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SUSTRAC

MOBILITY FOR SUSTAINABLE DEVELOPMENT

BANGALORE CASE STUDY

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1. INTRODUCTION

1.1 Background and Motivation of "Mobility for Development" (M4D) Project

Mobility is one of the essential conditions for economic and social development. Advanced countries and regions have made good use of the merits of mobility, while overcoming or minimizing its drawbacks. One of the most crucial issues today is whether, and how well, less developed and developing countries and regions can do the same in the near future and thus secure their share in the kind of social prosperity that has been achieved in the developed countries. Unfortunately there are certain substantial obstacles blocking the path to economic and social development for these countries due to current conditions of poverty and income disparity, low education, quantitative and qualitative deficiencies in infrastructure and subsequent bottlenecks such as traffic congestion even at the present low levels of traffic volume. This makes it all the more urgent to highlight the internal mechanisms of the positive and negative feedback effects of mobility, including its social implications and its detrimental impacts on the environment.

We believe an important role should be played by the business sector in improving mobility and avoiding its detriments in less developed and developing countries. The simple provision of this or that mode of transport may solve mobility problems in the short term but can obviously also lead to negative effects such as more congestion and environmental damage, more income disparity, and a greater mobility divide in the long term. Therefore mobility for development must be of the sort that generates as high a level of individual happiness as possible and has the smallest possible adverse and negative impacts on society.

It was with these problems in mind that the World Business Council for Sustainable Development (WBCSD) initiated the Sustainable Mobility Project in 2002. The Project set out a global vision covering the sustainable mobility of people, goods and services in road transport. In 2004 the resulting report "Mobility 2030: Meeting the challenges to sustainability" presented a framework to connect up a diverse set of economic, social and environmental strands; by identifying some key issues and choices, it also developed a set of goals as a focus for future action, and charted a number of pathways as a means to their fulfillment. A project like this, however, can be no more than an introduction to this complex web of problems that confronts all societies. As a consequence, it was found appropriate to launch a new WBCSD project entitled "Mobility for Development" (M4D) in 2006.

In M4D, the scope has shifted from the general approach of Mobility 2030 to a more empirical and case-based analysis, focusing on four cities from four developing countries and regions: India;

China; Africa; and Latin America. In selecting suitable locations for case studies, M4D endeavored to come up with fast growing cities in different stages of economic development which have had to struggle with problems of urbanization, motorization and the environment.

1.2 Selection of Case City: Bangalore

Bangalore, located in the South of India, has been selected as one study area. This is because the city is typical as a rapidly developing mega-city that has long been suffering from a shortage of urban services and urban management. High-tech industries such as automobile and IT enterprises have been agglomerating in the area in recent years, and a good deal of attention has been given to the question of how well Bangalore, as a new model "growth pole" in a developing country, will succeed in increasing people's QOL (quality of life) while mitigating the negative impacts. Within the M4D project, an interim report (TERI, 2007), mostly consisting of statistical data, was recently completed. It supplied the main basis for the discussions in the Stakeholder Dialogue for Mobility for Development held in Bangalore in September 2007. Both the report and the Stakeholder Dialogue drew a general picture of the city with a focus on the key concepts developed by M4D, i.e. mobility as an economic engine, the mobility divide and sustainable mobility solutions.

Bangalore has acquired a reputation as the "Garden City of India" with its tree lined streets, and well laid out extensive gardens and parks. The character of the city has also been marked by strong globalization influences and a rapid growth of information technology since the beginning of the 1980s. Forces which have visibly shaped the local economy have earned the region a name as the "Silicon Valley of India." In our judgment, therefore, Bangalore is one of the best and most timely case study candidates among the large Indian cities and allows a deep exploration of the issues of sustainable development and mobility, bearing in mind a number of factors summarized below:

Photo set 1.1: Two attractive city center landscapes in Bangalore

- Rapid population growth due to natural increase and immigration. Between 1981 and 2001,

natural increase and immigration accounted respectively for 22% and 45% of the total increase (JNNURM, 2006). With a high share of technically skilled and well educated potential employees, Bangalore is very attractive economically among Indian cities.

- High-technology industries within the global economy have been the growth engine of the local Bangalore economy, with a rapid emergence of information technology and of industries based on it (Annapurna and Satish, 2007). Apart from national and international software companies, other major industries such as automobile manufacturing and aviation have also had a fair part in shaping the economy. However, the urban structure and infrastructure lags far behind what is required for the efficient promotion of such growth, and this sets constraints on the expansion of the city and poses a need for immediate and consistent urban management (Sudhira *et al.*, 2007).

- Bangalore has a leading place as the regional center of culture and information, and is one of the most important agglomerations in terms of both urbanization and job opportunities in the southern part of India (northern India is dominated by Mumbai, Delhi and Kolkata).

- As a criterion of the stage reached in economic development, the Globalization and World Cities (GaWC) Study Group and Network ranks cities in terms of their "world city-ness," with values ranging from 1-12, where those scoring 10 and above are regarded as fully fledged world cities (alpha), those from 7 to 9 as major world cities (beta), those from 4 to 6 as minor world cities (gamma), and those from 1 to 3 as showing evidence of world city formation. Bangalore is included in this last group of cities with a rating of 1 (Delhi has a rating of 3) together with cities like Glasgow, Brasilia and Antwerp.
  (http://www.lboro.ac.uk/gawc/citylist.html)

- The United Nations included Bangalore among the 30 largest world agglomerations in 2015, ranking 29th after three other Indian cities: Mumbai 3rd, Delhi 5th and Kolkata 9th (United Nations World Urbanization Prospects: 2001 Revision, 2002).
  (http://www.un.org/esa/population/publications/wup2001/wup2001dh.pdf)

- Although Bangalore's rapid economic growth has brought an expansion of local qualitative and quantitative needs and desires, the spatial and transport organization of the city cannot yet meet even present required living standards, and still less those that will be urgent in the near future unless immediate actions are taken. One group of almost unavoidable problems for economic

centers in the developing world is the widening disparity in incomes and the consequent worsening of social stratification such as the mobility divide. This is certainly the case in Bangalore, which requires urgent planning efforts to provide much better minimal means of mobility and other urban amenities for all of its citizens, including the poor and the rural.

- The Bangalore urban highway and public transport system is far behind what is needed to foster economic development. Traffic problems are acute, and the regional and local authorities are now developing many improvement plans and proposing heavy budget allocations for highway construction. The only means of motorized transport is road-based on an insufficient road network with low speeds and long travel times (the average speed in the city area is already as low as 10-13 km/hr, which is bad even compared to many other growing Asian cities). The only form of public transport is by bus and only very recently have the first 40 air-conditioned buses been introduced. Intermediate forms of public transport are not managed or organized (the share of intermediate public transport is 12.6%).

- All growing metropolises, whether in developing or developed countries, sooner or later have to face the problem of spatial re-organization (Richardson, 1993). At present, Bangalore is at the stage of extending in all directions: departing from the classical monocentric form to an urban structure in which industries are becoming decentralized and new districts are being constructed in the suburbs. The city planning boundaries are being extended to promote and manage developments at the periphery as the city core is overloaded and cannot accommodate new schemes. The Bangalore Metropolitan Regional Development Authority has announced the creation of five integrated townships for different groupings of major economic activities at a distance of 30 km to 40 km from central Bangalore.

1.3 Scope and Contribution of the Report

This report is unique in that it provides perspectives through two original methodologies based on new concepts of representation for the current state of urbanization and motorization in Bangalore and various important associated planning problems (Hayashi *et al.*, 1994; Hayashi and Sugiyama, 2003):

a) Comparative trend analysis, and

b) Quality of life (QOL) analysis.

The report features the concepts of sustainability, Accessibility, mobility and QOL, and tries to express the mobility divide in a generalized way, namely in terms of disparity in QOL.

Although the aim of urban policy debates and efforts around the world is to achieve sustainable development, there is no one solution or optimum combination of policies that assures both economic, social and environmental sustainability and of political and public acceptability (Hall and Pfeiffer, 2000). Given the complex nature of urban systems and human behaviors both in the global and the local economy and environment, sustainable development in a modern urban architecture is not at all straightforward. Therefore this report takes the line of starting out from a review of current problems of sustainability and mobility in Bangalore. From there, it seeks to provide the decision-makers in the city area with guidelines for the design of future strategies and policies aiming at a politically and economically practicable land use and transport development in harmony with the changing socio-economic profiles and directions of growth.

We specifically try to examine the stage of economic development, urbanization and motorization of Bangalore in comparison with five other Asian cities: Tokyo, Nagoya, Bangkok, Jakarta and Delhi (Hayashi *et al.*, 1994), by way of the following steps:

1) positioning the stage of economic development
2) devising suitable strategies and relevant sets of policy and technological instruments
3) evaluating the instruments in terms of an enhancement in QOL, which is a fundamental measure taking account not only of economic benefits but also of cultural opportunities, Amenity, Safety & Security, and environmental well-being.

This comparative analysis highlights the current state and likely future trends of growth. One crucial horizon for goal-setting in urban studies is how to plan for a minimal individual satisfaction or happiness irrespective of socio-economic class. One way to pursue this is through the idea of QOL which was a concept first born in the 1960s. Here, we suggest employing the QOL concept to quantitatively measure individual well-being and social equity in urban planning in a perspective derived from the framework proposed in this report. We explore citizens' feedback about their perceptions of urban life, and then carry out a more detailed survey into the weight they place on various components of QOL. This survey, which was completed in September, 2007, was based on a modest sample of 215 respondents, but is valuable as one of the few QOL surveys that have been conducted in the city. We believe that this Nagoya University Report on Bangalore not only provides perspectives on policy solutions for sustainable mobility and development to meet the needs of the day but also constitutes a document for the dissemination of know-how and experience to numerous other cities that are, or soon will be, passing through the same stages of development that Bangalore and the other reference cities are traversing now.

1.4 Field Survey Schedules

We conducted our project using three main sets of data: secondary data from other relevant reports, a citizens' perception survey (Chapter 5), and findings from two field inspection trips. The principal aim of these two trips to Bangalore was to have discussions with senior urban planners representing important governmental and nongovernmental organizations and to collect planning documents for a better understanding of projected land use and transport developments. We also explored the city core and visited two information technology center developments in the suburbs to see the urban problems in situ (Table 1.1).

Table 1.1: Bangalore field survey schedules, July and September, 2007

BANGALORE FIELD SURVEY I July 17-20, 2007

Wed., July 18

The Energy and Resource Institute (TERI), Delhi: Dr. Ranjan Bose and Ms. Chavi Dhingra
- Information about progress of the TERI report and introduction to the Nagoya University approach

Thurs., July 19

Toyota Kirloskar Motors Ltd. (TKM, UB office): Mr. Ono, Director and Mr. Sadanah, Manager of Corporate Planning Division
- Presentation by TKM on transport in Bangalore and exchange of views

Bangalore Metropolitan Transport Corporation (BMTC): Mr. Tripathy, Managing Director
- Information about Bangalore bus operations and management

Bruhat Bangalore Mahanagara Palike (BBMP): Mr. Dillip Rau, Administrative Director and Mr. B.V. Myrthy, Personal Secretary
- Information about BBMP town planning

Fri., July 20

Bangalore Metropolitan Regional Development Authority (BMRDA): Mr.Chandrashekar, Assistant Director of Town Planning
- Information about regional spatial development

TV conference with TERI, Delhi
- Exchange of ideas with Dr. Ranjan K Bose, Senior Fellow, and his group

BANGALORE FIELD SURVEY II September 11-14, 2007

Wed., Sept. 12

Stakeholder Dialogue in Bangalore

Thurs., Sept. 13

Bangalore Development Authority (BDA): Mr. Shankaralinge Gowda, Commissioner
- Information about the extent of BDA's operations in town planning

Bangalore Metropolitan Transport Corporation (BMTC): Mr. Chandra Mouri
- Discussion of BDA and BMTC planning

Visits to two information technology centers (Whitefield and Electronic City) and city center

1.5 Structure of Report

This report stresses the importance of mobility for development, defining it in a broader framework in connection with related concepts such as Accessibility and sustainability. Taking Bangalore for its case study, the report clarifies the socio-economic trends and current plans for land use and transport in the city and region, and then comes to grips with the critical issue of the mobility divide by income classes and locations. These issues of mobility are analyzed by means of QOL measures as generalized indicators, allowing Bangalore to be positioned in a framework of economic development stages in comparison with such mega-cities as London, Tokyo, Nagoya, Bangkok, Jakarta and Delhi, Finally the report recommends strategies for a better integrated land use and transport system, together with a corresponding range of technology and policy instruments, and discusses the roles of various stakeholders in promoting them.

The report is organized into seven chapters.
Chapter 1 provides an introduction, explaining the motivation of the M4D project, the suitability of the Bangalore area for a case study, and the scope and approach of the report.
Chapter 2 reviews sustainability and mobility, with the associated key definitions, and introduces a framework for the evaluation of mobility for sustainable development, which can be adapted to the Bangalore case study.
Chapter 3 is an introduction to local spatial and transportation planning and also reviews the urban problems facing sustainability which fall within the scope of the report.
Chapter 4 presents and analyzes a set of basic socio-economic and urban parameters (per capita GDP, population, vehicle ownership, length of paved roads etc.) to serve as data for a further discussion of the circumstances in the city compared with five other selected mega-cities.
Chapter 5 interprets local people's perceptions of relevant components of QOL (Accessibilty, Amenity, Safety & Security) from a mobility and urban development perspective, in the light of results from a small-scale survey conducted in Bangalore.
Chapter 6 elaborates on the questions of how well current planning serves the objective of mobility for sustainable development, and what revisions are needed in policy implementation.
Finally, Chapter 7 makes some concluding remarks from the general perspective of urban planning for sustainable development and mobility in Bangalore.

2. MOBILITY FOR SUSTAINABLE DEVELOPMENT: A POLICY CHALLENGE

2.1 Concept of Sustainability

Although the term sustainability has long been in use, it was in "The Limits to Growth" (Meadows *et al.*, 1972) that it was first defined in a sense similar to the one in which it is understood now. The standard definition of sustainable development commonly accepted and used today was formulated in the Brundtland Report "Towards Sustainable Development" prepared for the World Commission on Environment and Development (WCED, 1987).

> *"..development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs."*

Since the Brundtland Report sustainability has been one of the central policy issues asserted in many, perhaps almost all countries, and there has been general agreement on the need for sustainable urban development (urban sustainability) and environmentally sustainable urban transport. In a subsequent milestone agreement, the Rio Declaration on Environment and Development from the Agenda 21 United Nations Earth Summit (1992), attention was drawn to the three main perspectives of Economy, Environment and Equity in sustainability studies. A few years later, the United Nations Conference on Human Settlements (HABITAT II) in Istanbul (1996) produced a lengthy consensus document on urban development principles and a catalogue of global best practices in sustainable city building (See Wheeler and Beatley, 2004 for an extensive review of the historical development of the sustainability concept).

To date, a tremendous number of reports, government policy documents, and scientific conferences and books have continued to discuss urban sustainability problems of all kinds, exploring sustainability indicators and suggesting ways of achieving urban sustainability in general or specific cases. Maclaren, in her 1996 paper on urban sustainability reporting, reviewed key characteristics of the term "urban sustainability" and summarized them as: intergenerational equity, intra-generational equity (social equity, geographical equity, equity in governance), protection of the natural environment, minimal use of nonrenewable resources, economic vitality and diversity, community self-reliance, individual well-being and satisfaction of basic human needs. Within this wide spectrum the definitions and indicators are straightforward, but the design and adoption of policies is complex in practice, particularly for the developing countries.

2.2 Concept of Mobility

Mobility is a widely acknowledged concept in the service of social and economic development in urban and regional planning. The OECD defines Environmentally Sustainable Transport (EST) as that which meets mobility needs (OECD, 2002). The European Union also seeks for sustainable mobility at the European level. For example, "European Transport Policy and Sustainable Mobility" (Banister *et al.*, 2000) looks at mobility issues and suggests European level transport policies. However, in practice, mobility has been far more narrowly evaluated by single indicators such as average travel time and road volume/capacity which have often served as references in transport master plans over the last three decades.

The American Heritage Dictionary, Fourth Edition, defines mobility as the "quality or state of being mobile," and mobile as "capable of moving or of being moved readily from place to place." In the context of transport planning, Handy defines it more particularly in association with Accessibility as "potential for movement, ability to get from one place to another and ability to move around" (Handy 2002).

Mobility can be interpreted as "freedom to move around" and is a component of happiness. It is influenced by the following factors:

1) Accessibility
2) Congestion
3) Comfort in travel
4) Punctuality and information about delays

Accessibility is the determinant factor for mobility. Accessibility is defined as "potential for economic benefits gained by interactions in the spatial system" Mobility is "the satisfaction or enjoyment obtained through travel." However, transport is a derived demand that emerges out of the mobility need for people or goods to reach a destination where the objectives of socio-economic activities can be satisfied.

Advanced countries and regions have managed to utilize the advantages of mobility while overcoming and minimizing its drawbacks. However, in less developed countries and regions, one of the most crucial issues today is how to find ways of overcoming mobility problems under conditions of national poverty and income disparity, low levels of education and poor awareness of urban and environmental problems, mismatches between demand and supply in urbanization, and quantitative and qualitative insufficiencies in urban design and infrastructure provision. Obviously, there is a need here for a broader scope in which to explore ways of facilitating mobility under sustainable conditions (Section 2.4).

2.3 The Mobility Divide

The mobility divide has recently been gaining attention as a prominent concept in studies concerned with the theory and practice of mobility enhancement. The term refers to gaps in the level of mobility between rich and poor due to the restricted affordability of cars, between the younger and older generations due to the ability or inability to drive, between the physically able and impaired due to difficulties in using public transport, and more generally, also between urban and rural areas.

The mobility divide in the rapidly growing cities of Third World countries shows up in two domains: the socio-economic and the spatial. In the socio-economic domain, stratification occurs in individual well-being depending on the economic ability to afford various means of mobility such as cars, two-wheelers or public transport. In many cases, the lowest income groups cannot even afford any of the public modes of transport but have to rely on non-motorized modes even for longer trips. A strong dependency on two-wheelers and non-motorized transport for longish journeys creates safety & security problems, and is apparently a contributing cause to the high rate of accidents in developing countries. The markedly low levels of service in public transport, coupled with problems in safety, reliability and punctuality, make it difficult to satisfy the demands of equity with respect to the ease and comfort of mobility compared to private car ownership. Another aspect of the problem is the low level of mobility available to elderly and disabled people, who may have no option but to depend on public transport services. The spatial domain is the supply side of mobility and is characterized by heterogeneity in the extent to which residential areas are provided with access to such urban needs as work, education and health care. The relative inadequacy of public transport in suburban areas, where it has not developed in pace with urban expansion, further adds to the gap in spatial mobility and makes it harder to meet the most basic needs of urban and suburban residents.

