of the poly-nucleated strategy is that it results in an even larger and more polarized metropolitan region, which will be self defeating in the long run. This type of development does not bear on the problems of backward regions of the state and moreover, it will accentuate further the core-periphery differences, widening the gap between the two even more, by manifesting itself through 'backwash effects' in the rest of the state (Nydral, 1966).

Nevertheless, if the objective is to decongest Bombay city then the plan is justified. In a State where social and economic infrastructure is not available everywhere, future development will have to be in close proximity to Greater Bombay in order for it to be successful.
Technological innovations to help alleviate transport problems may appear promising especially as solutions to problems of urban areas. It is tempting to look to new technology for answers to our current problems. However, improvement in transport technology, whether proposed or actual, are not dramatic but marginal.

Virtually no major technological breakthrough has been achieved in urban transport in recent years. Improvements in urban travel will most likely be made by modifications to or replication of existing bus, subway and commuter rail facilities. Efficiency can be increased by concentrating on new operational methods using off the shelf technology. Despite the very many technological ideas, only a few are applicable in urban areas and there are at present only a few economically viable technologies (Hutchinson, 1970).

Any new technology developed will definitely have a great impact on the urban structure as past innovations in transport technology have done (Chapter 1.2).

Different scales and conditions of movement necessitate different modes of transport. The concept of transport 'gaps' was first introduced by Bouladon in 1967. He discusses at some length the different transport technologies needed to satisfy the variety of demands.

Much of the research on transport technology has concentrated on the transport 'gaps' especially the gap between 400 metres and 4 km. Over about 400 m walking becomes increasingly unacceptable for a growing number of people yet these shorter distances are not satisfied adequately by the conventional forms of transport. Many of the journeys in this range are within the CBD or within the suburbs and not so well satisfied by public transport as the larger radial routes centred on the CBD (Brand, 1970, 365). The technologies that have been proposed for serving this type of travel demand include speedwalk, minirail, network cabs, People mover and the
urbanrail (Hutchinson, 1970, 290). In Bombay's situation the cost of such modes would be prohibitive. For longer line haul movements, technologies such as Automatic Taxis, Dashavewayor, Monorails and Rapid Belts have been proposed. Although innovative, these have very little to offer in terms of alleviating Bombay's present traffic condition. One of the disadvantages of the overhead technologies like monorails is the high costs of the guideway and the maintenance costs of such sophisticated systems.

Most of these technological innovations have been developed in the DCs and have been aimed primarily at their markets and many of the proposals put forward do not even appear to provide economically viable alternatives. In DC cities, the overriding urban transport problem is how to wean the motorist away from his car. Suggestions are that a mode offering equally comfortable and convenient service will be required. Research orientation on this subject has, therefore, focussed predominantly on modes that can provide a door-to-door service, modes such as dual-mode automated system, public demand activated systems and rapid transit fall into this category. Supporters of these technologies claim that they go far towards resolving problems such as noise, air pollution, accidents and congestion.

Requirements for public transport in DCs are ones that will serve the fundamental characteristics of widely dispersed origins and destinations with high qualities of service, emphasizing comfort, convenience and the desire for privacy of individuals or small groups. This is not the situation in LDC cities, including Bombay where scope for such systems is limited. Poulton (1980) contemplates that 'new technology is unlikely to be very productive because of the major remaining flaw in the provision of transport services, the inability of one mode to provide good service to concentrated and dispersed trip ends seems unavoidable. New mode must be economical in its demand for space, flexible in its operation and fast'.
Poulton reached the conclusion that there is a fundamental technological barrier that precludes any one mode possessing more than two of these three attributes. Therefore, as a result, any one technology cannot satisfy the varied transport demands of urban areas as individual users.

Solving urban transport problems does not then lie in new technology but in the integration and coordination of different modes through the development of a multi-modal system for a given region. Technology will not provide ready answers to the transport problems any more than the past modal innovations have done, unless at the same time they are accompanied by measures designed to make them work, such as new towns designed with separate circulatory networks for pedestrians, cycles and motorized traffic. This could possibly be successfully implemented in the New Bombay development plan.

Except in very special circumstances the new technology is not a panacea for the urban transport problems as we know them today. Schaeffer and Sclar (1975) are not too optimistic about new technological innovations in transport. They stress that they provide no effective answer, that it was not the old technology that created the transport problems and that what is needed is — proper organization of transport and control of land use.

The hovercraft could be part of the answer to the baffling transport problems of Bombay. Hongkong has made use of such transport for development and expansion of outlying areas. In Bombay, growth and expansion has been historically towards the north determined by the pre-existing railway lines. Future development, as has been shown above, will out of necessity have to be towards the East, across the water.

Srinivasan (1980) is of the view that the inherent potentialities of inland water transport have not been taken advantage of to the extent required for improving the access and consequently bringing economic development to the area.
Patankar (1978) is also in favour of water transport for Bombay. He is of the opinion that it would relieve some load from other modes especially as Bombay has a natural harbour which is well protected from storms. Hydrofoils and hovercraft have the advantage of shallow draught high speeds and in recent versions high capacity but the disadvantage in comparison with conventional boats of high cost (Hutchinson, 1970, 293).