2.4 Framework to Evaluate Mobility for Sustainable Development

Urban planning, in its long history, is an area in which powerful mechanisms and frameworks have been developed for policy design, evaluation, application and monitoring, but fresh thinking is needed for the promotion of sustainability in rapidly growing cities. Frameworks for sustainability in the three dimensions of economic, environmental and social development have played a leading part in many recent studies. For example the European Conference of Ministers of Transport (ECMT) uses these three heads as the main “pillars” for its sustainability objectives and relevant indicators. Economic sustainability includes ease of transport access through the alleviation of congestion and the creation and conservation of wealth. Environmental sustainability also depends on a reduction of congestion, together with the protection of landscape and biodiversity, the reduction of noise and greenhouse gas emissions,

and the improvement of air quality. Social sustainability has to do with the improvement of transport safety as well as with safeguards against isolation, fears and threats.

For expressing mobility, single indicators such as average travel time and road volume/capacity have long been recognized in transport master plans. However, it is obvious that such indicators far overshoot the aims of evaluating mobility for development, especially for sustainable development in rapidly growing cities in developing countries.

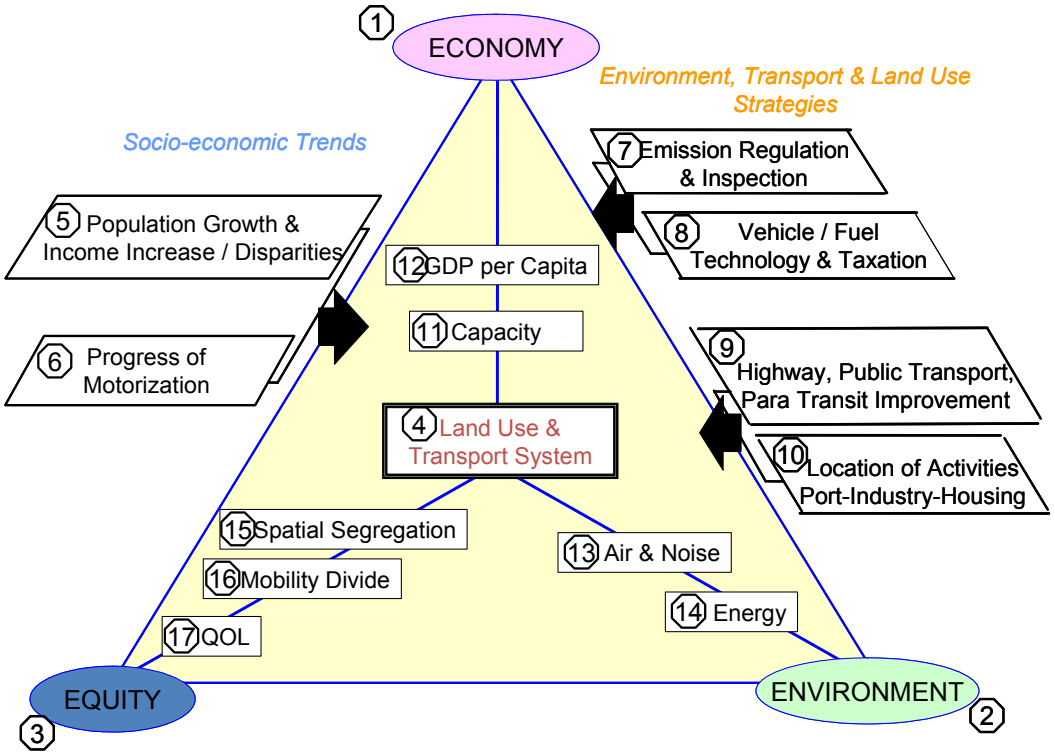

Figure 2.1: Framework to evaluate sustainability and mobility for development

For the purpose of examining mobility in the present report, therefore, we set up three pillars representing not only 1) Economy and 2) Environment, but also 3) Equity, as shown in Figure 2.1. We also propose a structural set of input indicators representing QOL (quality of life) as a more generalized evaluative measure of mobility taking account of both the positive and negative effects of providing various modes of transport for the enhancement of mobility.

Given the existing approaches and the strategic significance of mobility and sustainability, we find it appropriate here to create a framework that allows a general evaluation of mobility and sustainable development. For this purpose, it is important to select indicators and features of design that are particularly suitable for urban planning in Third World countries.

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A) Inputs to the Land Use and Transport System

In an urban land use and transport system (4), each of the three pillars will be affected by relevant key indicators of population growth and urbanization (5) leading to rapid progress in motorization (private vehicle ownership (6)) and relevant spatial and transport policies and environmental policies (environment, land use and transport strategies). The technological and policy instruments for mobility and spatial development are core factors for policy making and these are clearly the central concern for the present case study.

The technological and policy instruments determining mobility and spatial development are grouped into four categories of land use, mode coordination, vehicle technology, and IT and mobility management. The main instruments for each category have to be further examined for efficiency, applicability and integrality (see Figure 2.2 in Section 2.6, and Figure 6.1 in Section 6.2). For example, decentralized concentration and mixed land use under the "land use" category, para-transit development and control under "mode coordination," active and passive safety systems under "vehicle technology," and IT applications and virtual mobility coverage under "IT and mobility management" are particularly important instruments to adopt and control closely because while they may not be easy to understand or manage, they provide crucial elements for the guidance and reinforcement of policy-making and mobility management in developing cities (see Figure 2.1).

B) Evaluation Framework

In the framework shown in Figure 2.1, the three pillars of sustainability, the so called "three Es" of Economy (1), Environment (2) and Equity (3), represent the broadest orientations of our policy goals. The aim will not be to quantify them but to explore the balance between them. For the Economy and Environment pillars, commonly used macro-scale indicators will be appropriate, and the adequacy of the evaluation will obviously depend on the data available.

The main engines for development under Economy will be population growth and business opportunities for new domestic and foreign investments. In most rapidly growing cities, global economic forces also apparently act as an economic engine, as is the case for Bangalore. The increases in business opportunities and GDP per capita (12) further encourage population increase by attracting more immigrants. To accelerate economic growth (1), large-scale improvements in transport facilities such as ports, highways and public transport (9) are essential in order to increase capacity, thus mitigating congestion in the network and providing better mobility for goods and passenger movements.

Capacity (11) is directly related to Economy as it defines the volume and ease of travel. A capacity increase can be achieved either by provision of new infrastructure (roads or new public transport systems) or through applications of IT, that is in the form of either physical or virtual mobility. Within the scope of the M4D project, it is important to consider not only the automobile market but also the alternative potentials of both public transport and IT developments as instruments for alleviating road congestion. In the case of public transport, a trend reversal may be needed, since the failure of public transport to respond sufficiently to the rising demand for mobility that accompanies economic growth is likely to have been one of the causes behind the steady rise in private vehicle ownership in the first place.

Environment is another important aspect to consider in the management of mobility for development. Key policy measures for managing mobility for economic growth on the one hand, while alleviating its worst effects of air and noise pollution (13) and increased energy use (15) on the other, include emissions regulations and a vehicle inspection system (7), together with technological improvements and a taxation system that takes preferential account of them (8). Other relevant instruments will be transport and infrastructure improvements (9) and location policies (10). The guiding principle will obviously be to strive for the best balance between the economic and environmental interests (see Nakamura *et al.*, 2004 for an extensive review and analysis of urban policy design).

But in developing countries, the third pillar, Equity, is the one that raises the most challenging questions and requires the most careful attention. In developing cities around the world, citizens find themselves faced simultaneously with economic growth and inequality in forms such as inadequate urbanization and motorization. For a balanced social and economic development of the kind which the M4D project is seeking, this makes Equity the most crucial of the three Es in this kind of case. It is unfortunate that in many studies of development only a relatively minor emphasis is placed on the measurement of Equity (or Inequity) with the result that the focus of interest is effectively narrowed down to the balance between economic prosperity and environmental conservation.

In a general context, Equity is basically defined as:

> *" attainment of some minimum standard or norm, beyond which the individual may have as much or as little as he or she wishes to or can attain…"*

The concern of Equity in the context of urban planning from the transport planner's or urban economist's point of view is to provide each individual citizen with a minimum standard of well-being irrespective of the effects of urban and suburban (or rural) spatial segregation (15) through a minimally equitable distribution of urban amenities and the assurance of urban safety & security. The other important aspect of equity in urban planning is in the area of mobility needs, or the mobility divide (16), as it is called here,

as already discussed in Section 2.3. In our triangular framework, we suggest QOL (17) as a key indicator to represent the degree and extent of equity in the context of social sustainability and urban planning (Section 2.5).

Within this general framework of the three Es, therefore, we will attempt to provide highlights for planning aims with respect to mobility and sustainable development in Bangalore.

2.5 Relationship between Quality of Life (QOL) and Sustainable Development

2.5.1 Quality of Life (QOL)

QOL is a multidimensional concept (Wish, 1986). In wide ranging studies, various authors have tried to define it with varying sets of components. Veenhoven (1996) equated QOL with happiness, where "happy life expectancy" is equal to the product of life expectancy (in years) and mean happiness. Bunge (1975) defined QOL in terms of well-being using a number of physical, social, economic, cultural and biological measures. The World Health Organization Quality of Life Group (1993) defined QOL as:

> *"An individual's perception of his/her position in life in the context of the culture and value system in which he/she lives in relation to his/her goals, expectations, standards and concerns"*

QOL plays an important role in any enquiry into how sustainability, in particular social sustainability, can be achieved. The concept offers a useful frame within which to understand physical and other kinds of human needs. Although it may be a short-term measure, QOL is a necessary condition for the longer-term target of sustainability especially in the developing world. Given the aim of assuring an equitable QOL in an urban setting – a physical environment of opportunities for basic human needs and desires (Smith *et al.*, 1997) – we attempt to measure urban QOL perceptions for individuals of various socio-economic profiles. It is appropriate to categorize QOL on three parameters. The first is Accessibility, considered either in terms of highway provision or of a public transport network (e.g., access to and from ports for industrial locations, or access to work from homes). The second is the spatial distribution of urban Amenities and the opportunities for mobility that provide access to them (e.g., health facilities, open green spaces). Through a control of spatial development, it is possible to enhance mobility and increase efficient access to basic urban facilities within and outside the city center. The third parameter is urban Safety & Security, which can be defined as the protection of individual citizens from air and noise pollution, from social disruption and traffic accidents, and from the risks of crime.

2.5.2 QOL as a Generalized Measure of Mobility

Taking both positive and negative effects into account, we have developed a QOL indicator as a generalized measure of mobility. QOL is taken as consisting of the three components of Accessibility, Amenity, and Safety & Security. When mobility is enhanced (or spatial development takes place) each of these three components may increase or decrease. As a result of mutual trade-offs among the three, the value of QOL will then change, supplying an answer to the question of whether this particular way of mobility enhancement (or spatial development) has been beneficial or not overall. Figure 2.1 above, showed the relationship between QOL and spatial or mobility development. The changes in the QOL indicators over the whole city area and among different socio-economic groups provide an indication of the degree of Equity.

This method of measuring QOL and its variations also provides an appropriate way of quantifying Equity. But when evaluating QOL, emphasis has to be placed on ascertaining the weights assigned by individuals to the different QOL components as a measure of perceptions and preferences. For this, it is necessary to go deeper into relevant indicators for each of the main components, and to conduct the survey in a way that reveals the trade-offs among the indicators. Figure 2.2, below, will give closer details of the indicators and their relations. More detailed remarks will now be made on the Environment and Equity pillars. The first pillar, Economy, will be passed over more summarily, as it can be evaluated using very well known indicators.

2.5.3 Indicators for the Effects of Mobility and Spatial Development

A) Economy

Per capita income increase in the metropolitan area and the contribution of the city to the regional economic development are widely used indicators. Since income disparity is a severe problem in developing countries, it is important to consider the change in the income gap with economic growth and population increase.

B) Environment

Air pollution, noise pollution and energy use by the transport sector are key indicators for the Environment which may vary as a result of emissions regulations and changes in vehicle and fuel types. Figure 2.2 represents the detailed relations between technological/policy instruments related to transport development strategy and mobility management strategy, which affect the relevant policies concerning the local and global environment. An extremely important point about the flowcharts in Figure 2.2 is that

it is necessary to manage mobility for economic growth on the one hand while also planning to alleviate the adverse effects on the environment on the other. The contextual fit of each box needs to be subjected to further evaluation for its applicability, effectiveness and integration potential in the case city.

C) Equity

Within the scope of the M4D Project, QOL will be used as the key indicator to represent the degree of Equity. The QOL approach reflects the mobility divide (car ownership and increase in vehicle use), spatial segregation and income disparity. The way in which it is proposed to measure QOL, as already mentioned, will be to divide it into the three components of Accessibility, Amenity, and Safety & Security. Accessibility may be by highway or public transport, for example the ease of access between industrial locations and ports, or between workplaces and homes. By controlling spatial development, it is also possible to induce an increase in Accessibility (basically defined as potential for interaction) in terms of the time and/or cost needed to get to a destination, and this should be considered as well as mobility and capacity. Amenity (for example, availability of green parks) and Safety & Security (like traffic accidents) make up the second and third sets of QOL indicators.

2.6 Mechanisms for Improving QOL through Enhancement of Accessibility and Spatial Development

Figure 2.2 shows the mechanisms of four strategies for the improvement of QOL through enhancements of Accessibility and spatial development. Land Use Management strategies such as city center revitalization and decentralized concentrations in suburbs can improve Accessibility as well as facilitating a coordinated supply of transport modes. The improvement of highways and of public transport systems for the movements required for industrial activities and commuting is crucially important for regional development. It is the role of national and local government to supply these public infrastructures.

Bangalore is known as the “Silicon Valley of India” and IT is already utilized in the city and regional governments to a degree that is impressive compared even with developed countries. The “IT & trip demand management” strategy has a twofold significance for transport planning. First, it offers an alternative means of communication, virtual mobility, which removes the need for people to move physically and allows a reduction in trips. For example, e-governance, now being promoted, is expected to contribute to a local saving of some six million trips a year. Secondly, through intelligent transport systems (ITS) it is capable of supporting systems of private and public transport. As has been successfully shown in Seoul, an IT-supported integrated public transport system of metro and buses has the potential to attract people to make optimal use of transport services and in this way to cut out excess car demand and ease the volume of road traffic. There is a strong need for national and local government

and for the IT industries not to stay at the level of conventional transport infrastructure systems but to develop new systems of this sort jointly. For the new mega-cities, there will not be time to catch up in conventional infrastructure; they will need to leapfrog it. Bangalore has already equipped itself with the potential to achieve this, and is in a position to provide a model for other developing mega-cities in the form of a new type of IT-supported integrated transport system, coordinated with spatial development.

The strategy by way of "car/vehicle and fuel technology" is a question of improving fuel economy, reducing emissions and at the same time assuring more road safety. The latest IT technologies are likely to provide useful active and passive safety systems well adapted to road traffic conditions in the developing mega-cities. This will contribute greatly to improvement of Safety & Security such as mitigation of traffic accidents while on the performance side it can be confidently predicted that the automobile and energy industries will continue to develop higher standards of technology. This will also create a fine opportunity for the automobile and IT industries in Bangalore to jointly develop a new ITS along with the mass- and para-transit systems best suited to the excess demand situation in this developing mega-city, with the full utilization of local research and development results in IT and of the highly educated human resources.

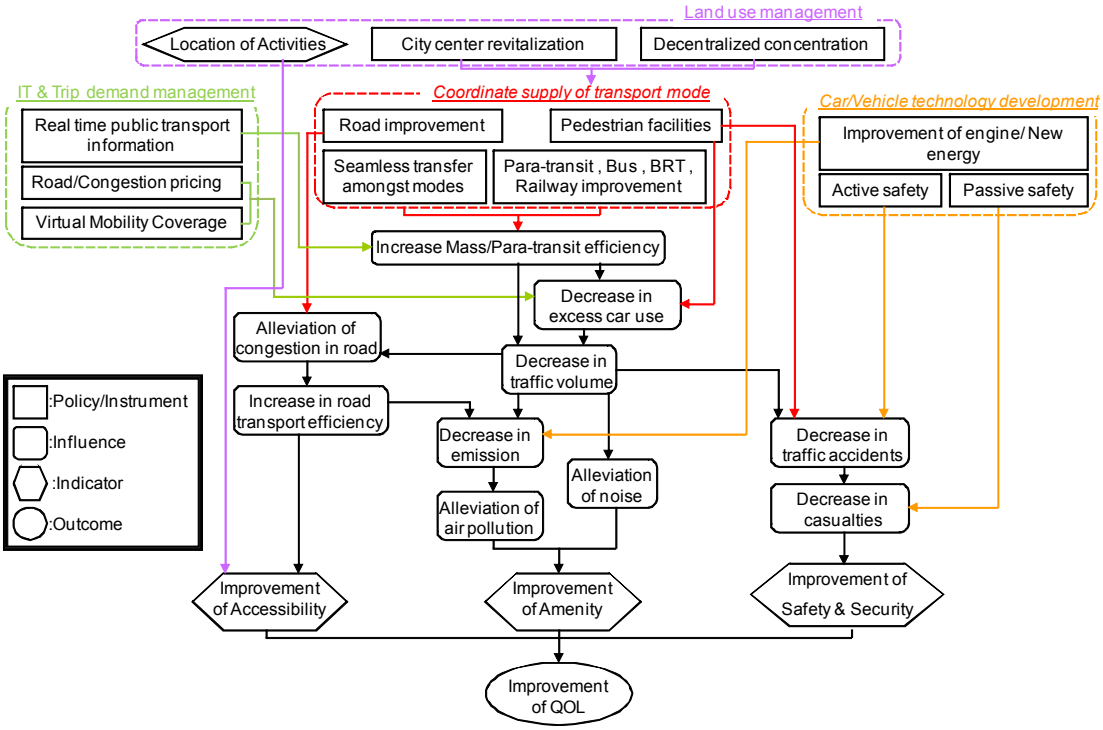


Figure 2.2: Mechanisms for improving QOL through enhancement of Accessibility and spatial development

The strategy by way of a "coordinated supply of transport modes" is of decisive importance for the efficiency of the mass- and para- transit systems, and through them it will have an easing influence on the

overuse of cars, bringing an alleviation of congestion on the road network. For once alternative modes are successfully improved and the available modes of public and private transport are coordinated, there will be less motivation for inappropriate car use. Instead, mobile space will be left free on the roads for really necessary traffic such as the industrial freight that assures stable economic activities. Together with progress in IT and car/vehicle technology, the change will further lead to reductions in emission and noise, and thus to improved amenities.

To sum up, the way to an enhancement of QOL will be through the three components of improved Accessibility, Amenity, and Safety & Security. In this scheme of analysis, the strategies to enhance mobility for development can be systematically and aptly evaluated by disaggregating the effects of development into three sets of positive and negative components and reintegrating them into QOL.

3. URBAN FEATURES AND PROBLEMS IN BANGALORE

3.1 Summary Description of Bangalore

In the same way that Mumbai, Delhi and Kolkata form the points of a geographical triangle in the north of India, a similar triangle also exists in the south with Hyderabad, Bangalore and Chennai. Bangalore has been the preferred location for many software companies over the years (Hall *et al.*, 2003). The city is also drawing migrants not only from throughout its hinterlands in the Karnataka region but also from the whole of India, because the salaries there are known to be high.

The link between globalization forces and the creation of jobs under the new global economy has been very evident in recent years in Karnataka. The stratification of employment has substantially changed due to the growth of the information technology sector, which has created a new economy. The tertiary sector share has increased from 24 % in 1960 to 48 % in 2000 (TERI, 2007). Manufacturing and service dominate the employment structure profile accounting between them for almost 75 % of the total job opportunities in the city.

Social increase of population through immigration, combined with natural increase, is accelerating the urbanization process and rapidly transforming Bangalore into a mega-city spilling over into the Karnataka region. With the concentration of global economic forces since the beginning of the 1980s, the population of the metropolitan area has increased from 2.8 million in 1980 to 6.5 million in an area of 1306 km^2 today. The whole region is home to a population of approximately 8.5 million including all peripheral villages and small towns in a total area of 5184 km^2. The city is expected to continue this course of consistent growth and will reach 15 million by 2050 according to one United Nations projection, making it the 20^{th} largest city in the world by population.

Bangalore has one of the highest GDPs in India at US$ 1200 per capita, which slightly exceeds that of Delhi, at US$ 1100. But income differences and an informal sector exist as in other Indian cities. In one of the recent transport planning studies, the average incomes for users of different transport modes were reported as US$ 620 for public transport users, US$ 1320 for two-wheeler users, and US$ 2170 for car owners.

While the sample was very small, a household survey was conducted in our study for the purpose of exploring QOL awareness, which is contextually relevant to this report. Out of the 215 respondents,

64 put their average monthly household income at less than 10,000 rupees (US$ 244), 129 between 10,000 and 30,000 rupees (US$ 244-734), and 22 in the highest income group of the questionnaire, at more than 30,000 rupees (see Chapter 5 for details). On a simple interpretation of these results, this suggests that 35 % of the population live on a household income of less than US$ 700, which is only 60 % of the average income in the city (US$ 1200); this clearly sets a brake on socio-economic and spatial equity in the local society.

The need for systematic urban transport planning is one of the most urgent priorities in the city. Although the city is rated as one of the fastest growing and soon to be one of the most populous in India, the first transport master plan study was only launched quite recently. Household trip origin and destination surveys have also only recently begun. As in many other cities in developing countries, the results of this report give a picture of transport in which buses and individual trips on two-wheelers dominate daily travel (the mode shares of motorcycles and buses are 30 % and 42 %, respectively). One might expect a considerable proportion of journeys also in the non-motorized modes of walking and cycling. But in fact the combined share of these is only 11 %, which is lower than expected (non-motorized trips constitute 35 % of the total trips in Delhi).

3.2 Urban Spatial and Transport Development Authorities

Among the urban and regional planning and development authorities in Bangalore, five agencies with authority and responsibility for carrying out spatial structural and transport planning schemes with real implications and management powers are listed in Figure 3.1 (See TERI, 2007 for a full list of associated planning bodies). For the purposes of our research, we visited these five authorities (Table 1.1) to discuss their recent planning tasks and were able to view their plans.

- **Bruhat Bangalore Mahanagara Palike (BBMP)**: Bangalore has been expanding its jurisdictional limits so as to take in more peripheral areas. Bangalore Mahanagara Palike (BMP) became Buhat Bangalore Mahanagara Palike (BBMP; in English Greater Bangalore Municipal Body) by absorbing seven city municipal councils (CMC) and one town municipal council (TMC). BBMP is mainly responsible for urban amenity developments (education, health, road concerns).

- **Bangalore Development Authority (BDA):** BDA is entrusted with the task of preparing a Comprehensive Development Plan (CPD) that is subject to revision every 10 years. The Bangalore Development Authority (BDA) is responsible for planning, implementation and

monitoring of plans in the Bangalore Metropolitan Area (BMA), whereas Bangalore Metropolitan Regional Development Authority (BMRDA) is responsible for the surrounding region (Figure3.1).

- **Bangalore Metropolitan Regional Development Authority (BMRDA):** Mainly responsible for developing outer regional development (areas outside the responsibility of BDA), BMRDA also has an overseeing role over BDA, with authority to control and reject plans; in fact, there are recent examples of this being done. BMRDA also creates local planning authorities: for the Bangalore International Airport Planning Area (BIAPA), the local areas of Anekal, Hosakote, Kanakapura, Nelamangala and Magadi, the Bangalore-Mysore Infrastructure Corridor Planning Area (BMICA) and The Ramanagaram-Channapatna Urban Development Authority (RCUDA); and prepares "Structure Plans" for the planned development of the BMR Region.

- **Bangalore Metropolitan Transport Corporation (BMTC):** BMTC is responsible for inter-city bus operations and management, and is making substantial efforts to improve the bus network in the city. BMTC is the only public transport organization in any of the metropolitan regions in India that has succeeded in running at a profit.

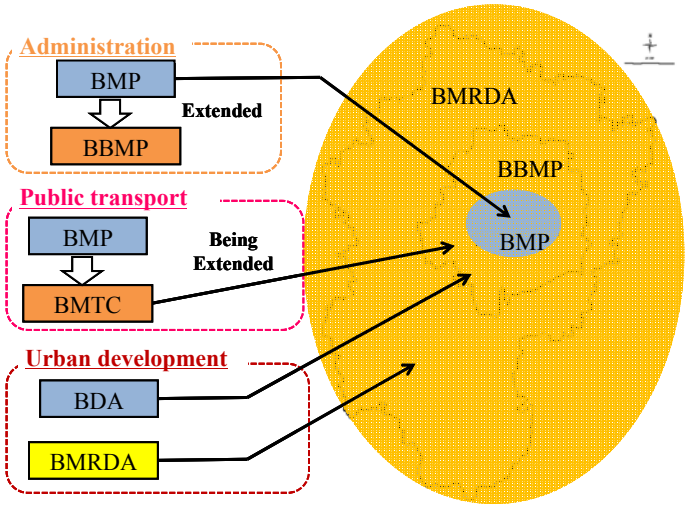


Figure 3.1: Bangalore Metropolitan area and its development authorities

3.2.1 Bangalore Development Authority (BDA)

The draft Master Plan 2015 prepared under the KTCP Act, covers a local planning area of 1306 km^2, taking in 387 villages, seven cities and one town. It serves as the foundation for developing strategic plans and local planning areas and, in the last instance, for the design of neighborhoods.

Based on the ward boundaries and existing physical features, 47 planning districts have been marked out to implement the draft master plan. Planning districts (PDs) are organized in three rings

1st ring – core area PDs 1 to 7

2nd ring – Developed urban area surrounding the core area PDs 2.01 to 2.18

3rd ring – The urban extension areas in the city's outskirts PDs 3.01 to 3. 22

The Structure Plan is based on the governing principle of "structured continuity." This principle directs that development in existing urbanized areas and new extensions must be "structured" spatially and functionally to avoid unmanageable urban sprawl. Existing urban patterns must be strengthened through urban renewal, and proposed developments must be "continued" selective extensions of already developed areas. This is to avoid new developments in distant outskirts that are not serviced by infrastructure and transportation.

The plan envisions that development will be spatially organized in five concentric circles; linearly along major radial roads (national/state highways); and around centers within the city which have a high density of compact urban development and a concentration of mixed urban functions to serve the surrounding residential areas.

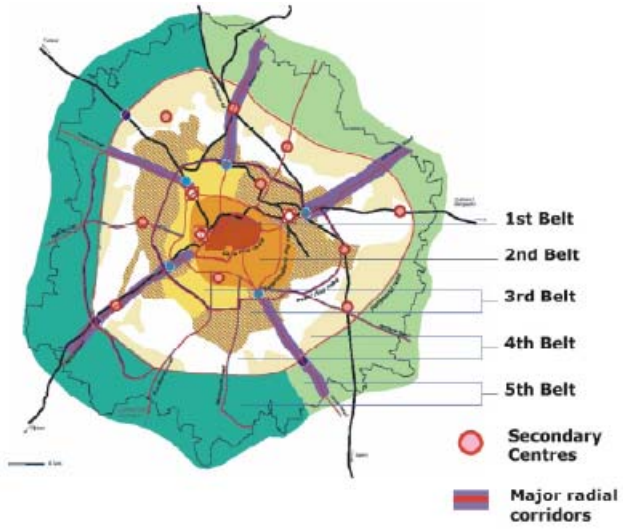


Figure 3.2: Spatial configuration according to revised master plan for 2015, BDA

1st Belt – The core area – consisting of the historic Petta, the administrative center and the CBD

2nd Belt – Peri-central area – with older planned residential areas surrounding the core area

3rd Belt – recent extensions (2003) of the city flanking both sides of the outer ring road, a portion which lacks services and infrastructure facilities and is described as a shadow area

4th Belt – New layouts with some vacant lots and agricultural land

5th Belt – Green belt and agricultural area in the city's outskirts, including small villages

Land use zonal regulations play a significant role in Master Plan 2015, as they govern all development and regulate activities within the Local Planning Area of 1306 km^2. The land use zonal regulations are an integral part of Master Plan 2015.

3.2.2 Bangalore Metropolitan Regional Development Authority (BMRDA)

The Structure Plan prepared by the BMRDA has the character of a broad area development plan for the entire BMR and requires the preparation of detailed sector and area plans. The BMRDA has over the years drawn up various schemes to implement the Structure Plan in coordination with the organizations concerned. This includes the following:

1. Development of BMR Intermediate Ring Road (BMR-IRR), the BMR Satellite Town Ring Road (BMR-STRR) and the Radial Roads
2. Development of new urbanisable blocks
3. Preparation of interim master plans for the Local Planning Areas
4. Preparation of base maps for the major towns in the LPAs
5. Development of an expressway to the new International Airport.

A summary account of the progress and status of some of the urbanization work in the peripheral areas of the city is given below.

Integrated Township Development

BMRDA has undertaken the development of five integrated townships following an all-round concept Work-Live-Play concept at Bidadi, Ramanagara, Sathanur, Solur and Nandagudi (Figure 3.3).

The concept behind this policy is the development of thematic townships. Each township is to be designated for specific economic activities, for example: "T-BT City," "Health City," "Education City," "Finance City" etc. The development of the new integrated urban settlement will aim in each case to create a self-contained habitat within the Work-Live-Play concept.

In connection with this development, BMRDA invited bids in August 2006 for the selection of the approved developer and received responses from 32 firms/consortia of which 24 firms/consortia were found qualified and allowed to submit their bids by June 2007. The master plan for each township is to be prepared by the developer and approved by the government, and implementation

will be monitored by BMRDA to ensure compliance with the project objectives.

BMR Integrated Townships and designated areas in acres

		Private	Gov	Tot
1.	Bidadi Township (Ramanagara Taluk)	6,959	2,725	9,684
2.	Ramanagara Township (Ramanagara Taluk)	3,621	392	4,013
3.	Sathanur Township (Kanakapura Taluk)	5,891	10,341	16,232
4.	Solur Township (Magadi Taluk)	9,661	2,864	12,525
5.	Nandagudi Township (Hosakote Taluk)	13,762	4,745	18,507
	Total	39,894	21,067	60,961

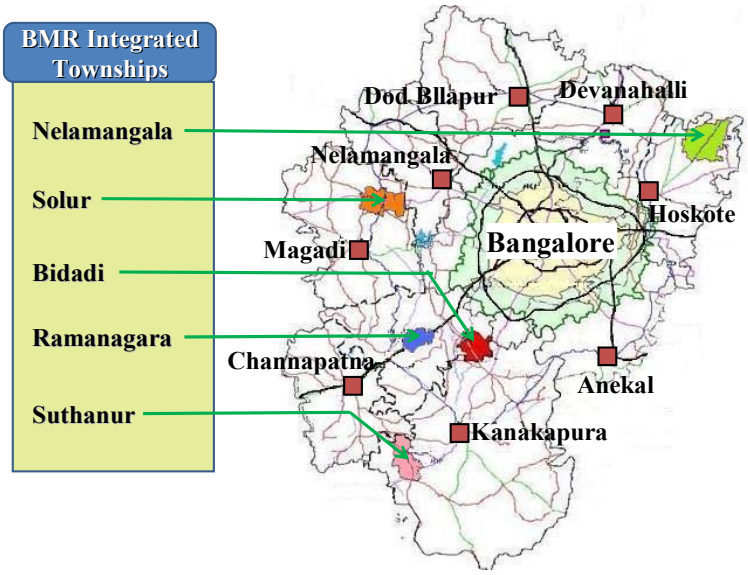


Figure 3.3: Designated integrated Townships, BMRDA

Foreign firms may participate either through an Indian subsidiary or in a JV/Consortium with Indian firms and are subject to the relevant FDI norms/regulations. BMRDA will provide external infrastructure by way of access roads and radial and ring roads for speedy access to and from downtown Bangalore and the new International Airport. The private developer is required to finance and develop the entire internal project infrastructure including roads, storm water drains, civic amenities, telecom connectivity, water and power supply, and waste treatment and disposal, as well as bearing the capital cost of bringing drinking water and power up to the periphery.

One example of an Integrated Township development is the Bidadi Integrated Township Project (BITP). Bidadi is located 35 km. from the core area of Bangalore and has the highest priority among the five satellite townships as a self-contained habitat for two main economic activities of

information technology and an auto industrial park. The plan projects a mixed land use in which the shares will be 25 % each for industrial, residential, and parks / open spaces, leaving 15 % for civic amenities and the rest for roads and utilities etc.

3.3 Problems Facing Sustainable Development

In this section, we note a number of important problems facing the sustainable urban development and sustainable mobility objectives. All of them are closely related to concepts of central concern for the Mobility for Development Project: the mobility divide, motorization and urbanization, economic growth and income disparity, natural population growth and immigration, and transport improvements and management. These are general problems but we will confine our remarks and views to the context of sustainable development in Bangalore as observed in the two field surveys and in the light of what we have been able to see from our secondary data sources.

3.3.1 Globalization, the New Economy and Urban Dynamics

Globalization and the new economy have a very evident impact on movements of goods and people and on spatial developments on the national and regional scale. Today, businesses are seeking to invest in the countries with the most favorable cost efficient facilities in order to benefit from, e.g., a cheap labor force or from other location advantages. The impact of such economic forces extends to the urban level, where it shapes the urban configuration, requires increases in mobility, and creates needs for further transport investments (Dick and Rimmer, 1998).

Bangalore is one typical example of the working of such forces in that the city is not only changing its socio-economic profile but also undergoing a transformation of its spatial structure under the impact of globalization. The separate central business district is not quantitatively and qualitatively capable of accommodating information technology developments, and since the 1980s two main sub-centers for software production, Electronic City and Whitefield, have grown up approximately 20 km from the city core (Photo set 3.1). These IT dominated agglomerations have a different appearance compared to the city center and draw a considerable number of commuters from the whole metropolitan area by way of the now congested roads. Highway developments, public transport operations, public facilities and the planning and completion of housing projects have all failed to keep pace with this spatial transition process toward a more complex polycentric structure. Additionally, a second phase of decentralization, this time on a regional basis by way of a ring of satellite townships for specific activities, mainly industrial, now lies ahead of Bangalore. As in many other Third World cities, one obvious consequence of globalization and urbanization is that job

creation on the urban fringe calls for special consideration and planning efforts.

Photo set 3.1: Different urban appearances of information technology development in a sub-center (left) and old city center (right)

3.3.2 Informal Sector

In developing countries, it is extremely important to address the social question of the informal sector and how this is changing (being eroded?) with time. It is recognized that a substantial part of the economic activity in the developing countries takes place in the informal sector, stimulating a great amount of employment. Agenor (1996) has suggested that the share of informal employment may be as high as 70-80 percent in developing countries. Nevertheless, hardly any precise data exist in the great majority of cases, and in Bangalore, too, we are not in a position to undertake an elaborate analysis of how the informal sector affects the urban dynamics. Petta planning district, located in the core of the Bangalore Metropolitan Area, and Kempapura Agrahara in the southwest, are the largest hubs for the informal economy of the city. Historically the city core has been the central business district all through the post independence era but now it mainly accommodates small-scale commercial and manufacturing activities.

The first Indian National Commission on Labor (1966-69) defined the unorganized sector workforce as “those workers who have not been able to organize themselves in pursuit of their common interests due to certain constraints such as the casual nature of their employment, ignorance and illiteracy, and the small and scattered nature of establishments.” Employees are considered to be part of the informal sector when their employment, officially or in practice, is not subject to national labor legislation, income taxation, social protections or entitlement to certain employment benefits. They include self-employed workers working in their own informal enterprise, and employees holding informal jobs whether under a formal sector enterprise or as domestic workers in households. In India as a whole the share of informal labor may be as high as 90 % if agriculture is considered as

a part of this sector. About 370 million workers constituting 92 % of the entire national workforce are employed in the unorganized sector according to a survey for 1999-2000, with a share in the total Net Domestic Product (NDP) of over 60 %. The NCAER has that the informal sector – or the unorganized sector as it is called in India – generates about 62 % of GDP, 50 % of gross national savings, and 40 % of national exports.

3.3.3 Housing Developments

2001 Census data indicate that 92 % of households in India live in permanent houses. Between 1990 and 2003, there was an increase in total living space of 44 km^2, equivalent to an annual rise of 2.89 %. But this has lagged behind the annual population growth rate of 3.28 % in the same period. With the number of households increasing, the demand for housing has naturally been going up too, and in the absence of affordable alternatives this results in an unorganized and inadequately equipped type of housing.

Within the context of the Bangalore case study, we find it appropriate to raise two concerns in particular in relation to housing developments, although housing problems in developing countries is a vast field for further discussion. First, as in many other developing countries, a notable part of the population is living in slum neighborhoods or squatter settlements. Most of the slum dwellers and squatters obviously belong to the lowest income groups who do not own private vehicles, and they therefore generate a high volume of non-motorized trips and journeys by public transport, especially buses, since some slums and squatter developments are partly accessible by public transport services (TERI, 2007). But most of the squatter settlements, especially on the fringes of the city, are not within walking distance of any bus route. Here, transport is a major problem and these are the extreme cases of the mobility divide in the city. As the city is expanding its boundaries, one can expect the emergence of many more of these slums and squatter settlements on the peripheries of the city, which will further add to the amenity and transport problems in these unorganized housing areas.