Communication innovations have also been hailed by many as a solution to UTP by their total substitution for travel con-frac—vision telephones, two-way T.V., high speed facsimile devices and advanced audio conferencing are all thought of as potential substitutes for travel.

A closer examination of the advantages of these systems shows that they may perhaps reduce the need for air travel more readily than intra-city travel and for most movements in Bombay actual physical transport is needed more than mere communication. Telecommunication has abetted expansion and promoted segregation of office from the production function. Office activity is a prime candidate for decentralization. Offices are bound together because of the communication-intensive nature of their activities. Improved communications have helped in the dispersal of office activity into the suburbs in DC cities. In LDC cities, where communications have not developed to the same level of sophistication, office activity remains firmly concentrated in the CBD and there is evidence to show signs of further concentration (Bombay City).

The communication revolution that makes decentralization feasible occurred through the invention of the telephone. In the case of Bombay, there is little incentive for offices to relocate away from Greater Bombay as there is no direct dial facility. Even within Greater Bombay connections are extremely difficult to obtain and a small proportion of the total population possess telephones. As a result, a large number of trips are necessary for face-to-face communication within the CBD. Locational freedom has not been achieved in Bombay in
comparison with DC cities. The real question that is outstanding is can LDC afford sophisticated, high technology, capital-intensive substitutes for travel?

This dissertation has examined the transport problems of one LDC city, Bombay. It has shown that its special problems arise as a result of a distinctive geographical site and history of urban development. In Schaeffer's terms, Bombay is still in large measure a 'walking city', there is nonetheless a simple but vital 'tracks' (railways), however, little as yet of the 'rubber' (motor car) which characterizes cities of DCs. It can be concluded that any viable long term remedy to Bombay's transport problem requires an integrated land use and transport planning strategy so that economic activity is located closer to where people live. Given the dynamic character of movement in urban areas we must be careful that we do not create a 'cure' which is worse than the disease.
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APPENDIX I

QUESTIONNAIRE ON USER PERCEPTION OF URBAN TRANSPORT PROBLEMS IN BOMBAY

Section 1: General

1. Profession/Occupation
   - Administrator/Professional
   - Clerical
   - Industrial/Manual
   - Trader/Business
   - Other

2. Where do you live?
   - City-Bombay South
   - Between Bandra and Borivli
   - Between Borivli and Virar
   - Between Kurla and Kulund
   - Between Mulund and Kalyan

3. Where do you work?
   - City-Bombay South
   - Between Bandra and Borivli
   - Between Borivli and Virar
   - Between Kurla and Kulund
   - Between Mulund and Kalyan

4. How far is your workplace from home? (Kilometres)
   - 0-5
   - 5-10
   - 10-15
   - 15-20
   - 20-25
   - 25-30
   - 30-35
   - 35+

Section 2: Buses

5. How often do you travel by bus for each of the following?
   - To and from work/business...per week
   - To and from market/bazar...per week
   - For social and leisure...per week
   - Other purposes...per week

6. How long do you usually wait for the bus? (Minutes)
   - 0-5
   - 5-10
   - 10-15
   - 15-20
   - 20-25
   - 25-30
   - 30+

7. How is the existing bus service?
   - Extremely poor
   - Poor
   - Satisfactory
   - Good
   - Excellent

8. Why do you travel by bus? (Please number 1 to 6 in order of importance)
   - (...) Reliable
   - (...) Convenient
   - (...) Cheap
   - (...) Headily available
   - (...) Quick
   - (...) No other alternative

9. How can the bus service be improved? (Mark upto 3)
   - Lower fares
   - Extra bus stops
   - More bus routes
   - Better bus/train connection
   - More frequent service
   - Separate bus lanes
   - Any other

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10. Why are the buses delayed on roads?
   (please number 1 to 8 in order of importance)
   (...) Pedestrians   (...) Scooters/Motorcycles
   (...) Cyclists      (...) Tongas
   (...) Rickshaws    (...) Taxis
   (...) Buses        (...) Cars & Lorries

Trains:

11. How often do you travel by train for each of the following?
   To and from work/business ....... per week
   To and from market/bazar ....... per week
   For social and leisure ......... per week
   Other purposes ............... per week

12. How far do you live from the station? (Kilometres)
   0-2  2-1  1-2  2-3  3-4  4-5  5+

13. How long do you usually wait for the train? (Minutes)
   0-5  5-10  10-15  15-20  20-25  25-30  30+

14. How is the existing train service?
   [ ] Extremely poor   [ ] Poor   [ ] Satisfactory
   [ ] Good            [ ] Excellent

15. Why do you travel by train?
   (Please number 1 to 6 in order of importance)
   (...) Reliable      (...) Convenient
   (...) Cheap        (...) Readily available
   (...) Quick        (...) No other alternative

16. How can the train service be improved? (Mark upto 3)
   [ ] Lower fares      [ ] Extra 'fast' trains
   [ ] Improved train standards [ ] More frequent trains
   [ ] Better passenger behaviour [ ] Better station facilities
   Any other .................