Photo set 3.2: Examples of new housing developments

Karnataka Slum Clearance Board (KSCB) conducted a survey in 1994 and declared that out of the total 2491 slum areas in the Karnataka state, 473 were in Bangalore Metropolitan Region. Of these 473 slums, 106 are sited in the peripheral parts of the Bangalore Development Area. A similar survey in 1999 found a 20 % increase in the number of slum areas. Although the board has a program of constructing houses for the slum dwellers by removing the existing huts and building houses in the same place, it is not a straightforward policy for providing shelters for the slum dwellers. Here we could draw attention to a number of earlier experiences which mostly ended in failure because after construction these publicly built houses were rarely bought by the former slum dwellers but tended to attract the medium income class of the population.

The second concern is for well planned housing developments in a context of mixed land use development. Mixed land use has long been acknowledged as one urban policy solution for controlling the demand for longer journeys by providing various urban facilities that help to keep an important proportion of movements within one area of urban development. Bangalore is expanding into its hinterlands in every direction and the urban dynamics of growth are leading to a spatial re-structuring. The Bangalore Development Authority's revised Master Plan 2015 relies on a potential for land use transformation particularly outside the core of the city (BDA, 2007 (a)). For this to succeed, new residential developments and re-organizations of existing housing areas need to be consistent in their adoption of mixed land use development strategies. The emerging sub-centers within and around the city need to do more to bring services to housing developments, as one important policy tool for managing mobility in favor of a mixed urban pattern in which some workers may choose to live closer to where they work. In order to respond effectively to the housing needs of different socio-economic groups, it is of great importance to provide not only luxury residences but different types of houses that meet the demands of the lower-income part of the population, too.

3.3.4 Non-monocentric Urban Structure

Bangalore city center is a densely crowded district with narrow streets and obviously cannot accommodate new developments of any great size (the core district Petta has a gross density of 519 person/ km^2, and an actual net density 4 times greater). Therefore the real urban dynamics are occurring outside the city core and Bangalore is growing beyond the bounds of its central area. There are two types of non-central agglomeration growth. The first type is in urban sub-centers,

which either already exist or are designated in Master Plan 2015 (BDA, 2007 (a)), and are located in the outlying areas of the central zone in the Bangalore Development Area. Examples of such urban sub-centers are Majestic and Vasant Nagar in the first ring, Koramangala, Shantinagar, Jayanagar, Mathikere, Rajajinagara and Peenya (traditional industrial) in the second, and Yelehanka (industrial and residential), KR Puram, Whitefield and Electronic City (two major IT centers) in the third. The second type are the five satellites ("integrated townships") under the jurisdiction of BMRDA. Of these five townships, Bidadi has the highest potential for urbanization and growth (Section 3.1.2).

As has been said, particularly for the third ring urban sub-centers and the five suburban townships, the development plan takes as its starting point form a pattern of mixed land use which it calls Work-Live-Play. Poly-nodal development is a promising and effective policy in growing and decentralizing cities, provided the sub-centers are developed as districts of mixed land use so that a considerable proportion of trips stay inside the sub-center and the need for longer trips in and out is kept under control. Admittedly, the two information technology sub-centers have not proved a great success to date with regard to mixed land use. For example in Whitefield, due to the lack of affordable housing, most of the employees of the industrial works and information technology firms live in distant neighborhoods and commute around 25 km a day (BDA, 2007 (a)). The main means of transport are private vehicles and company buses, whereas the share of city buses is rather low compared to the metropolitan average.

Bangalore Metropolitan Transport Corporation BMTC plans to extend its service area, but so far these satellite cities are not included in the bus network development plans, and they are not well provided for in public transport schemes either within their own boundaries or in their links with other centers, as can be seen from route maps. In discussing how to cope with the change in pattern that the newly emerging poly-nodal form will bring to trip profiles, particularly for commuting, the greatest challenge to face, as a number of empirical results have already revealed, is that suburban travelers will much prefer private vehicle trips. Yet there are some results that show that if the level of public transport transportation provision is kept in step with sub-center growth, this imbalance in the modal share will tend to diminish.

3.3.5 Traffic Management Problems

The issues currently plaguing the traffic and transportation system in Bangalore are lack of adequate road space, or of controlled rights of way, a rapidly increasing fleet of personal vehicles partly due to the absence of a well defined public transport system, lack of parking space and the near absence of

a parking policy, lack of enforcement, and worst of all, road user indiscipline. Bangalore also has a predominantly road-based public transport system. BMTC currently transports 3.15 million passengers per day, representing 55,000 daily vehicle trips on 3800 routes. However, a glaring imbalance exists between the trip needs and the transportation modes. The lack of efficient public transport modes has led to a sharp increase in the number of personal vehicles, especially two-wheelers, which constitute about 74% of registered motor vehicles.

Another major problem in the city is the inadequate road infrastructure and the poor quality of roads. Bangalore has a concentric radial road system that consists of ring roads, five major radial roads and five secondary radial roads that all feed in to the city centre. Commuters face serious congestion on the road network because of the poor configuration of the roads that converge on the core of the city without transverse links between the radial roads. The traffic police have a difficult task manning the signalized intersections to control and manage the traffic flows. Currently Bangalore Metro Rail is being proposed as a mass rapid transport system to decongest the clogged city roads and encourage private vehicle owners to use public transport. It has been laid out on two busy corridors, north-south and east-west.

Photo set 3.3: Two views of traffic management problems

3.3.6 Institutional Aspects

During our field surveys in Bangalore, we were well looked after by urban planning institutions and agencies which were well equipped and had adequately trained technical and management staff. This is a distinctively positive feature in Bangalore, as indeed in India as a whole compared to the majority of other growing countries. A study of individual problems can lead to sound suggestions for future planning, but for the general picture there is still a lack of an institutional framework for land use and transport planning, and this hampers efforts at all levels of action. An institutional framework is simply defined as the planning practice with the inclusion of all relevant agencies and

institutions of government, government-sponsored and private, at three levels of national, regional and city planning (Barat, 1990). Given the institutional framework functioning in Bangalore, we would like to pick up three concerns which we think would serve for useful discussion here.

The first is the inadequate approach toward integrated land use and transport plans. In recognition of this problem, the state government has recently established two new planning authorities: The State Directorate of Urban Land Transport (DULT) and the Bangalore Metropolitan Land Transport Authority (BMLTA). Delegation of responsibilities to authorities of this kind is a way of easing centralization but as the number of agencies increases, greater efforts are also required to ensure co-ordination in planning and implementation. The second concern is the need for a strengthening of links between the urban space plans of BDA and the more rural spatial plans for the whole metropolitan region drawn up by BMRDA. And the third, finally, is the need for more public-private partnership, as one way of overcoming the financial problems in a developing country. One example of this good practice in Bangalore is in the construction of the new airport. Naturally, an increase of private sector involvement is to be welcomed not only for transport infrastructures but also for spatial developments such as the integrated townships (Section 3.1.2).

3.4 Current Issues Related to Mobility

3.4.1 Large-scale Highway Development Plans

Almost as soon as a city starts to expand, or sometimes even before it happens, outer ring and radial expressway development plans are suggested, which are indispensable but always far more complex than generally supposed. In Bangalore, too, as a complementary measure to the coming poly-centric transformation, both BDA and BMRDA are proposing large-scale highway developments in line with the regional development (Figure 3.4). Such highway schemes require meticulous consideration in planning for the scale and timing of the investments, and a detailed demand and socio-economic impact analysis is needed for a maximally efficient use of the limited financial resources.

- BMRDA – Satellite Towns Ring Roads (STRR): 284 km., 90 meters (connecting towns located around Bangalore City to each other and to International Airport).
- BMRDA – Intermediate Ring Road: 188 km, 90 meters (connecting industrial and residential developments located around Bangalore City to each other and to International Airport).
- BMRDA – Radial Roads: (Radiating from Bangalore City connecting BMR – Satellite Town Ring Roads & BMR – Intermediate Ring Road to the Peripheral and Outer Ring Roads).
- Town Ring Road, New Airport Expressway

- BDA – Peripheral Ring Road: 117 km, 100 meters, 5-20 km from existing outer ring road

In these circumstance, it is very common to find that governments allocate the largest portion (even in some cases the whole) of the total transport budget to the development of new highways and physical improvements of the existing roads. In the case of Bangalore, the service levels and total length of the roads are below minimum standard. At the same time, the current development plans both in Karnataka state and in Bangalore designate only 2% of the transport development budget to the railways. The railway infrastructure is insufficient to cope with transport needs.

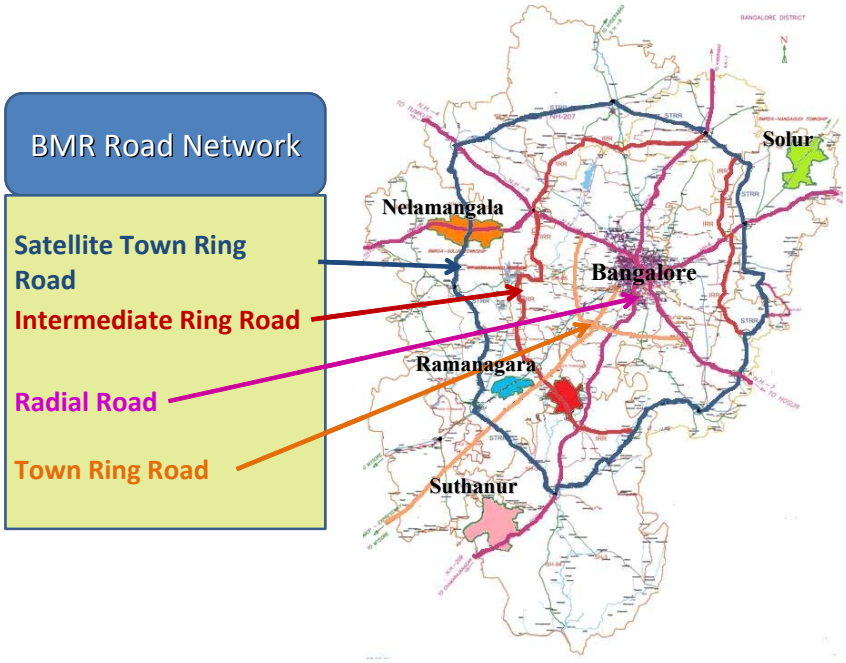


Figure 3.4: Regional highway developments in BMRDA

However, the success of the highway improvement policies in Bangalore, which require substantial investment, will greatly depend on how efficiently they serve to meet the emerging demand, how well they succeed in connecting the primary and secondary nodes for metropolitan regional integration, and how well they are coupled with land use plans. Inadequate patterns of land use development without population and job thresholds and without other forms of land use for a fully mixed balance of activities will simply contribute to longer commuting distances from outlying settlements, rather than to the primary aim of linking primary and secondary centers. Or at the other extreme, in some cases the urban sub-centers may not develop in pace with the roads and a wasteful capacity surplus may arise.

Photo set 3.4: Views of elevated highway construction in progress

3.4.2 Public Transport and Intermediate Public Transport Management

In general, deficiencies of urban public transport in developing countries are not limited to the use of low technology vehicles but also have a lot to do with the predominantly road-based public transport (buses and intermediate modes of public transport) that are severely affected by the high loads on the roads. Additionally, the lack of co-ordination for seamless transfer also contributes to a lower service level which results in a further failure to attract passengers with higher incomes or to serve better off socio-economic groups generally.

In the case of Bangalore, the city's bus operation and management is one of the success stories in India. Recently around 40 Volvo buses – air-conditioned and offering higher levels of service but at a higher fare compared to the other buses in the city – have been successfully added to the fleet. However, these buses are still running on the same congested roads and suffering the same problems of low traveling speeds and loss of time. The lesson from this is that bus priority lanes are necessary especially on the main arteries of trip demand, for the bus network to flourish in a way that can match the economic and population growth. At the moment BMTC is negotiating with BDA for the assignment of bus priority lanes, and these measures for cost-efficient public transport development in the city call for urgent implementation.

Photo set 3.5: Buses, cars, two-wheelers and three-wheelers: Main means of transport

Another branch of transport consists of the intermediate modes of public transport, widely known as para-transits, which range from man-powered rickshaws to minibuses. Such systems are mostly private and rarely regulated as to their routes and fares. These intermediate modes can either vanish in time with the introduction of conventional public transport or can continue to serve for smaller demands. But the difficulty with intermediate public transport lies in the management and the design of it in terms of routes, fares, stops and environmental loads.

The three-wheelers which make up the highest share of para-transit trips in Bangalore aggravate congestion by making frequent stops. Currently, policies regarding these auto rickshaws are limited to getting them converted to run on LPG. Although there are opinions opposed to the existence of para-transit modes in developing countries, there are certainly cases in which these modes may be well suited to serving as an alternative mode to two-wheelers or public transport modes over shorter distances for a more limited demand. From the point of view of policy, however, the existing intermediate transport modes in Bangalore are not well enough regulated to effectively respond to the urban transport problems in the city. Improvement of the bus network together with opening of the first phase of the metro, and the emergence of the peripheral sub-centers will strengthen the need for a revision of para-transit policy and a re-design of operations or their abolishment in some areas. Any revision would need to ensure that they do not compete with the conventional public transport modes but provide a complementary service as feeder transport or else function as a stopgap solution in the new development zones until these areas are adequately served by public transport.

4. POSITIONING OF BANGALORE IN THE STAGES OF URBANIZATION AND MOTORIZATION

4.1 Comparative Trend Analysis

How to secure the co-existence of economic growth and a good living environment is a considerable challenge in rapidly growing mega-cities. It is urgent to change course away from past modes of development and toward a more continuous management of motorization and suburbanization with an aim of sustainability. In most developing countries congestion is very serious even at a much lower stage of motorization than in developed countries. The traffic is concentrated primarily in larger cities and is stimulated by rapid growth of population and incomes.

Bangkok Post
Sept 4 1993

Photo 4.1: As it was: Before dawn in a suburb of Bangkok (1993)

There has already been one past experience of extreme mutual acceleration in both motorization and suburbanization in the case of Bangkok in the early 1990s. Thailand achieved more than 10% economic growth in 1988, 1989 and 1990. The results can be seen in the series of accompanying photographs: Photo 4.1, from 1993, shows a school student in a suburb of Bangkok waiting for a bus at 4:30 am. His school started at 8:30 in the city center, and it took him four hours each way just to get to school. Around that time traffic congestion in Bangkok was at a peak so that more than 10% of commuters spent over eight hours a day commuting.

Photo 4.2: As it was: Slower than walkers on Sukunvit Road, Bangkok (1993)

Photo 4.2 shows the Sukunvit Road, the most frequented street in Bangkok, choked with cars in the morning. One of the authors of this report took a van from the hotel to this place and needed more than one hour to cover only 300 m distance. Bangkok, with a population of 6 million, had three main inter-city railway lines which were under-utilized, operating fewer than 20 trains a day, while the tracks were used between trains as pedestrian walkways and for a goods market (Photo 4.3). As Bangalore has now entered a similar stage of economic development to that of Bangkok in the early 90s, there is naturally the danger that it will face equally serious bottlenecks.

Photo 4.3: As it was: Neglected Railways in Bangkok (1994)

Photo 4.4: Sukunvit Road after opening of Sky Train in Bangkok (2002)

At that time there was already a plan to construct elevated urban railways in Bangkok. But because people were afraid of even worse road traffic congestion due to the closure of lanes for constructing the railway piers, they did not have the motivation to think in the long term. Because of the road congestion and the consequent uncertainty of travel times at that period, many companies simply moved away to other neighboring countries. As it was, Bangkok badly missed out on mobility for development.

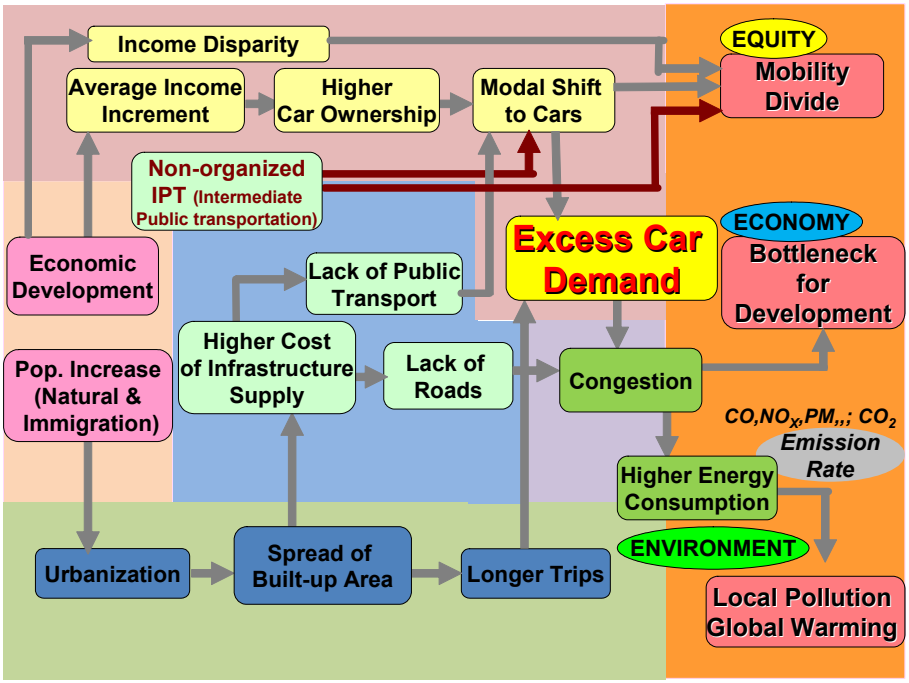


Figure 4.1: Development, motorization, urbanization and environmental problems

Economic growth brings people to expect happiness. However in many cases in the developing mega-cities, it actually brings unhappiness to citizens through serious traffic congestion, wasted energy, air pollution and greenhouse gas emissions. Bangkok was a classic example of this. Figure 4.1 shows connections by which economic development bottlenecks inevitably lead to social burdens and environmental problems in developing mega-cities. GDP increase creates an average income increment and further triggers population increase by attracting more immigration from rural regions. At the same time, as often observed in developing mega-cities, it also generates an income disparity that leads to two pressing problems of urban equity, the mobility divide, and spatial segregation.

Economic growth and motorization contribute to the increase in the number of cars and two-wheelers on the roads and in some cases to more intermediate public transport trips. Inadequacies in timely road investments and failures to improve the service levels of public transport result in a modal shift to other road-based transport. This leads to further deteriorations in service levels on the roads and generates longer trips and severe time losses with highly detrimental effects on local air and noise conditions as well as a degradation of the global environment.

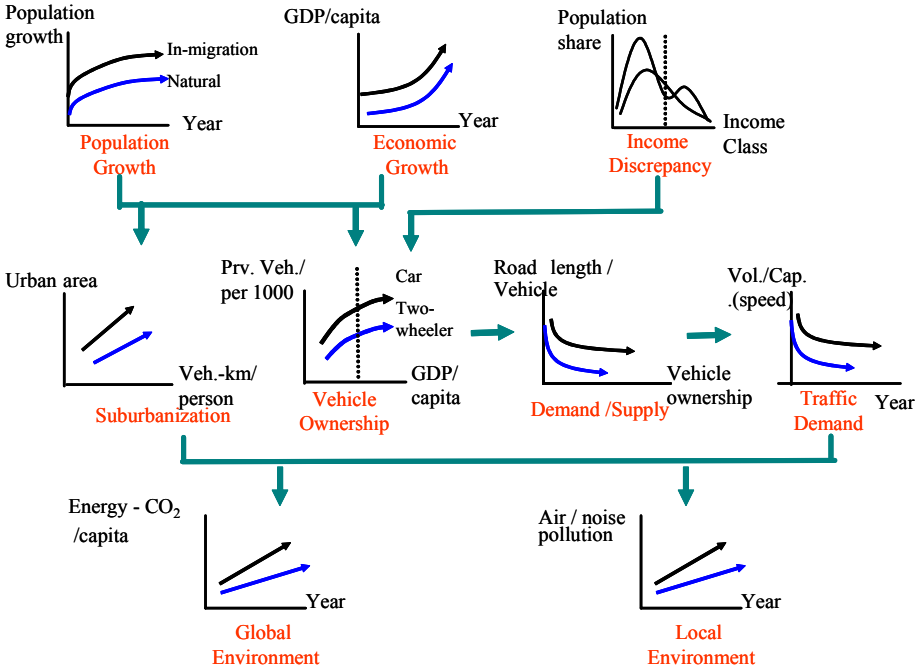


Figure 4.2: Process of Hayashi's comparative trend analysis, modified

For urban planning studies of developing mega-cities, the economy, urbanization, motorization, lack of infrastructure, and environmental impacts, factors that are all closely interrelated, may be observed empirically through a display of socio-economic, urban and environmental indicators

(Figure 4.2). In a comparison between cities at the same economic development stage, as measured, say, by income per capita, this may be a means of explicitly identifying common phenomena under similar constraints. These could be phenomena of a shared sort, which recur at given stages of urban and socio-economic development or they could be unique features for particular cases due to special circumstances. Such a comparison, which will be referred to here as Hayashi's comparative trend analysis, can serve as a tool for systematic analysis, and remain appropriate even where precise data are insufficient and rigorous future projections are not possible (see Hayashi *et al.*, 1994 for a comprehensive pioneering study on comparative trend analysis).

The second stage sections of the urban expressways have been open in Bangkok since 1995 and an elevated railway and a subway system, each now about 20 km long, have been brought into service. With this, the congestion level inside the city has been much alleviated, though the average trip time in the Bangkok Metropolitan Area, which has an area of about 1500 km^2, has still risen from 36.4 minutes in 1995 to 42.7 minutes in 2005 due to suburbanization.

Historically, similar problems have occurred in most cities, but the stage dependency and extent of these problems may differ for a number of reasons which require in depth analysis to clarify. Additionally, it is still difficult to offer a clear forecast of future conditions of land use and transport and of the consequent state of the environment in the changing development path of a city due to the unobservable and non-linear relations of such changing factors as car ownership, income disparity and technological innovations. This being so, comparative trend analysis provides us with meaningful evidence to address the issues on the macro scale at least, in a variable order of relative importance for different cases. The analogies obtained from this comparative analysis, based primarily on land use/transport and socio-economic considerations, suggest useful implications for understanding the directions of current trends and likely future development paths in the cities concerned.

The richness of the analysis obviously depends on the data. But for our purposes, given the limited amount of (especially) environment quality data available for Bangalore and many other developing mega-cities, we believe that a trend analysis employing nine or so simple traditional indicators (Section 4.2) provides a rational basis for discussing urban problems in Bangalore a step before they arrive. Eight parameters we will need to refer to are: 1) total population growth; 2) rise in per capita GDP; 3) increase in car and two-wheeler (motorcycle or scooter ownership); 4) length of paved roads; 5) average peak speeds on main road network; 6) mode shares (including intermediate modes) of public transport; 7) energy use in transport, and 8) air pollution (taking NOx as a typical

pollutant).

To provide a grasp of the variations between distinct cases in similar development stages while also maintaining a balance between developed and developing cities, we choose five other cities as references for comparison with Bangalore. Two of them are in Japan: Tokyo, one of the largest urban agglomerations in the world, and Nagoya, a major economic center; two others are metropolises in developing countries in Asia: Jakarta and Bangkok, the capitals and economic centers of Indonesia and Thailand respectively; and the last is Delhi, the capital and third most populous city in India.

4.2 Trends in Bangalore in a National and International Comparison

Figure 4.3 shows population growth in the six cities: the metropolitan region for Bangkok; the national capital territory for Delhi; the city area for Nagoya; and for Tokyo and Jakarta separate figures for the city and metropolitan areas. The reason for the two sets of figures in the cases of Tokyo and Jakarta is to give an insight into the variation in urban population growth between the city core and the outlying areas. The fastest growth is found in Delhi (15.3 million in 2005 for an area of 1483 km^2) and Greater Jakarta (24.7 million in 2005 for an area of 6500 km^2). The core area in Jakarta has been saturated since the 1990s, but population in the metropolitan area as a whole has been growing at a pace similar to that in the national capital territory in Delhi.

The Bangalore Development Area (BDA) (1306 km^2, of which 565km^2 is urbanized) has a population of 6.5 million and is showing a steady growth but at a lower rate than in Delhi. The Bangalore Metropolitan Region as a whole (8700 km^2) has a total population of 8.5 million, the additional 2 million being the population of the agricultural area. The strong global economic forces behind Indian IT development will continue to accelerate population growth and attract immigration from the whole country. Taking account of this, the BDA can expect a population of 8.8 million by 2015, and 10 million by 2021, with a decreasing growth rate and at a lower density than in Delhi at present. Since decentralization is in progress, both through the working of market forces and in accordance with BDA and BMRDA planning, the real growth will very likely occur outside of the city core, in the second and third rings of development in the BDA, and in the first ring of the BMRDA as the integrated townships (satellite cities) start to come into existence. A further increase both in the number and scale of these urban satellite settlements is expected by the BMRDA. It will be crucial to apply the BDA and BMRDA decentralization policies in concert in order to to come up with the optimal extent and timing for decentralization and achieve a regionally balanced pattern of urban development.

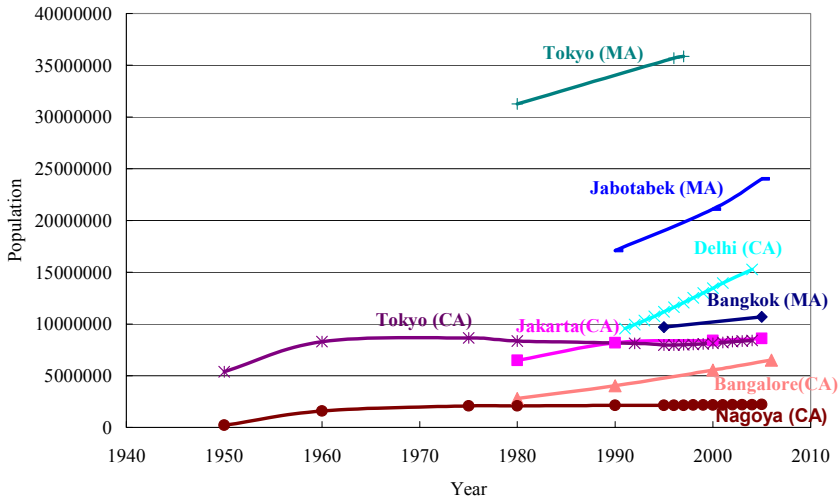


Figure 4.3: Comparative trend analysis: Population

Figure 4.4 shows the data for GDP per capita, and reveals that economic wealth is lowest for the two Indian cities despite their function as economic engines for the country (GDP per capita in the BDA is US$ 1200, slightly exceeding that of Delhi). Average incomes are still below the average earnings for Jakarta in the 1980s (US$ 1800). However, economists and urban planners are marking Bangalore as one of the Indian cities with the highest potential for fast economic growth in view of the city's status as the main base for multinational IT firms in India, and with continuing economic growth the urban life-style and mobility profiles of the people are certain to undergo change.

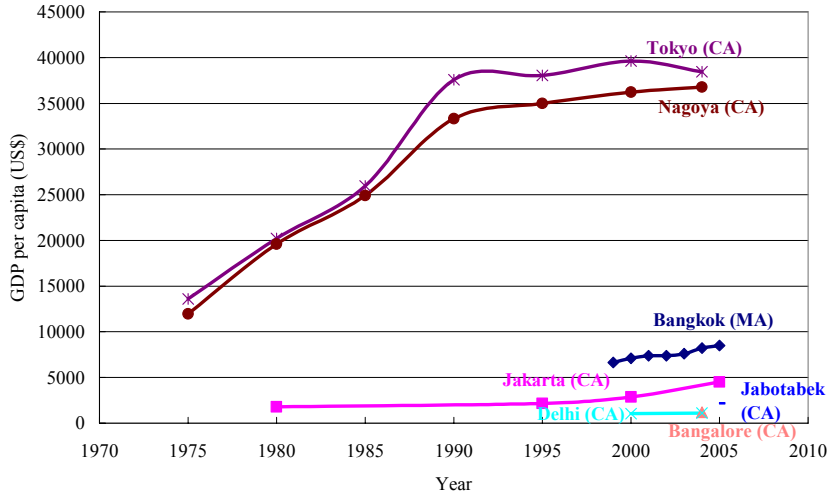


Figure 4.4: Comparative trend analysis: GDP per capita

Figures 4.5 and 4.6 compare the six cities for changes in car and two-wheeler ownership per 1000 population. Bangalore has the second lowest car ownership after Delhi, at barely half the level of Jakarta and a little over a third of that of Bangkok. As no past data for car ownership in Bangalore are available to us it is difficult to make out a trend, but compared with Jakarta in 1980 Bangalore shows a higher number of registered cars per 1000 population today although per capita income is lower. Bangalore is also notable for having the highest rate of motorcycle and scooter use among the six cities. Two-wheeler ownership in Bangkok, Jakarta and Delhi stood at roughly the same level early in the 1990s and since then has shown a similar moderate increase, except that this has included an intervening peak and sharp fall in the case of Bangkok. Two-wheeler ownership in Bangkok in 1995 was at a similar level to that in Bangalore in 2005, with around 250 two-wheelers per 1000 inhabitants, whereas ownership in the Jakarta city area has stayed below that in Bangalore.

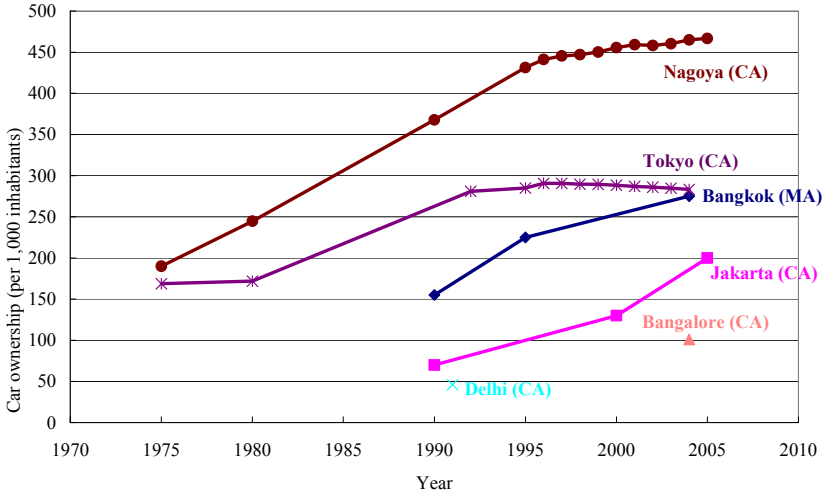


Figure 4.5: Comparative trend analysis: Car ownership

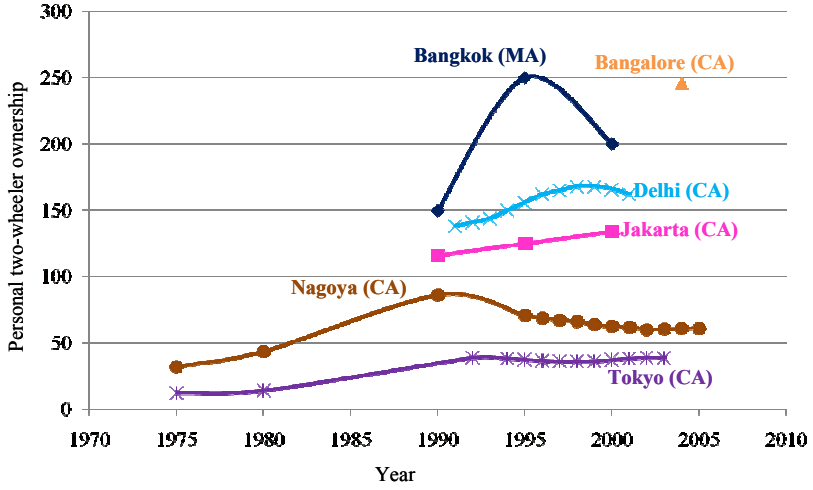


Figure 4.6: Comparative trend analysis: Two-wheeler ownership

Both in Bangkok and Jakarta, cars have taken over as the main type of privately owned vehicles in the past 15 years, whereas in Delhi car and two-wheeler ownership are following similar rising curves. Taking cars and two-wheelers together, private vehicle ownership in Bangalore now stands at around 350 vehicles per 1000 population, and with continuing economic growth, a large part of the present two-wheeler share is likely to shift to car ownership. Taking account, also, of economic development forces and the plans for large-scale highway constructions and the automobile industry park, we may expect a faster rise in car ownership in Bangalore than in Delhi. One way to manage such a change is to provide a better level of public transport service that meets the increasing mobility needs of the city and wins back some of the potential two-wheeler and automobile users.

Figure 4.7, next, represents the state of paved road provision in meters per person and its variation over time. In terms of road length, Delhi has held the leading place among the four developing cities, despite having the lowest rate of car ownership. The road data for Bangalore partly includes unpaved roads owing to the unavailability of clearly separate data. This is one reason why Bangalore shows a slightly greater road length per person compared to Bangkok and Jakarta, but even so the road provision in Bangalore is still less than half that in Delhi. Assuming that all planned roads will be completed (Section 3.4.5) and that the population will reach 10 million in the metropolitan region, the road provision in meters per person can be expected to increase from the present 0.9 m to approximately 1.4 m in 2010.

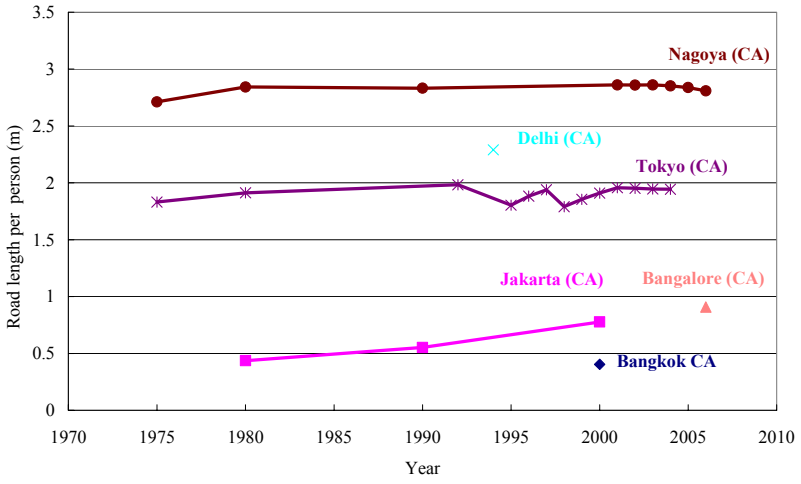


Figure 4.7: Comparative trend analysis: Road provision

Figure 4.8 shows another phenomenon that has been evident in most of the cities: a decline in traffic speed due in part to the failure of road improvements to keep pace with the rapid growth of road

traffic, and in part to inadequate traffic management which severely reduces the capacity of the road network as it currently exists. Bangalore shows the worst average road speed of all the six cities, and it is the only city in which speed is now noticeably falling clearly. Better traffic management on the city's roads is therefore an urgent necessity.

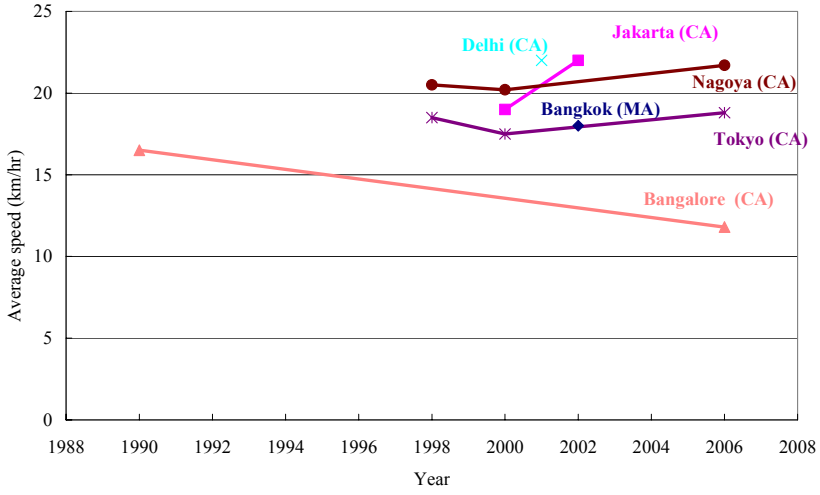


Figure 4.8: Comparative trend analysis: Speed of road traffic

Apart from the direct problem of the decline in average speed, the time loss and environmental load are made inevitably worse in most cases by an increase in the average distance traveled. The main causes for this are population sprawl, motorization, and the inadequacy of policies for ensuring efficient locations for urban facilities and mixed land use. In short, there are failures in spatial development policies generally. To put a figure on this, the average distance for a motorized trip is approximately 14 km in Delhi, and 11 km in Jakarta or Bangalore. In urban planning, two sensible ways of countering this increase in distances traveled are through compact and poly-nodal development. All very large metropolises, whether in developing or developed countries, sooner or later have to face the problem of spatial re-organization from the monocentric structure to either the dispersed or polycentric sorts of structure being planned for by BDA and BMRDA. Most previous experiences of poly-nodal development have proved unsuccessful in controlling the increase in distances traveled, but there is theoretical evidence that it can be done even if it seems hard to achieve in practice.

The last graph, Figure 4.9, shows public transport shares of motorized trips. Intermediate modes of public transport (taxis, motorcycle taxis, and auto-rickshaw) are included. Service levels are often low, essentially because of inadequate public transport infrastructures, the limited capacity of vehicles, and poor management and operations. Therefore, given an increase in income, former

public transport users are easily and irrevocably encouraged to shift to private vehicles (two-wheelers or cars). The only way to counter this is to make higher quality modes available. At the other extreme, the lowest income groups may not be able to afford public transport at all, or may not even have access to it. Managing public transport in circumstances like these is extremely difficult, but success in the task can contribute to the achievement of many urban transport development objectives.