Section 3: Pedestrians

17. Do you walk mostly on:
   [ ] Footpaths   or   [ ] Roads?

18. The condition, standard and maintenance of footpaths are:
   [ ] Extremely bad   [ ] Bad   [ ] Satisfactory
   [ ] Good            [ ] Excellent

19. What are your reasons for not walking on footpaths?
   (Please number 1 to 5 in order of importance)
   (...) Harrow       (...) Squatter/Slum Dwellers
   (...) Poor condition (...) Pedestrian Overcrowding
   (...) Hawker/Pedlar Hindrance
   Any other .................

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20. Do you use the footbridge or underpass at major crossings?

☐ Yes  ☐ No

If no, please give reasons: ........................................

21. Are you in favour of areas reserved for pedestrians only?

☐ Yes  ☐ No

How else can they be improved? ................................

Section 4: Conclusion

22. Enforcement of road traffic regulation is:

☐ Extremely bad  ☐ Bad  ☐ Satisfactory

☐ Good  ☐ Excellent

23. Which of the following cause traffic problems? (Please number)

☐ Pedestrians  ☐ Scooters/Motorcycles

☐ Cyclists  ☐ Tongas

☐ Rickshaws  ☐ Taxis

☐ Buses  ☐ Cars & Lorries

☐ Hawkers/Pedlars

24. Public Transport Services for the following areas are:

<table>
<thead>
<tr>
<th></th>
<th>Poor</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Excellent</th>
</tr>
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<tbody>
<tr>
<td>Between Churchgate/Virar</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Between Bombay VT/Kalyan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between East &amp; West Suburbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Bombay South</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

25. Transport Problems:

(Please number 1 to 8 in order of importance)

(....) Overcrowded buses and trains

(....) High accident rates

(....) Road Traffic congestion

(....) Poor services

(....) Air/Noise pollution

(....) Poor road user behaviour

(....) Pedestrian/Vehicle conflict

(....) Vehicle conflict

Any other: ........................................

Thank you for your help.

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APPENDIX II
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tr>
<td><strong>WARD A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Upper Colaba</td>
<td>2.45</td>
<td>31506</td>
<td>59597</td>
<td>89.2%</td>
<td>129.00</td>
<td>243.00</td>
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<tr>
<td>(2) Middle and Lower Colaba</td>
<td>3.20</td>
<td>50853</td>
<td>53584</td>
<td>5.4%</td>
<td>159.00</td>
<td>167.00</td>
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<td>(3) Port South</td>
<td>1.83</td>
<td>23535</td>
<td>14862</td>
<td>-36.9%</td>
<td>129.00</td>
<td>81.00</td>
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<td>(4) Port North</td>
<td>0.36</td>
<td>35977</td>
<td>24451</td>
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<td>679.00</td>
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<td>(5) Esplanade</td>
<td>2.62</td>
<td>42233</td>
<td>36873</td>
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<td><strong>NET TOTAL</strong></td>
<td>10.46</td>
<td>184104</td>
<td>189367</td>
<td>+ 2.9%</td>
<td>176.00</td>
<td>181.00</td>
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<tr>
<td>(6) Mandvi</td>
<td>0.69</td>
<td>36020</td>
<td>30948</td>
<td>-14.1%</td>
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<tr>
<td>(7) Chakala</td>
<td>0.18</td>
<td>25196</td>
<td>20992</td>
<td>-17.7%</td>
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<td>1312.00</td>
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<td>(8) Umerkhadi</td>
<td>0.38</td>
<td>75191</td>
<td>61888</td>
<td>-17.7%</td>
<td>1979.00</td>
<td>1629.00</td>
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<td>(9) Dongari</td>
<td>1.19</td>
<td>38424</td>
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<td>271.00</td>
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<td>175131</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>(10) Khara Talao</td>
<td>0.23</td>
<td>35278</td>
<td>27883</td>
<td>-21.0%</td>
<td>1534.00</td>
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<tr>
<td>(11) Kumbhar Wada</td>
<td>0.17</td>
<td>45473</td>
<td>40179</td>
<td>-11.7%</td>
<td>2675.00</td>
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<tr>
<td>(12) Bhuleshwar</td>
<td>0.17</td>
<td>63113</td>
<td>50834</td>
<td>-19.5%</td>
<td>3713.00</td>
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### WARD C

<table>
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<tr>
<th>Ward</th>
<th>Population</th>
<th>Population</th>
<th>Change (%)</th>
<th>Revenue</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>(13) Market</td>
<td>0.33</td>
<td>47916</td>
<td>-35.5%</td>
<td>1452.00</td>
<td>937.00</td>
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<td>(14) Dhobi Talao</td>
<td>0.46</td>
<td>67405</td>
<td>-20.8%</td>
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<td>1161.00</td>
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<td>(15) Pana swadi</td>
<td>0.41</td>
<td>53285</td>
<td>-15.0%</td>
<td>1300.00</td>
<td>1105.00</td>
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<td><strong>NET TOTAL</strong></td>
<td>1.77</td>
<td>312472</td>
<td>-20.5%</td>
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<td>1404.00</td>
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### WARD D

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<th>Change (%)</th>
<th>Revenue</th>
<th>Revenue</th>
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<td>(16) Khetwadi</td>
<td>0.62</td>
<td>80520</td>
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<td>0.46</td>
<td>67702</td>
<td>-16.7%</td>
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<td>(18) Chaupat</td>
<td>0.43</td>
<td>29645</td>
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<td>602.00</td>
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<td>(20) Walkeshwar</td>
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<td>23.6%</td>
<td>292.00</td>
<td>360.00</td>
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<tr>
<td>(21) Mahalakshmi</td>
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<td>136037</td>
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<td><strong>NET TOTAL</strong></td>
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### WARD E

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<tr>
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<th>Change (%)</th>
<th>Revenue</th>
<th>Revenue</th>
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<td>(17) Tardeo</td>
<td>0.59</td>
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<td>(23) Tadwadi</td>
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<td>1.8%</td>
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<td>499.00</td>
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<td>(24) 1st Nagpada</td>
<td>0.38</td>
<td>26035</td>
<td>- 4.2%</td>
<td>685.00</td>
<td>657.00</td>
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<td>(25) 2nd Nagpada</td>
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<td>46391</td>
<td>-12.7%</td>
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<tr>
<td>(26) Kamathipura</td>
<td>0.24</td>
<td>56666</td>
<td>- 7.9%</td>
<td>2361.00</td>
<td>2152.00</td>
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<tr>
<td>(27) Eyculla</td>
<td>2.17</td>
<td>182688</td>
<td>1.2%</td>
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<td>851.00</td>
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<tr>
<td><strong>NET TOTAL</strong></td>
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<td>528736</td>
<td>- 2.5%</td>
<td>716.00</td>
<td>699.00</td>
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<tr>
<td>WARD</td>
<td>Area</td>
<td>Population</td>
<td>Housing</td>
<td>Population</td>
<td>Increase</td>
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<td>88588</td>
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<td>0.79</td>
<td>2634</td>
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<td>8.05</td>
<td>1,34,857</td>
<td>21,3601</td>
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### WARD K

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<th>Literacy Rate</th>
<th>Average Household Size</th>
<th>Rent</th>
<th>Total</th>
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<td>7.99</td>
<td>101860</td>
<td>126993</td>
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<td>(50) Vile Parle (West)</td>
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<td>43059</td>
<td>53447</td>
<td>24.1</td>
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<td>396.00</td>
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<td>(51) Juhu</td>
<td>4.27</td>
<td>21852</td>
<td>43159</td>
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<td>196787</td>
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<td>(54) Madh</td>
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<td>5679</td>
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### WARD P

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<th>Average Household Size</th>
<th>Rent</th>
<th>Total</th>
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<td>4583</td>
<td>17539</td>
<td>282.6</td>
<td>6.00</td>
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<td>(59) Aarey</td>
<td>4.66</td>
<td>15198</td>
<td>31765</td>
<td>126.1</td>
<td>33.00</td>
<td>74.00</td>
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<td>(60) Ekdar Pakhadi</td>
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<td>23671</td>
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<td>(61) Erangal and Daroli</td>
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<td>Chincholi &amp; Vadhwan</td>
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<td>(65) Valnai, Malwani,</td>
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<td><strong>372335</strong></td>
<td><strong>663246</strong></td>
<td><strong>78.1%</strong></td>
<td><strong>58.00</strong></td>
<td><strong>104.00</strong></td>
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<tr>
<td>(67) Kandivli and</td>
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<td>97147</td>
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<td>744.00</td>
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<td>16540</td>
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<td>(74) Dahisar</td>
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<td>66596</td>
<td>84981</td>
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<td>515.00</td>
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<td>(76) Station Takia, Kurla</td>
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<td>21233</td>
<td>23200</td>
<td>9.2%</td>
<td>589.00</td>
<td>644.00</td>
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<td>(77) Swedeshi Mills, Chunna Mills, Khajur Bhatti &amp; Kasaiwada</td>
<td>2.18</td>
<td>79632</td>
<td>122847</td>
<td>54.7%</td>
<td>365.00</td>
<td>564.00</td>
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<td>(78) Bazar Hall, Navpada Villages</td>
<td>9.11</td>
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<td>202543</td>
<td>90.9%</td>
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<td><strong>273507</strong></td>
<td><strong>433571</strong></td>
<td><strong>58.5%</strong></td>
<td><strong>206.00</strong></td>
<td><strong>326.00</strong></td>
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## WARD M

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<td>79 Chembur Bazar</td>
<td>736</td>
<td>198812</td>
<td>258445</td>
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<td>270.00</td>
<td>351.00</td>
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<td>(80) Mahol, Trombay, Govanid, Vadvali, Borla, Mankhurd, Mandala</td>
<td>46.92</td>
<td>117559</td>
<td>309180</td>
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## WARD N

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<td>93643</td>
<td>150528</td>
<td>60.7%</td>
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<td>46740</td>
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<td>97505</td>
<td>185562</td>
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## WARD T