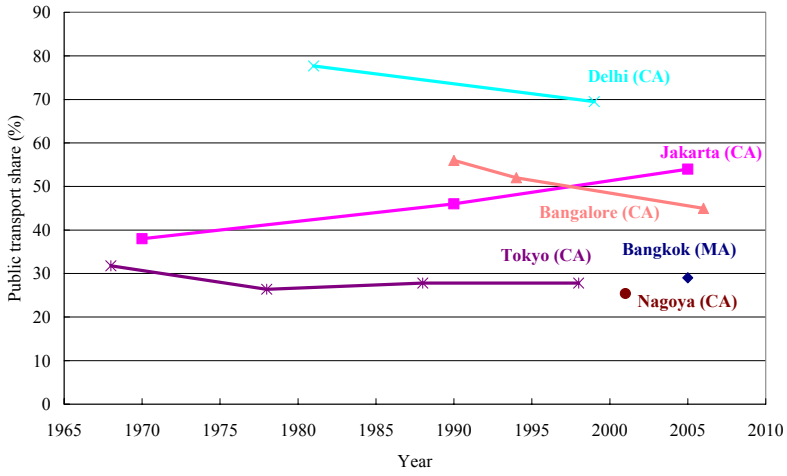


Figure 4.9: Comparative trend analysis: Public transport share

The two Indian cities show a closely similar pattern of decline in the public transport share over the years. In the case of Bangalore, 10% of public transport trips have been lost to two-wheelers and cars over the past decade, despite the fact of BMTC being one of the best operators in the country. Of the other cities, only Jakarta has been following a noticeable upward trend in public transport; here, the high share achieved in 2005 is attributable to the substantial efforts put into promoting the development of a rapid bus transit system.

4.3 Some Further Results from Comparative Trend Analysis

For a more global perspective, Figure 4.10 shows the linkages between economic development and motorization, and the directions of both, for six diverse cities, Nagoya, London, Tokyo, Bangkok, Shanghai and Seoul. Bangalore is shown positioned against this group according to its per capita income and car ownership in 2004. While the high levels of ownership in Tokyo and London exhibit a saturation trend, Bangkok and Shanghai continue to pursue a strikingly rapid upward path, which is evidence of a strong linkage between economic growth and motorization. Among the seven cities at an early stage of economic development (approximately US$ 1000 per capita), where car ownership varies from 20 to 180 cars/1000 persons, Bangalore shows a clear upward trend of car

ownership reaching 100 cars/1000 persons, only slightly lower than in the three large cities in advanced countries, Nagoya, Tokyo, and London. This may be predictive of a considerable wave of motorization lying ahead of Bangalore with its future prospering economy and increasing population.

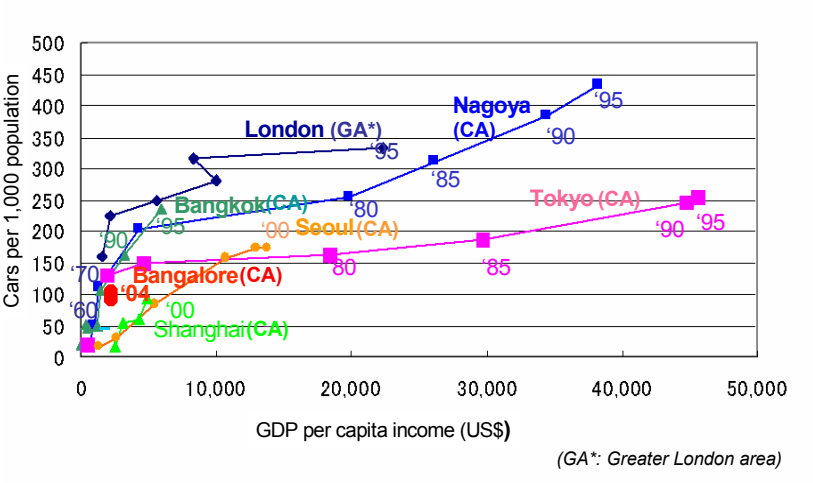


Figure 4.10: Trend of income increase and car ownership

Returning to the comparison of the six Asian cities, their road congestion problems can be said to result first from inefficient traffic management at existing capacity loads, and second from the gap between the rapid increases in car use and the inadequate levels of road infrastructure, that is, from a mismatch of demand and supply. Figure 4.11 shows the relationship between vehicle ownership per 1000 persons and road length per vehicle.

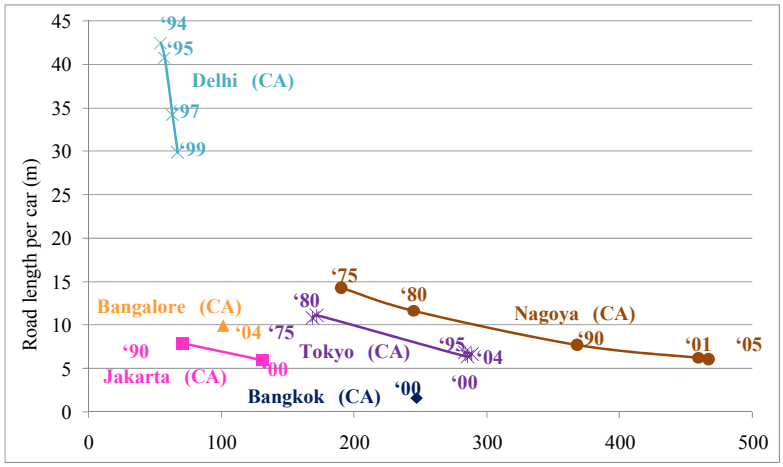


Figure 4.11: Trend of car ownership and road space

The graph indicates that road investment cannot cope with the rapid increase in cars which brings

about congestion and is also a cause of road accidents in the three developing cities, Jakarta, Bangalore and Bangkok. These cities show similar values for road length normalized by the number of private vehicles in use although the absolute values differ considerably. The very high level of two-wheeler ownership in Bangalore carries with it an implied warning of a further worsening of congestion on the roads, as economic growth will not only lead to an increase in the total registered number of vehicles but will also encourage a shift from two-wheelers to automobiles.

With regard to budgeting, the budget share allocated to road improvements has been declining in advanced countries like the UK and the US where there is already a high existing level of infrastructure stock. Japan has been investing in roads almost in proportion with its GNP at a rate of 2.0 – 2.7 % per annum. Tokyo and Nagoya are good examples of cities that have managed to avoid catastrophic congestion by increasing their road budgets proportionately to meet increasing car traffic demand and financing this from taxes indexed to fuel consumption and vehicle weight. On this principle it would seem that the budget for road developments should be increased automatically in proportion with rising car use. However, even in Tokyo and Nagoya it has been possible to keep the curve perfectly flat because the rate of rise in vehicle ownership has proved more rapid than that the increase in road provision. This can be pictured as meaning that the tax revenue obtained from a vehicle is smaller than the cost of constructing and maintaining a sufficient length of road to keep the traffic, after the addition of that vehicle, smoothly flowing. Tokyo has compensated for the lack of road space through an advance investment on improving its railways as a basic alternative means for transporting the huge volume of passenger traffic in this mega-city.

5. QUALITY OF LIFE SURVEY FOR MOBILITY NEEDS IN BANGALORE

Among the current main planning documents for development in Bangalore, the two we have already examined, that is, the BDA and BMRDA spatial development plans, address the challenges of how to achieve and integrate spatial, economic, social, transport and environmental planning. They further elaborate upon important key concepts, as discussed in Chapter 3. However, there is no long-term planning vision for QOL (quality of life), which is indispensable for the underpinning of social sustainability in a developing country where people frequently suffer all kinds of inequity problems in their everyday urban lives. Mobility is one of the most important factors for identifying QOL level, which is discussed in Chapter 2. In this chapter, an attempt will be made to quantify the mobility divide by using QOL indicators.

5.1 Importance of QOL Indicator Measuring for Equity: The Mobility Divide

QOL has been long a concept of recognized importance in studies of urban development and social sustainability. The physical urban environment and individual preferences can both be readily evaluated with reference to QOL (Myers, 1998). For example one recent work on urban planning and QOL has examined the impact of different spatial configurations on the QOL of various population groups and argued the case for a lifestyle-oriented approach to the spatial planning and configuring of residential areas (Eck *et al.*, 2005).

In our framework for sustainable development and mobility in Section 2.4, we proposed a QOL evaluation as one way of establishing explicit directions for an appreciation of Equity as one of the decisive pillars of social sustainability in urban planning. Social segregation and inequity are longstanding issues in the social sciences, and urban planning as a discipline needs to incorporate a description of people's living conditions if it is ever to succeed in minimizing the socio-economic gaps in a society. With this in mind, feedback on citizens' perceptions of their own needs and desires is bound to provide assistance to urban planners concerned with equity matters.

The two main contexts of equity dealt with in this report, spatial variations in urban amenity distributions and transport infrastructures that fail to keep pace with the urbanization effects of economic and demographic growth, both constitute central themes for the urban sciences. Especially in the developing countries, extreme socio-economic stratification often leads to increased inequity in the form of the mobility divide as a result of differences in the Accessibility of urban amenities and unequal opportunities for benefiting from them, whether this is viewed as a divide between rich and poor or between urban and rural areas. Therefore a QOL survey investigating citizens' satisfaction with their

socio-economic situations with regard to urban amenities, Accessibility and safety & security, will make an effective input for policy design and evaluation.

5.2 Designing the QOL Survey

QOL surveys in urban studies vary greatly but all have to do with the focus, scale and degree of the interests surveyed. In considering the feasibility of a survey and the extent to which it can properly be analyzed, it helps to define QOL through three components of Accessibility, Amenity, and Safety & Security, each of which can be assessed through four indicator features. In order to arrive at the needs and desires of each socio-economic group, the questionnaire has to be designed so as to allow comparison of the different weights of importance placed on different indicators according to age, gender, occupation, income, and vehicle ownership (Figure 5.1).

Quality of Life is determined by:	Quality of Life depends on:
1. Accessibility - determined from Travel time/ distance to work Travel time/ distance to education Travel time/ distance to health services Travel time/ distance to commercial centers	1. Gender Male Female
2. Amenity – determined from Water supply Power supply Sanitation Availability of parks/ green spaces	2. Age group 20-29 yrs 30-39 yrs 40-59 yrs
3. Safety & Security - determined from Crime rate Accident rate Air pollution Noise pollution	3. Occupation Self-employed Employees Students
	4. Family income < 10,000 Rupees 10,000 – 30,000 Rupees > 30,000 Rupees
	5. Ownership of private vehicles Personal vehicle owners Non vehicle owners

Figure 5.1: QOL components and socio-economic indicator features

As already described in Chapter 2, mobility is the capability of moving or being transported and does not in itself do anything to explain the effects of being mobile on trip patterns, either in terms of trip purposes or numbers of trips. Access to urban facilities is relevant to the planning of land use and transport systems for the reason that Accessibility gives residents the opportunity to participate in activities in different locations. It is an important component of QOL and may have a bearing on decisions of where to live. Thus it is used here to refer to the extent to which the land use and transport systems enable groups of people or goods to reach destinations where they can engage in purposeful activities. These destinations

are classified here under four kinds of activity: work, education, health, and commercial.

Amenity is a component that has to do with the immediate conditions in each zone or neighborhood; it can be measured directly in terms of local features and need not be affected by the situation in other zones, as is always the case with Accessibility. Amenity includes living comforts, which mainly depend on the conditions for each household or group of households in a given location. Particular factors to include under Amenity are water supply, power supply, sanitation (e.g., provisions for garbage disposal), and availability of parks or green spaces. The adequate availability of water and power are presently the two most critical issues in developing countries, are therefore included in this survey although they might not be considered worth mentioning in advanced countries.

Safety & Security includes problems such as high crime rates, especially against women, on buses and other transport systems, high accident rates, especially for pedestrians and two-wheeler users, and air and noise pollution.

5.3 Conducting the QOL Survey in Bangalore

Social perception and satisfaction surveys and related empirical analyses have been much more widely applied in developed countries than in Third World ones although the need for such studies is in fact more urgent in the early stages of development. In this sense, the present QOL survey comes as a well-timed project for Bangalore and also allows some valuable insights into individual perceptions of well-being in India as a whole, while additionally contributing to the international literature where there continues to be a regrettable research gap in this area.

The QOL survey was conducted at eight different spots in Bangalore during August and September 2007, with the collaboration of Toyota Kirloskar Motors Ltd. In order to minimize the sampling bias and ensure statistically acceptable degrees of significance, the locations were chosen so as to be spread out across the city and cover different age groups and occupations. The respondents were questioned in public places such as offices, parks, bus stops and shopping centers. The areas covered were Srirampura, Malleswaram, Yeswantpur, Banaswadi, Madiwala, Bommanahalli, VV Puram, and Majestic. An additional 10 respondents were obtained through the Bangalore office of TERI, which circulated the questionnaire among its own staff. In all, a total of 215 responses were collected.

One shortcoming of the survey was the overwhelming preponderance of male responses (209 out of 215), but the distributions on the other socio-economic parameters of income, age and occupation were reasonably unbiased. 152 respondents belonged to the younger age group between 20 and 29, with 39 respondents aged 30-39, and 21 aged 40-59. As for household income, 64 respondents were in the lower

income group (under 10,000 rupees a month), 129 in the middle group (10,000-30,000 rupees), and 22 in the higher group (over 30,000 rupees). By occupation, students were the largest group (90), followed by company employees (74), self-employed (33), unemployed (7), and retired (11).

The questionnaire consisted of six pages, including the accounts of its purpose and procedures, and took respondents approximately ten minutes on average to complete. As a first step, respondents were asked to rate the relative importance they gave to the main components Accessibility, Amenity and Safety & Security so as to reveal variations in perception. At the next step, they had to rank three indicators which had been selected as representative of the three main components, to reveal more exactly the variations in QOL perceptions within each component area.

5.4 Mobility Divide Measured by QOL in Bangalore

5.4.1 Impact of Income Disparity on Mode Choices

Figure 5.2 summarizes the results of the survey for the groups of car and two-wheeler owners and across

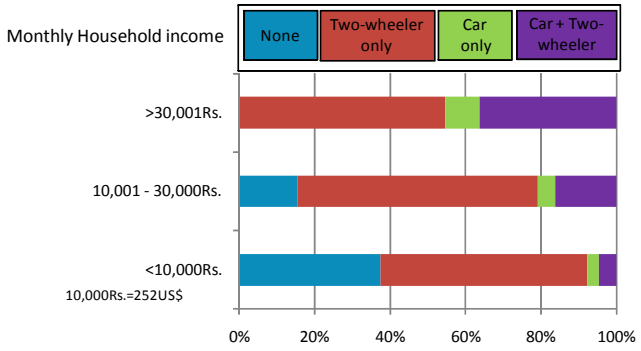


Figure 5.2: Income groups and personal vehicle ownership

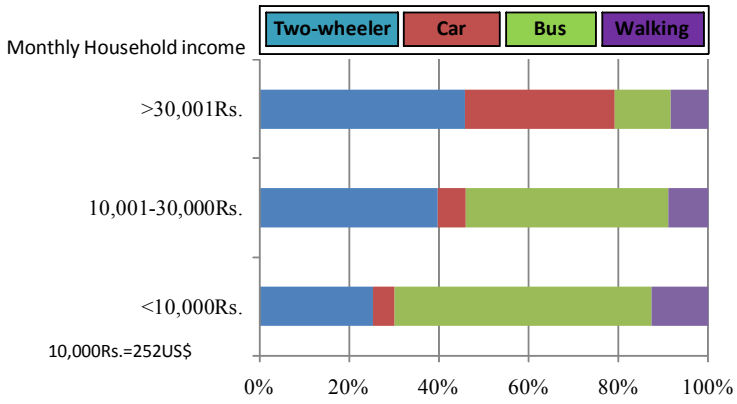


Figure 5.3: Income groups and mode choices for trips to work or school

the income groups. As one might expect, car ownership is found to be high for higher income groups and low for lower income groups. Two-wheelers are the most important mode of transport for private trips and the high rate of two-wheeler ownership does not vary much with income. As average incomes increase, many of the present two-wheeler owners will most likely shift to car use.

Figure 5.3 shows the results grouped this time by income groups and mode choices for travel to work or school. Here, the rates of car and two-wheeler ownership in the higher income groups are very high whereas the lower income groups overwhelmingly use the public transportation modes, particularly the extensive bus network in the city.

As an approximate guide to the mode shares by income groups in Bangalore, we can look at results available for another Indian city, Pune, where IT and software companies play a similarly dominant part in shaping the regional economy (Figure 5.4). Table 5.4 presents results for trip lengths grouped by income and mode choices in Pune city. From Figure 5.4 and Table 5.1, it can easily be inferred, in the

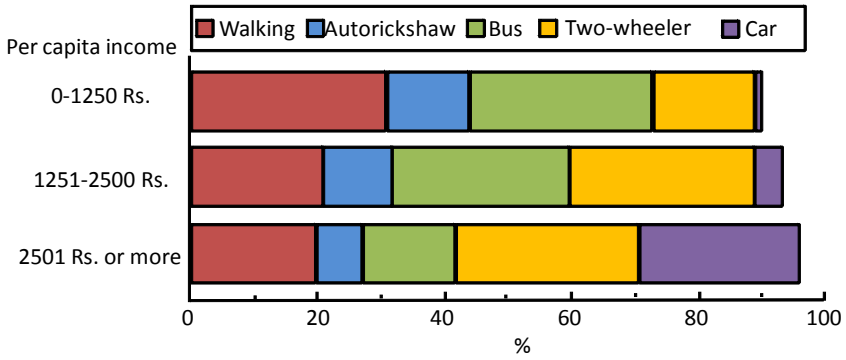


Figure 5.4: Income groups and mode choices (Pune city)

(Source: Astorp, 1996)

Table 5.1 Trip lengths (km) grouped under income and mode choices in Pune city

	Income Groups		
	Low Income	Middle Income	High Income
Car	3.5	8.0	11.2
Personal two-wheeler or scooter	6.9	8.0	8.1
Bicycle	4.3	3.9	4.2
Bus	7.9	9.5	10.5
Auto rickshaw	4.0	5.1	3.3
Walking	2.0	1.3	0.9
Total	5.4	7.2	7.1

(Source A.Astorp, 1996)

case of Pune, that income level disparity is very apparent between public transport and private vehicle users, and that higher income earners also tend to make longer trips than the lower earners. Paying closer attention to the results by income groups, the results from Pune indicate that bus and private vehicle trips in the high income group are longer, whereas in the lower income groups, walking and auto rickshaw trips are longer. This is a reflection of the fact that higher income earners can afford a choice between various transport modes for longer trips while lower earners are intent to be economical in their choices of transport. In other words, the ability to afford different means of transport is the leading cause of the "Mobility Divide."

5.4.2 Trip Mode Specific Accessibility and Mobility

As some of the basic data that are needed to carry out Accessibility calculations, such as details of urban facility distributions, roads, bus routes and railway network, are just not available for Bangalore, a simple and appropriate alternative way of computing Accessibility indicators is through the use of equations 5.1 and 5.2, below.

$$Ac = D \cdot E \tag{5.1}$$

$$E = \pi \cdot l^2 \tag{5.2}$$

Ac : Individual Accessibility, D : Population density, E : Total area accessible in one hour,
l : Total longitudinal distance accessible in one hour

To compute a given simple Accessibility indicator defined by population and area of Accessibility in one hour, the average vehicle speed on the network is calculated from the 2004 origin destination surveys as 11.8 km/h, an average walking speed is assumed to be 4.0km/hr and population density is calculated as 10,389 persons /km^2. Table 5.2 presents the results of two Accessibility calculations from which Accessibility by car is found to be 8.7 times higher than Accessibility on foot. For example in a suburban area which is not well urbanized – in other words, where there is no good mix of different types of urban facilities – and which is also poorly served by public transport, residents without a private vehicle enjoy 8.7 times less Accessibility than they would in Bangalore city center. 8.7 gives only a rough estimate however, because in fact population density and patterns of urban facility location vary spatially and so

Table 5.2 Accessibility computation results

Trip mode	Car	Walking
Area [km^2]	437	50.0
Population	4.54×10^6	5.22×10^5

therefore do the local Accessibility indicators. This already severe mobility divide is likely to widen still further, unless appropriate land use and transport policy measures are urgently taken.

5.4.3 Mobility Needs and Desires

Figure 5.5 shows respondents' rankings of the three components of Accessibility, Amenity and Safety & Security for personal vehicle owners and non-owners. Irrespective of personal vehicle possession, water supply was uniformly ranked as the most important QOL component, reflecting the fact that water supply is currently one of the most widespread and critical urban problems in the city. Regarding the other two components, personal vehicle owners gave a slightly higher priority to shopping Accessibility compared with non-owners.

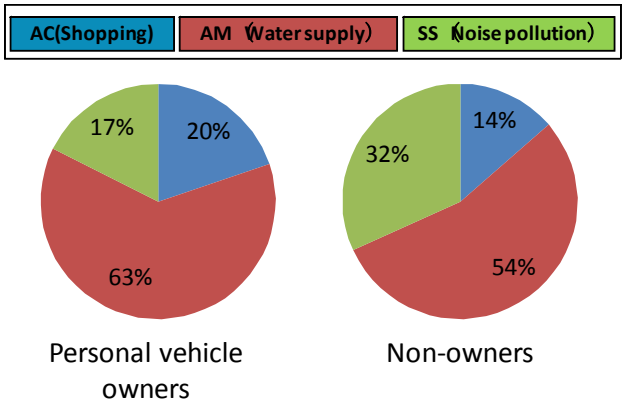


Figure 5.5: Priorities among accessibility, amenity and safety & security by personal vehicle possession

Table 5.3 summarizes the parameter estimates for the QOL components included in the analysis. Table 5.4 gives the ratios of the estimated priorities given by respondents to Accessibility and Amenity. The ratio of Accessibility to Amenity is 4.8 times higher for private vehicle owners than for non-owners. This indicates that non-owners, most of whom belong to the low income group, perceive the Amenity component of QOL as more important because for them basic amenity problems are much more pressing.

Table 5.3: Parameter estimates for QOL components

	AC (shopping)		*AM* (water supply)		*SS* (noise pollution)	
	parameter	t value	parameter	t value	parameter	t value
Private vehicle owners	0.012	1.7	0.013	0.76	0.66	3.4
Non-owners	0.016	1.1	0.079	2.3	0.42	1.1

Table 5.4: Ratio of *AC* to *AM*

	AC/AM
Private vehicle owners	0.95
Non-owners	0.20

In addition, mobility needs are generally considered to increase with rises in income level, and this too helps to explain why the lower income earners seem to place less priority on the Accessibility component.

QOL appears to be 1.9 times higher for private vehicle owners compared with non-owners, from a consideration of the parameters.

Notice, too, that if the parameter for AC were the same for owners and non-owners of private vehicles, the potential mobility divide would go up much higher.

5.5 Amenities and Safety & Security in Relation with Mobility

A) Amenity

Amenity is measured by indicators of water supply, power supply, sanitation and green spaces. Bangalore is now displaying glaring inequality in standards of living. It has been described as a divided city where high class residential neighborhoods co-exist with slums. Water supply and sanitation have also been highlighted as crucial issues in Bangalore, and serve as useful indicators of the existing inequalities (Benjamin, 2000). According to the Bangalore Master Plan 2015 Vision document, the average volume of water supply is presently estimated at 80 liters/person/day, which does not meet the minimum required standard. The plan aims to ensure an accessible water supply for all citizens on a continuous basis. Another aim is to provide an uninterrupted power supply to all citizens within the Greater Bangalore area, including the satellite townships and special economic zones.

B) Safety & Security

The indicators for the Safety & Security component of QOL are the crime rate, traffic accidents, air pollution and noise pollution. To assess the national position of Bangalore as shown by these indicators, it is worth comparing it with the two metropolises of Delhi and Mumbai. The cities of Delhi, Mumbai and Bangalore accounted for 15.7%, 9.5% and 9.2% respectively of the total crime reported from 35 cities in India in 2004. The crime rate for Bangalore stood in third place nationally. As for accidents, road traffic injuries in India result in economic losses of 550 billion rupees, or nearly 3% of GDP, every year (Gururaj, 2005). In 2001, Bangalore ranked fifth worst for accidents amongst India's fourteen major cities with an estimated 13 deaths per 100,000 population (Gururaj, 2005). Regarding pollution, the ambient air quality around three busy intersections in Bangalore has been monitored against air quality indices for the period 1997 to 2005 (Shiva Nagendra et al, 2007), with results indicating 'good' to 'moderate' levels of SO_2 and NO_x for most of the year, and a decreasing trend in levels of SPM and RSPM from 'poor' or 'worse' to 'moderate'. A study conducted by the Bangalore Metro Rail Corporation (BMRC) between January and December 2006 found high noise levels at many key junctions, with readings almost 10 decibels above the permissible limits set by the Central Pollution Control Board (The Hindu, July 9, 2007).

Traffic loads on the major roads of the three cities, as estimated in a recent study (CRRI, 2003), are shown below (Table 5.5). Delhi shows the highest VKT load per day at almost 80 million. The second highest is in Bangalore, at 33 million per day, followed by Mumbai at 30 million per day. The estimated pollution loads for CO (Table 5.6) are also reported to be highest in Delhi, followed by Bangalore and Mumbai.

Table 5.5: Share of traffic load in three cities by vehicle type

Vehicle type	**Vehicle kilometers per day (lakhs)**		
	Bangalore	**Delhi**	**Mumbai***
Cars/ jeeps/ vans	5.112 (15.67 %)	30.088 (37.97%)	9.490 (31.08%)
Taxis	0.235 (0.72 %)	0.601 (0.76%)	2.606 (8.53%)
Two-wheelers	20.367 (62.43 %)	33.823 (42.69%)	9.509 (31.14 %)
Autos_CNG	-	7.137 (9.01%)	-
Autos_petrol	5..045 (1.546 %)	2.220 (2.8%)	5.388 (17.65 %)
LCV	0.592 (1.81 %)	1.657 (2.09%)	1.213 (3.97%)
HCV	0.426 (1.31 %)	0.857 (1.08%)	1.329 (4.35 %)
Buses_CNG	-	1.053 (1.33%)	-
Buses_diesel	0.848 (2.6 %)	1.798 (2.27 %)	1.000 (3.27 %)
Total	32.625 (100 %)	79.234 (100%)	30.535 (100 %)

* The buses and taxis running on CNG could not be identified from the roadside

Table 5.6: Estimated pollution load in three cities

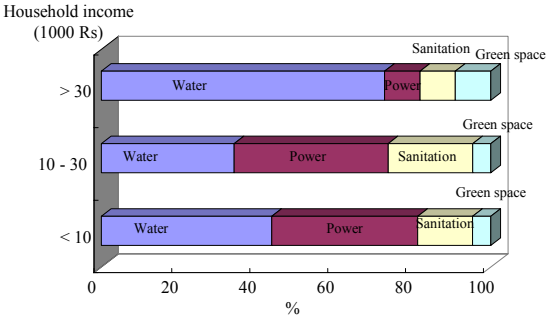
City	**Pollution load in metric tonnes per day**			
	CO	**NOx**	**HC**	**PM**
Bangalore	207.04	29.72	117.37	8.11
Delhi	421.84	110.45	184.37	12.77
Mumbai	189.55	46.37	89.93	10.58

C) Results of the survey

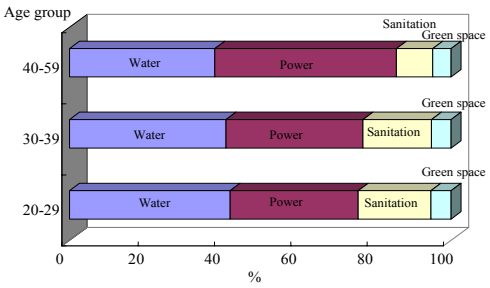
Similar surveys were conducted in Delhi (352 respondents) and Nagoya (218 respondents). The cross-comparisons contribute to an understanding of similarities and differences in QOL perceptions associated with similar or differing stages of economic development.

Following the first set of questions about Accessibility rankings, the second and third parts of the questionnaire similarly asked respondents to give priority ratings among four components in each of the other two categories, Amenity, and Safety & Security, supposing they were deciding on a place to live.

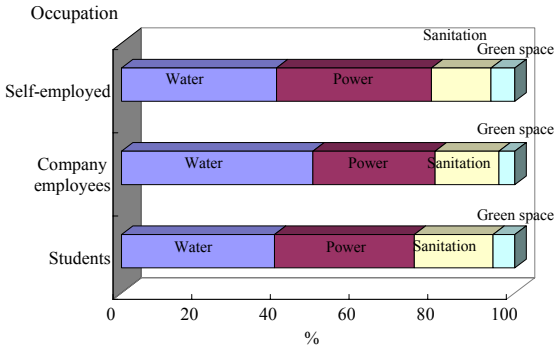
The criteria for urban amenity were a) assured continuous water supply, b) assured power supply, c) provisions for garbage disposal, and d) availability of green space (parks, fields, forest) within 15 minutes walking distance. The criteria for Safety & Security were a) the crime rate, b) the rate of traffic accidents, c) air pollution, and d) noise pollution. Irrespective of age group, occupation and income group, all categories of respondents rated availability of water as the most important amenity, followed by power supply (Figure 5.6). This may reflect the precarious highland location of Bangalore.



(a) By age group



(b) By household income



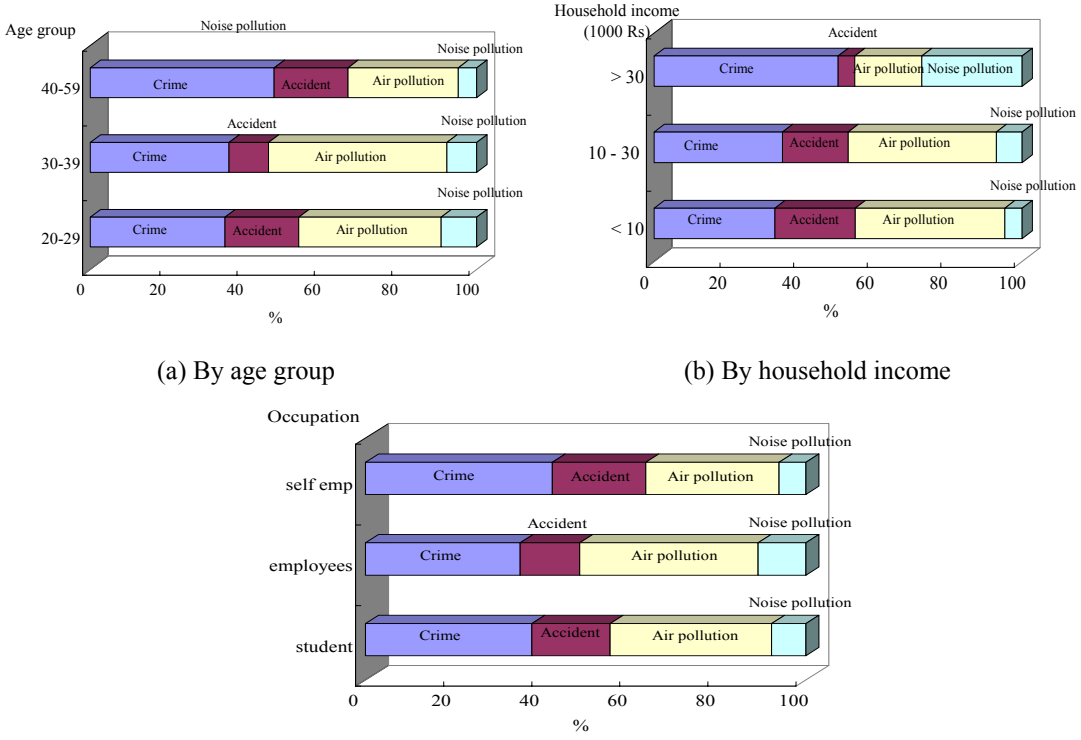
(c) By occupation

Figure 5.6: Urban facility-specific Amenity priority rates by different socio-economic profiles in Bangalore

The share of answers ranking the water supply first was 40 %, followed by power supply, at 37%. In Delhi too, highest, and nearly equal, importance went to the water and power supplies (33 % each). Availability of green space was the item selected by fewest respondents, whereas in Nagoya as many as 32 % of respondents ranked this as their first urban amenity concern. Naturally, water and power supply and basic sanitation are no longer amenity problems in the Japanese urban environment, and therefore the Amenity part of the questionnaire was redesigned for Nagoya to include architectural design, convenience of location, the availability of open and green spaces within walking distance, and local environmental pollution. A likely reason for the relative difference in value attached to green space in

Nagoya and Bangalore is that the need perceptions of Bangalore citizens have not yet shifted on from basics to quality so that concerns such as parks have not yet generally come to acquire first-order prominence. In the higher income groups, green space is given slightly more priority, but still very little compared with the basic needs of water and power supply.

In the perceptions about Safety & Security, crime and accidents were highly weighted by nearly half of the sample, while the other half chose air or noise pollution. This implies a notable awareness of accidents and crime, almost on a level with that of the environment problems. Between the two sorts of pollution, there was generally more concern for air pollution, but the concern for noise tended to increase considerably with an increase in income, leading to a more balanced perception of environmental problems (Figure 5.7).



(a) By age group

(b) By household income

(c) By occupation

Figure 5.7: Urban facility-specific Safety & Security priority rates by different socio-economic profiles in Bangalore

The Nagoya survey results revealed a somewhat lesser concern, slightly below 30 %, for local environment problems, which could be interpreted negatively as reflecting the smaller degree of discomfort from air and noise pollution in Nagoya. As for accidents, there was a remarkable decrease in perception in the highest income group. Half of the respondents belonging to this income group had a car in their household and may have had a lower level of awareness on that account, since accidents are more serious for two-wheeler users and pedestrians in developing countries. This is another facet of the

mobility divide.

In the final part of the questionnaire, one representative item was offered from each of the three main component categories and respondents were asked to rank them in order of importance. The items offered were access to shopping from Accessibility, adequate water supply from Amenity, and noise pollution from Safety & Security (Figure 5.5). Almost 60 % of the Bangalore respondents chose water as their first concern and the remainder split at 20% each between access to shopping and noise pollution. A similar result was obtained in the Delhi survey. In both cities, Accessibility is obviously one of the major problems of urban life, both for the bottleneck it creates for the macro-economy of the whole city and for the constraint it puts on personal well-being in both the economic and the social senses. The two problems of Accessibility and noise – both mainly associated with traffic conditions in the city – were perceived together as being the chief detractions from urban quality of life by as many as 40 % of the sample population, while the remaining 60 % named the more basic physical need of water supply. This indicates a widespread awareness in Bangalore that mobile and high-quality transport is a basic right of urban existence, and that life at the moment is impeded by the immobility and noise pollution resulting from the poorly managed state of the traffic.

6. POLICY DISCUSSIONS REGARDING PLANNING FOR BETTER MOBILITY AND SUSTAINABLE DEVELOPMENT

One of the purposes of this report is to discuss spatial and transport planning concepts and tools which will allow Bangalore to progress towards its goal of developing into a sustainable prosperous community and the sort of society in which glaring social gaps in urban planning objectives can be closed. Before going into details about current policy directions and their effectiveness, we wish to start by defining the term "planning". It has long been used without much practical consideration of its scope and essential meaning. In developing countries, it has been common for urban planners to propose metropolitan structure designs and action plans based on intuition. However, most projects of this sort end up as mere political statements or bureaucratic blueprints. Realistic urban planning needs to be directly linked to individual QOL (quality of life), and this calls for a significantly deeper and multidimensional attitude toward social design. In a general context relevant to our interests here, Hall (1992) defines the word "planning" as:

> *"... the making of an orderly sequence of action that will lead to the achievement of a stated goal or goals. Its main techniques will be written statements, supplemented as appropriate by statistical projections, mathematical representations, quantified illustrations and diagrams illustrating relationships..."*

In this report we attempt to base our concern for major planning issues in Bangalore upon just such a modern conception of planning, so far as the available data permit. Up to this point we have discussed various urban planning issues within a provisional framework arrived at through descriptions of urban problems, reviews of existing planning documents and statements, social perception surveys, and the clarification of some of the linkages among our chosen indicators of urban well-being.

In the light of what we have discussed, we will now begin to summarize planning issues in Bangalore, in particular the problematic ones. In the following sections we first offer an overall picture of the policy strategies and instruments available, and then try to interpret which of the prominent lines of current planning are likely to be successful and where failures are to be expected in design or in application, given the present policy and implementation instruments.

6.1 Summary of Critical Urban Planning Issues in Bangalore

Below is an initial point-by-point summary of urban planning issues in Bangalore based on what we have reviewed so far in the various areas of current and future policy-making:

- Bangalore, in its present early stage of economic development under the rapid impacts of urbanization and motorization, suffers from an insufficient road network, qualitatively and quantitatively. A partly avoidable increase in private vehicle ownership though the coming shift from two-wheeler to automobile ownership (Figures 4.5-4.7; 4.10, 4.11) threatens to lower travel speed still further, leading to severe economic losses on account of the inadequate road network (Figure 4.8).

Photo 6.1: Congestion caused by private vehicles

- Extreme congestion on the roads results not only from the acute mismatch between demand and supply, but also from an incompatible mix of vehicles (buses, three-wheelers, two-wheelers, non-motorized), from inadequate traffic control and management, and from a general lack of awareness and responsibility among individual users of the various transport modes where traffic issues are concerned (Section 3.3.5).