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<td>55737</td>
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<td>(88) Nahur, Tulsi Gundgain, Vihar Sal, Klerobad</td>
<td>21.83</td>
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<td>18330</td>
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<td><strong>125165</strong></td>
<td><strong>222114</strong></td>
<td><strong>77.4%</strong></td>
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<td><strong>64.00</strong></td>
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**Source:** Based on Census Data, 1981.
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<td>3,258,117</td>
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<td>Greater Bombay</td>
<td>429.84</td>
<td>5,970,575</td>
<td>8,227,332</td>
<td>37.8%</td>
<td>139.00</td>
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<tr>
<td></td>
<td>% of 1971</td>
<td>% of 1981</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
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<td></td>
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<tr>
<td>Island Wards A - G</td>
<td>51.4%</td>
<td>39.60%</td>
<td></td>
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<tr>
<td>Suburbs H - T</td>
<td>48.6%</td>
<td>60.40%</td>
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</tbody>
</table>

Western Suburbs: 28.56% 34.91%
Eastern Suburbs: 20.01% 25.48%
Inner Suburbs: 36.29% 42.81%
Extended Suburbs: 12.28% 17.58%
<table>
<thead>
<tr>
<th>WARD NAME</th>
<th>Area in Sq.km</th>
<th>Basic Employment</th>
<th>Non-basic Service Employment</th>
<th>Total Employment</th>
<th>% to Total</th>
<th>Density of Employment per hectare</th>
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<tbody>
<tr>
<td>WARD A</td>
<td>10.46</td>
<td>248,502</td>
<td>189,921</td>
<td>438,423</td>
<td>(18.6%)</td>
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<td>WARD B</td>
<td>2.44</td>
<td>40,320</td>
<td>102,392</td>
<td>142,712</td>
<td>(6.1)</td>
<td>585.00</td>
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<td>WARD C</td>
<td>1.77</td>
<td>68,674</td>
<td>99,931</td>
<td>168,605</td>
<td>(7.2%)</td>
<td>953.00</td>
</tr>
<tr>
<td>WARD D</td>
<td>6.62</td>
<td>59,574</td>
<td>61,908</td>
<td>121,482</td>
<td>(5.10)</td>
<td>184.00</td>
</tr>
<tr>
<td>WARD E</td>
<td>7.38</td>
<td>121,435</td>
<td>96,547</td>
<td>217,982</td>
<td>(9.2)</td>
<td>295.00</td>
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<td>WARD F</td>
<td>21.1</td>
<td>126,590</td>
<td>106,491</td>
<td>233,081</td>
<td>(10.00)</td>
<td>110.00</td>
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<td>WARD G</td>
<td>17.85</td>
<td>292,057</td>
<td>121,214</td>
<td>413,271</td>
<td>(17.5)</td>
<td>232.00</td>
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<tr>
<td>WARD H</td>
<td>19.56</td>
<td>22,682</td>
<td>39,562</td>
<td>62,244</td>
<td>(2.6)</td>
<td>32.00</td>
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<tr>
<td>WARD K</td>
<td>47.23</td>
<td>79,420</td>
<td>52,476</td>
<td>131,896</td>
<td>(5.6)</td>
<td>28.00</td>
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<tr>
<td>WARD P</td>
<td>63.67</td>
<td>50,608</td>
<td>32,592</td>
<td>83,200</td>
<td>(3.5)</td>
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<tr>
<td>WARD R</td>
<td>76.64</td>
<td>40,561</td>
<td>22,037</td>
<td>62,598</td>
<td>(2.7)</td>
<td>8.00</td>
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<tr>
<td>WARD L</td>
<td>13.3</td>
<td>56,042</td>
<td>31,157</td>
<td>87,199</td>
<td>(3.7)</td>
<td>66.00</td>
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<tr>
<td>WARD NAME</td>
<td>Area in Sq.km</td>
<td>Basic Employment</td>
<td>Non-basic Service Employment</td>
<td>Total Employment</td>
<td>% to Total</td>
<td>Density of Employment per hectare</td>
</tr>
<tr>
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<td>-----------------</td>
<td>----------------------------</td>
<td>----------------</td>
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<tr>
<td>WARD M</td>
<td>54.28</td>
<td>30,137</td>
<td>29,517</td>
<td>59,654</td>
<td>(2.5)</td>
<td>11.00</td>
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<tr>
<td>WARD N</td>
<td>53.09</td>
<td>53,655</td>
<td>33,006</td>
<td>116,659</td>
<td>(5.0)</td>
<td>22.00</td>
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<tr>
<td>WARD T</td>
<td>34.45</td>
<td>10,045</td>
<td>6,145</td>
<td>16,190</td>
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<td>NET TOTAL</td>
<td>429.84</td>
<td>1,330,300</td>
<td>1,024,890</td>
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<td>100%</td>
<td>55.00</td>
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Source: Based on data from BMR, Travel Demand and Social cost benefit analysis in BM, 1978, p. 86.
<table>
<thead>
<tr>
<th>City</th>
<th>Area</th>
<th>Basic Employment</th>
<th>Non-basic Service Employment</th>
<th>Total Employment</th>
<th>Density of Employment in hectare</th>
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<td>Wards A - G (7)</td>
<td>67.62</td>
<td>957,152</td>
<td>778,404</td>
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<td>Wards H, K, P, R (4)</td>
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<td>195,271</td>
<td>146,667</td>
<td>339,938</td>
<td>16.00</td>
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<td>Eastern Suburbs</td>
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<tr>
<td>Wards L, M, N, T (4)</td>
<td>155.12</td>
<td>179,877</td>
<td>99,825</td>
<td>279,702</td>
<td>18.00</td>
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<tr>
<td>Wards H, K, L, M, N</td>
<td>137.46</td>
<td>271,934</td>
<td>185,718</td>
<td>457,652</td>
<td>24.00</td>
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<td>Wards (P, T, R) (3)</td>
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<td>101,214</td>
<td>66,774</td>
<td>167,988</td>
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<td>Employment % of Total</td>
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<td>---------------------------</td>
<td>------------------------</td>
<td></td>
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<td></td>
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<tr>
<td>Island Wards A - G</td>
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<tr>
<td>Suburbs H - T</td>
<td>26.31%</td>
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</tr>
<tr>
<td></td>
<td><strong>100.00%</strong></td>
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<td>11.88%</td>
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<td>1977-78</td>
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<td>-------------------------</td>
<td>---------</td>
<td>---------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Vihar</td>
<td>46,375</td>
<td>62,739</td>
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<td>Bhausa Square</td>
<td>26,476</td>
<td>37,097</td>
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<td>Gadag Road</td>
<td>8,408</td>
<td>9,983</td>
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<tr>
<td>Hatghem</td>
<td>8,014</td>
<td>7,596</td>
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<td>Sanglepada</td>
<td>79,472</td>
<td>76,804</td>
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<tr>
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<td>1,936</td>
<td>2,748</td>
<td></td>
<td></td>
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<tr>
<td>Ravi Mandir</td>
<td>1,111,979</td>
<td>1,143,938</td>
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<tr>
<td>Salakot</td>
<td>4,117,317</td>
<td>4,858,864</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jhunjhunu</td>
<td>6,301,813</td>
<td>6,024,723</td>
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</tr>
<tr>
<td>Shrimati</td>
<td>10,544,354</td>
<td>10,897,316</td>
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</tr>
<tr>
<td>Ghatkopar</td>
<td>14,290,256</td>
<td>14,085,350</td>
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</tr>
<tr>
<td>scenario</td>
<td></td>
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</tr>
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<td>Total</td>
<td>32,153,345</td>
<td>32,797,246</td>
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</tbody>
</table>

**Appendix IV**

293
### Section-wise daily railway station volume and Line Volume

The Suburban System in the Bombay Metropolitan Region during 1978-79

<table>
<thead>
<tr>
<th>Name of Station</th>
<th>Two-way Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Station</td>
</tr>
<tr>
<td>Western Railway:</td>
<td></td>
</tr>
<tr>
<td>Virar</td>
<td>49,376</td>
</tr>
<tr>
<td>Nalla Sopara</td>
<td>18,374</td>
</tr>
<tr>
<td>Vasai Road</td>
<td>46,401</td>
</tr>
<tr>
<td>Naigaon</td>
<td>8,015</td>
</tr>
<tr>
<td>Bhayandar</td>
<td>55,870</td>
</tr>
<tr>
<td>Mira Road</td>
<td>5,276</td>
</tr>
<tr>
<td>Dahisar</td>
<td>52,630</td>
</tr>
<tr>
<td>Borivli</td>
<td>4,46,442</td>
</tr>
<tr>
<td>Kandivali</td>
<td>1,15,426</td>
</tr>
<tr>
<td>Malad</td>
<td>2,34,426</td>
</tr>
<tr>
<td>Goregaon</td>
<td>2,37,037</td>
</tr>
<tr>
<td>Jogeshwari</td>
<td>1,66,985</td>
</tr>
<tr>
<td>Andheri</td>
<td>5,91,951</td>
</tr>
<tr>
<td>Ville Parle</td>
<td>1,30,471</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>1,80,199</td>
</tr>
<tr>
<td>Khar Road</td>
<td>1,28,832</td>
</tr>
<tr>
<td>Bandra</td>
<td>1,79,315</td>
</tr>
<tr>
<td>Mahim</td>
<td>90,749</td>
</tr>
<tr>
<td>Matunga Road</td>
<td>52,067</td>
</tr>
<tr>
<td>Dadar</td>
<td>2,31,072</td>
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<tr>
<td>Elphinstone Road</td>
<td>1,49,894</td>
</tr>
<tr>
<td>Lower Parel</td>
<td>1,06,839</td>
</tr>
<tr>
<td>Mahalakshmi</td>
<td>61,026</td>
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<tr>
<td>Bombay Central (Local)</td>
<td>95,335</td>
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<tr>
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</tr>
<tr>
<td>Charni Road</td>
<td>1,13,749</td>
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<tr>
<td>Marine Lines</td>
<td>55,747</td>
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<td>Churchgate</td>
<td>8,41,598</td>
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<td>Name of Station</td>
<td>Two-way Volume</td>
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<tr>
<td>----------------</td>
<td>----------------</td>
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<tr>
<td></td>
<td>Station Line</td>
</tr>
<tr>
<td>Central Railway:</td>
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</tr>
<tr>
<td>I. Main Line Kalyan to Victoria Terminus:</td>
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<td>Kalyan</td>
<td>1,39,575</td>
</tr>
<tr>
<td>Thakurli</td>
<td>11,469</td>
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<td>Dombivli</td>
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<td>Diva</td>
<td>4,176</td>
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<td>Kalva</td>
<td>35,624</td>
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<td>62,601</td>
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<tr>
<td>Masjid</td>
<td>45,980</td>
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<tr>
<td>Victoria Terminus</td>
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II. Kasara-Kalyan Section:

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<th>Name of Station</th>
<th>Two-way Volume</th>
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<tr>
<td>Kasara</td>
<td>1,000</td>
</tr>
<tr>
<td>Khadri</td>
<td>929</td>
</tr>
<tr>
<td>Atgaon</td>
<td>416</td>
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<td>4,921</td>
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<td>Vasind</td>
<td>2,830</td>
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<tr>
<td>Khadavli</td>
<td>1,870</td>
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<tr>
<td>Titalva</td>
<td>7,469</td>
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<tr>
<td>Ambivali</td>
<td>17,007</td>
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<td>Shahad</td>
<td>27,979</td>
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<tr>
<td>Kalyan</td>
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APPENDIX V

PEAK HOUR COMMUTING LOADINGS ON

WESTERN RAILWAY
<table>
<thead>
<tr>
<th>Section</th>
<th>Total Line Volume in 24 hours</th>
<th>% of total line Volume</th>
<th>No. of trains per peak hour</th>
<th>Density per train</th>
<th>Excess over density crowding over load capacity (per train)</th>
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<td>3950</td>
<td>3</td>
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<td>8477</td>
<td>3</td>
<td>2826</td>
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<td>Bhayandar</td>
<td>148504</td>
<td>11880</td>
<td>3</td>
<td>3960</td>
<td>1360 52.31</td>
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<td>1484 57.08</td>
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<td>898 34.54</td>
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<tr>
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<td>55511</td>
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<td>78777</td>
<td>15</td>
<td>5252</td>
<td>2652 102.00</td>
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<td>15</td>
<td>5789</td>
<td>3189 122.65</td>
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<td>112807</td>
<td>24</td>
<td>4700</td>
<td>2100 80.77</td>
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<tr>
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<td>24</td>
<td>5046</td>
<td>2446 94.08</td>
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<tr>
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<td>5150</td>
<td>2550 98.08</td>
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<tr>
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<td>1461396</td>
<td>119912</td>
<td>27</td>
<td>4330</td>
<td>1730 66.54</td>
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<tr>
<td>Mahim</td>
<td>149919</td>
<td>119914</td>
<td>27</td>
<td>4441</td>
<td>1861 70.81</td>
</tr>
<tr>
<td>Matunga Road</td>
<td>1515296</td>
<td>121054</td>
<td>27</td>
<td>4484</td>
<td>1884 72.46</td>
</tr>
<tr>
<td>Dadar</td>
<td>1389597</td>
<td>110877</td>
<td>27</td>
<td>4107</td>
<td>1507 57.96</td>
</tr>
<tr>
<td>Elphinstone Road</td>
<td>1205055</td>
<td>102704</td>
<td>27</td>
<td>3804</td>
<td>1204 46.31</td>
</tr>
<tr>
<td>Lower Parel</td>
<td>1225746</td>
<td>93036</td>
<td>27</td>
<td>3631</td>
<td>1031 39.65</td>
</tr>
<tr>
<td>Mahalakshmi</td>
<td>1192090</td>
<td>93767</td>
<td>27</td>
<td>3532</td>
<td>952 35.85</td>
</tr>
<tr>
<td>Bombay Central</td>
<td>1135817</td>
<td>90665</td>
<td>27</td>
<td>3365</td>
<td>765 29.42</td>
</tr>
<tr>
<td>Grant Road</td>
<td>994262</td>
<td>89265</td>
<td>27</td>
<td>3682</td>
<td>1082 41.61</td>
</tr>
<tr>
<td>Charni Road</td>
<td>805997</td>
<td>82959</td>
<td>27</td>
<td>3317</td>
<td>717 27.58</td>
</tr>
<tr>
<td>Marine Lines</td>
<td>641598</td>
<td>64159</td>
<td>27</td>
<td>3117</td>
<td>517 19.88</td>
</tr>
</tbody>
</table>

Source: Data of Line Volume and Number of trains run per peak hour based on BMRA Transport and Communications Statistics, 1991.
APPENDIX VI

PEAK HOUR COMMUTING LOADINGS ON

CENTRAL RAILWAY
<table>
<thead>
<tr>
<th>Section</th>
<th>Total Line Volume in 24 hours</th>
<th>% of total line Volume</th>
<th>No. of trains per peak hour</th>
<th>Density per train</th>
<th>Excess over 2600 dense crush load capacity (per train)</th>
<th>Percentage overcrowding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalyan</td>
<td>263824</td>
<td>21106</td>
<td>8</td>
<td>2638</td>
<td>38</td>
<td>1.46%</td>
</tr>
<tr>
<td>Thakurli</td>
<td>271873</td>
<td>21750</td>
<td>8</td>
<td>2719</td>
<td>119</td>
<td>4.58%</td>
</tr>
<tr>
<td>Dombivli</td>
<td>330906</td>
<td>26472</td>
<td>8</td>
<td>3309</td>
<td>709</td>
<td>27.27%</td>
</tr>
<tr>
<td>Diva</td>
<td>333180</td>
<td>26678</td>
<td>8</td>
<td>3335</td>
<td>735</td>
<td>28.27%</td>
</tr>
<tr>
<td>Mumbra</td>
<td>351454</td>
<td>28116</td>
<td>8</td>
<td>3515</td>
<td>915</td>
<td>35.19%</td>
</tr>
<tr>
<td>Kalva</td>
<td>382274</td>
<td>30582</td>
<td>8</td>
<td>3833</td>
<td>1223</td>
<td>47.04%</td>
</tr>
<tr>
<td>Thane</td>
<td>641399</td>
<td>51312</td>
<td>15</td>
<td>3421</td>
<td>821</td>
<td>31.58%</td>
</tr>
<tr>
<td>Mulund</td>
<td>644598</td>
<td>55568</td>
<td>15</td>
<td>3705</td>
<td>1105</td>
<td>42.50%</td>
</tr>
<tr>
<td>Bhandup</td>
<td>779223</td>
<td>62338</td>
<td>15</td>
<td>4156</td>
<td>1556</td>
<td>59.85%</td>
</tr>
<tr>
<td>Kanjur Marg</td>
<td>819403</td>
<td>65557</td>
<td>15</td>
<td>4370</td>
<td>1770</td>
<td>68.08%</td>
</tr>
<tr>
<td>Vikhroli</td>
<td>889714</td>
<td>71177</td>
<td>15</td>
<td>4745</td>
<td>2145</td>
<td>82.50%</td>
</tr>
<tr>
<td>Chatkopar</td>
<td>1044598</td>
<td>83568</td>
<td>16</td>
<td>5223</td>
<td>2623</td>
<td>100.88%</td>
</tr>
<tr>
<td>Vidya Vihar</td>
<td>1049835</td>
<td>83987</td>
<td>16</td>
<td>5249</td>
<td>2649</td>
<td>101.88%</td>
</tr>
<tr>
<td>Kurla</td>
<td>1150667</td>
<td>92052</td>
<td>17</td>
<td>5415</td>
<td>2815</td>
<td>108.27%</td>
</tr>
<tr>
<td>Sion</td>
<td>1199604</td>
<td>95968</td>
<td>17</td>
<td>5645</td>
<td>3045</td>
<td>117.12%</td>
</tr>
<tr>
<td>Matunga</td>
<td>1214990</td>
<td>97199</td>
<td>17</td>
<td>5718</td>
<td>3118</td>
<td>119.92%</td>
</tr>
<tr>
<td>Dadar</td>
<td>1018641</td>
<td>81491</td>
<td>17</td>
<td>4794</td>
<td>2194</td>
<td>84.38%</td>
</tr>
<tr>
<td>Parel</td>
<td>975714</td>
<td>78057</td>
<td>17</td>
<td>4592</td>
<td>1992</td>
<td>76.62%</td>
</tr>
<tr>
<td>Currey Road</td>
<td>964719</td>
<td>77178</td>
<td>17</td>
<td>4540</td>
<td>1940</td>
<td>74.62%</td>
</tr>
<tr>
<td>Chinchpokli</td>
<td>932986</td>
<td>75519</td>
<td>17</td>
<td>4419</td>
<td>1819</td>
<td>69.96%</td>
</tr>
<tr>
<td>Byculla</td>
<td>802927</td>
<td>80926</td>
<td>17</td>
<td>4760</td>
<td>2160</td>
<td>83.08%</td>
</tr>
<tr>
<td>Sandhurst Road</td>
<td>774833</td>
<td>77483</td>
<td>17</td>
<td>4558</td>
<td>1958</td>
<td>75.31%</td>
</tr>
<tr>
<td>Masjid</td>
<td>734371</td>
<td>73437</td>
<td>17</td>
<td>4320</td>
<td>1720</td>
<td>66.15%</td>
</tr>
</tbody>
</table>

Source: Data of line volume and number of trains run per peak hour based on BMRDA Transport and Communications Statistics 1981.
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Bombay and its Suburbs

- Railway Routes
- Proposed Roads
- Beauty Spots (Flora & Fauna)
- Rivers
- Lakes
- Distance in Km
- From V.T. on C.Rly
- From Church Gate on W.Rly

The map shows Bombay City and its suburbs, along with distances to various places such as Karachi, Colombo, Aden, and others. The scale is 1 inch = 1.61 kilometers.