Photo 6.2: Incompatible mix of vehicles on the road

- Local authorities, supported by the central government, are working to redesign and improve the present limited network, especially the ring roads linking the suburban settlements near the second and third rings in the BDA and the further out "integrated townships" in the BMRDA (Sections 3.2.1, 3.2.2 and 3.4.1). Given the financial constraints, a good deal of perseverance will be required in order to ensure that this much needed investment in highways is realized in a timely fashion and in a manner compatible with actual and projected land use development.

Photo 6.3: Clover-leaf interchange between Bangalore and Mysore

- The imminent growth in population (natural and through immigration) will speed up urban expansion (Figure 4.3). As a result, any further addition of poorly planned suburban settlements without well designed highway connections, public transport and urban amenity facilities will only add to the existing urban problems of spatial segregation, the mobility divide, long journey distances, the poor balance of transport modes, and the failings in safety & security.

Photo 6.4: Public transport in Bangalore

The overcrowded public transport system, which effectively consists only in the buses, runs an extensive network, but cannot be said to provide a high level of service in terms of comfort and punctuality. The para-transit is not coordinated with the public system. This lack of organization further detracts from the carrying capacity of the roads (Figure 4.7 and Section 3.4.2).

- New residential developments are in planning or under construction, sometimes coupled with the clearance and replacement of slums and squatter settlements (Sections 3.3.3). However, the replacement of slums by public housing is very costly and does not always end in the rehousing of the original slum dwellers.

Photo set 6.5: Housing developments for employees in new industries (IT, automobilesetc.) in the suburbs of Bangalore

- In addition to the socio-economic stratification that comes from factors like income disparity, the uneven distribution of urban settlements and facilities adds to social gaps by exacerbating the mobility divide, spatial segregation and the general heterogeneity of urban amenities. This is an acute problem for a city such as Bangalore, which is already saddled with extremely unequal income distribution and is following a course of economic development and urbanization that leads to greater growth at the city peripheries than at the core. But the financial burdens impose a limit on the authorities' ability to adopt a unitary timely plan of city center revitalization and managed suburban development, and it is this failing which creates such the enormous variation in the levels of urban QOL and well-being. QOL is a measure of urban planning that calls for more attention from planners in the context of pursuing sustainable social development in a place like Bangalore (Chapter 5).

- India is one of the very few Third World countries that make real efforts to develop plans and train up human resources for the modern architecture challenges of urban planning. However, as far as institutional frameworks are concerned, the linkages among the governmental authorities responsible for land use, transport and other relevant aspects of urban development still need to be more efficiently cultivated. Successes of individual plans rest heavily on how well each plan accords with general objectives, and therefore on regular interaction and coordination from the design stage right through to implementation. Coordination cannot be limited only to a dialog among governmental agencies but must reach out to involve the private sector participants (Section 3.3.6).

6.2 Overall Policy Considerations for Better Planning

Figure 6.1 provides an overview of land use and transport policy strategies and instruments that seem to offer efficient answers to the planning concerns in Bangalore. Policy strategies are arranged in four groups of land use management, coordinated supply of transport modes, vehicle technology development, and IT and transportation demand management. Under these four strategy heads, we list a number of well proven policy instruments for with spatial and mobility development.

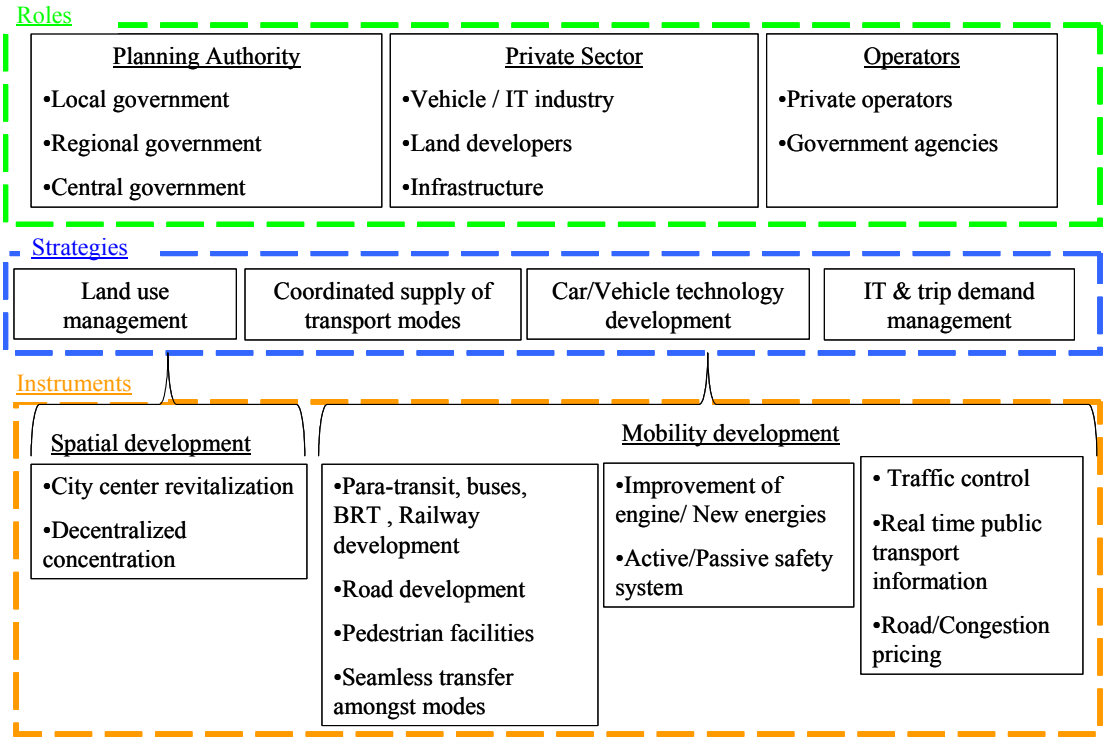


Figure 6.1: Planning strategies and instruments for sustainable spatial and mobility development

The “decentralized concentration” type of urban expansion proposed under land use management in the figure, and also in actual current planning in Bangalore, is one way of responding to emerging new patterns of growth of the city. In the area of transport modes, while motorization will inevitably continue to accelerate, parallel improvements to the public transport network also need to be developed through the introduction of new bus and rail systems, and the control and coordination of para-transit operations. However, improvement of transport, in particular public transport, is not only a matter of increasing capacity; it is also important to increase the efficiency of operations through enhanced service levels and the assurance of seamless transfer between modes. As for technology development, improvements in vehicle design and energy use are obviously indispensable at the present time. IT and demand management could of course have been included under technology development, but we have preferred

to make a separate fourth category for it, with three application areas of virtual mobility coverage, real time public transport information and road congestion pricing.

As for the institutional aspects, it is clear in Third World countries, particularly, that infrastructure and land development schemes cannot rely for their financing entirely on government management. This implies the need for stronger and better designed systems of collaboration between the governmental and private sectors and the involvement of the private sector in matters of technical and social guidance and in social acceptability assessments. In this sense, a clearly defined and integrated sharing of labor between governmental planning authorities and non-governmental land developers, as well as with the vehicle manufacturing and IT industries and operators, deserves emphasis. Governmental inter-agency coordination is also a problem that will need to be addressed to ensure progress towards a fuller integration of functions, especially between Bangalore City, the regional planning authorities, and the agencies that plan and operate public transport.

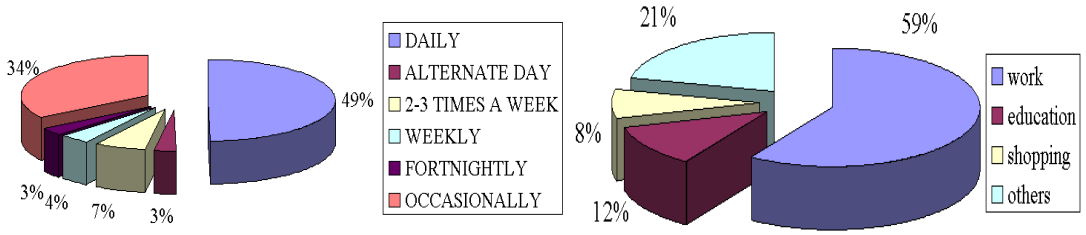
6.3 Specific Policy Considerations

6.3.1 Public Transport: Subway and Bus Rapid Transit Systems

The efficiency of public transport systems is heavily dependent on demand thresholds. In many mega-cities, rail systems should ideally carry the bulk of the high demand for motorized trips, as mass rapid transit systems have a capacity superior to any other urban transport system. But unfortunately, they also involve the highest costs for construction, maintenance and operation and present a city with severe financing and debt repayment difficulties. Further drawbacks are that metro systems often attract lower than expected numbers of passengers, and tend mainly to capture passengers from buses while the shift from cars to the metro remains limited. As a result, the success of a rail transit investment may not come up to full expectation unless supported by complementary policies of land use development, and by feeder systems not only in the physical sense but in the regulative form of coordinated fare systems that ensure ease of transfer to the rail system. For this kind of reason, any proposal for a mass rapid transit system in a developing country will require paying special attention to the cost-efficient optimization of the system, because whatever the aim was in the first place the practical problems and constraints facing the operators will generally be financial.

A recent example of a mass rapid transit system which opened in 2002 is the Delhi Metro operated by the Delhi Metro Rail Corporation (DMRC). A commuter survey was recently carried out with a total of 6771 respondents at 14 stations to assess the benefits of the system. The results of this survey may usefully highlight issues for Bangalore where the local government, in 2006, approved the first phase of a proposed metro system on which construction has yet not started. A sizeable proportion of trips on the

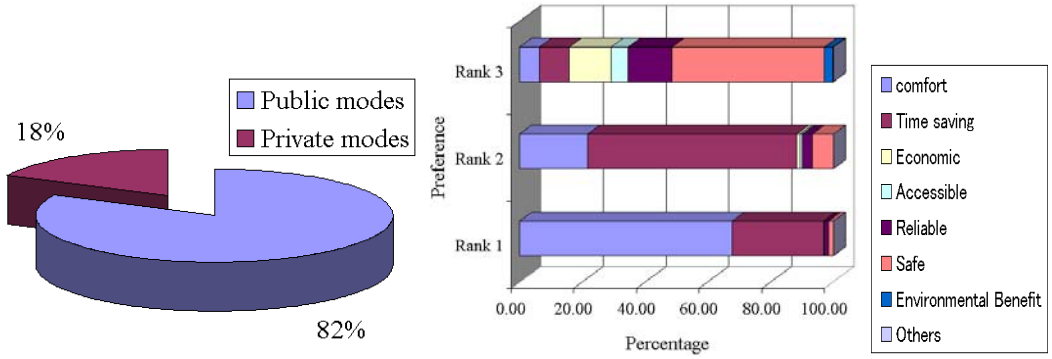
Delhi Metro, 49%, are apparently undertaken on a daily basis, while 34% of respondents make their trips only occasionally. Journeys to work seem to account for 59 % of all trips (Figure 6.2).



(a)Trip frequencies (b) Trip purposes

Figure 6.2: Delhi Metro user profile survey results for trip frequencies and trip purposes

Analysis shows that 82% of metro commuters have shifted from other public modes which include bus, chartered bus, RTV, minibus, taxi and auto rickshaw. The rest have shifted from private vehicles, including two-wheelers (scooters or motor cycles) as well as cars. Respondents were asked to rank their reasons for shifting to the metro, and out of the seven main reasons offered (comfort, time saving, economic, accessible, reliable, safe, and environmental benefit), the three chief reasons for shifting were that it was comfortable, time saving and safe (Figure 6.3).



(a) Shift from private and public transport modes (b) Reasons for modal shift

Figure 6.3: Delhi Metro user modal shift shares and reasons

Another finding was that about 77% of trips originated within 2 km of a metro station and 82% ended within 2 km of one, which must mean that close on four out of five metro users are starting and ending their trips within 2 km of a metro station.

There are clear signs that policy makers in large Asian cities have also begun to consider bus rapid transit (BRT) systems as a viable option for public transport. The first wide-scale development of BRT was in Curitiba, Brazil, in 1974. Since the late 1990s the trend has gained momentum and BRT systems are increasingly being chosen by cities as a cost-effective transit solution. Bangalore has already furnished a good example of how to upgrade a bus network without losing passengers, and has even succeeded in

turning its buses into a profitable enterprise in a world where public transport systems are struggling to compete with private vehicles. In a country where buses dominate daily trips, a city with such a successful record with buses ought to be well placed to continue the success with the implementation of a BRT scheme that gains popular acceptance. At the very least, BTR, a less costly alternative to the metro offering a maximum passenger capacity in one direction of as many as 20,000 persons/hour, promises an immediate remedy to difficulties until the proposed metro system is in operation.

At the moment, there are still institutional difficulties that are causing delays in the realization of a bus rapid transport system by BMTC. Discussions between BMTC and the BDA for the designation of bus priority lanes are still going on and progress with these will have to accelerate if the use of buses is not to decline as a result of a tardy and inefficient integration of the bus system with urban and socio-economic development.

6.3.2 Intermediate Modes for Public Transport: Organization and Coordination

Examples of well organized para-transit systems that facilitate journeys across a whole city are rare, especially in developing countries. Para-transit is a flexible and adaptable mode of public transport that can ensure a match between the services and needs for mobility, but it can also lead to a positive worsening of traffic problems unless there are consistent ways of regulating it so as to complement the operations of the primary means of public transport. Besides their adverse impact on the general traffic in unplanned conditions, one difficulty with para-transit vehicles is how to achieve the physical and management co-ordination needed between the public transport providers on the one side and the small private firms and individual owners, in extreme cases even casual operators, of para-transit vehicles on the other. Above a certain threshold of passenger demand, para-transit dramatically loses its efficiency and adds to the decline in capacity on the roads, with the ensuing economic loss. The best role for para-transit systems, particularly in circumstances where it is financially difficult to provide alternative modes of public transport, is as a complement rather than a competition to conventional public transport services for which they can act as feeder routes. Another efficient role could be as a coordinated mode in a newly emerging sub-center with a relatively small initial demand until such time as the potential number of passengers reaches the threshold from where it begins to make sense to provide a conventional means of public transport.

Bangalore's para-transit vehicles, mainly three-wheelers, play a notable role in daily travel. They are entirely unregulated small vehicles, without routes or stopping restrictions. The average income level of para-transit users is slightly higher than that of car users and four times that of bus users (TERI, 2007). Today's para-transit users are therefore likely to shift to automobiles with the present rapid pace of motorization.

6.3.3 Suburban Settlements and Highways for a Polycentric Structure

In current discussions of urbanization, especially in developing countries, it is regarded as self-evident that forces of globalization have played a substantial part in determining the outcomes of urban spatial arrangements (Dick and Rimmer, 1998). That is, the processes of urban development result in the relocation (decentralization and further de-concentration) of enterprises and housing away from the central business district (CBD) in particular to the emerging new employment centers. Polycentric employment distribution is defined as the decentralized, but clustered, formation of work agglomerations in sub-centers as distinct from employment concentrated in the CBD or sprawling haphazardly over the whole metropolitan region.

An urban policy oriented toward polycentric urban formation, will be concerned to define and promote suitable locations for its major relocation centers and/or developments. Former experiences show that the issuing of spatial and transport planning documents is a necessary but not sufficient procedure for the guidance of polycentric development. Some cities with problems of space shortage in their central districts have been overwhelmed by the pace of urbanization and the inability of local government to manage or finance the implications. For Bangalore, an enforceable metropolitan spatial plan, and a robust set of land use and transport policies and instruments, particularly financial plans for land development, will be needed to support this polycentric restructuring process. In the context of this restructuring now taking place in Bangalore, we wish to emphasize three prominent aspects of particular interest.

First, the scale of polycentrism is very notable. Spatial development plans by the BDA are based on the governing principle of structured continuity which directs that development in existing urbanized areas and new extensions must be spatially and functionally structured to avoid unmanageable urban sprawl. The same principle of multi-nodal spatial reconfiguration is also promoted by the BMRDA; as described in Chapter 3, the BMRDA has undertaken the development of five integrated townships equipped for the functions of Work-Live-Play, and each with its own distinctive township theme, at distances of 30-45 km from the city center. Optimum sites for development in response to the market forces of growth will have to be found within this strategic framework, as will any decisions about the locations of future employment centers, when and where there is a real need to grow. Within this large picture, the two levels of polycentrism announced by the BDA and BMRDA will have to be steadily and consistently planned for.

The second important aspect is the financial implication of this shift of urbanization to the city peripheries through the building of integrated townships. The general function of urban policy is to steer public resources, and hence urban development, in a certain direction. The growth of better suburban

centers conducive to individual urban well-being and equipped with land and infrastructure developments may also prove an attraction for public-private investment partnerships, in particular under the impulsion of global economic forces and financial constraints. Currently the BMRDA is counting on high private sector involvement, although the extent of these public-private partnerships is not yet clear.

The third aspect to consider is the transport demand. Polycentric employment growth and its impacts on trip profiles appear to be poorly understood in many developing countries. Mixed land use and public transport are the favored responses of planners and policy-makers to these challenges of poly-nodal metropolitan nodal structure and transport interaction (Alpkokin et al., 2007). Unless sub-center planning is in harmony with these two policies, the polycentric structure will plainly just add to the car kilometers traveled. Both the BDA and the BMRDA plans call for the same mixed structure of sub-center formation, but particularly under the BMRDA plan integrated townships will bring growth on a ring and radial pattern with reliance on a road-based transport system.

6.3.4 Effects of Alternative Means of Transport on Mobility

The means for developing urban transport in Bangalore can be classified into three types: a) road, b) mass-transit and para-transit, and c) IT. The primary policy question is how to keep mobility space open within this integrated transport and IT system. Within the whole system, IT not only offers a virtual alternative to the physical transport system but also an intelligent support to the road, rail, bus and para-transit systems. Figure 6.4 illustrates this relation. It is clear that in order to achieve a smoother flow of road transport, the most effective strategy lies in the improvement of alternative transport systems for a saving of space.

Tokyo is the outstanding example of a city which built up and improved a dense suburban railway system in advance of a new road system. It is widely recognized that this was the main factor that made it possible to keep commuter transport moving smoothly in the world's biggest metropolitan area (with a population of thirty-three million, double that of mega-cities like Mumbai or Shanghai). This order of priorities guided citizens into a habit of having to ride on rains for commuting. If the road system had been improved ahead of the railways, Tokyo would not have obtained the tidy systems of commuter transport it has today. Bangkok followed a totally reverse order of priorities, which initially allowed for road systems only, during the period of rapid growth. The end result is that Tokyo has succeeded in keeping a much larger reserve of mobile space than Bangkok. The choice between these two strategies is a crucial one for developing mega-cities.

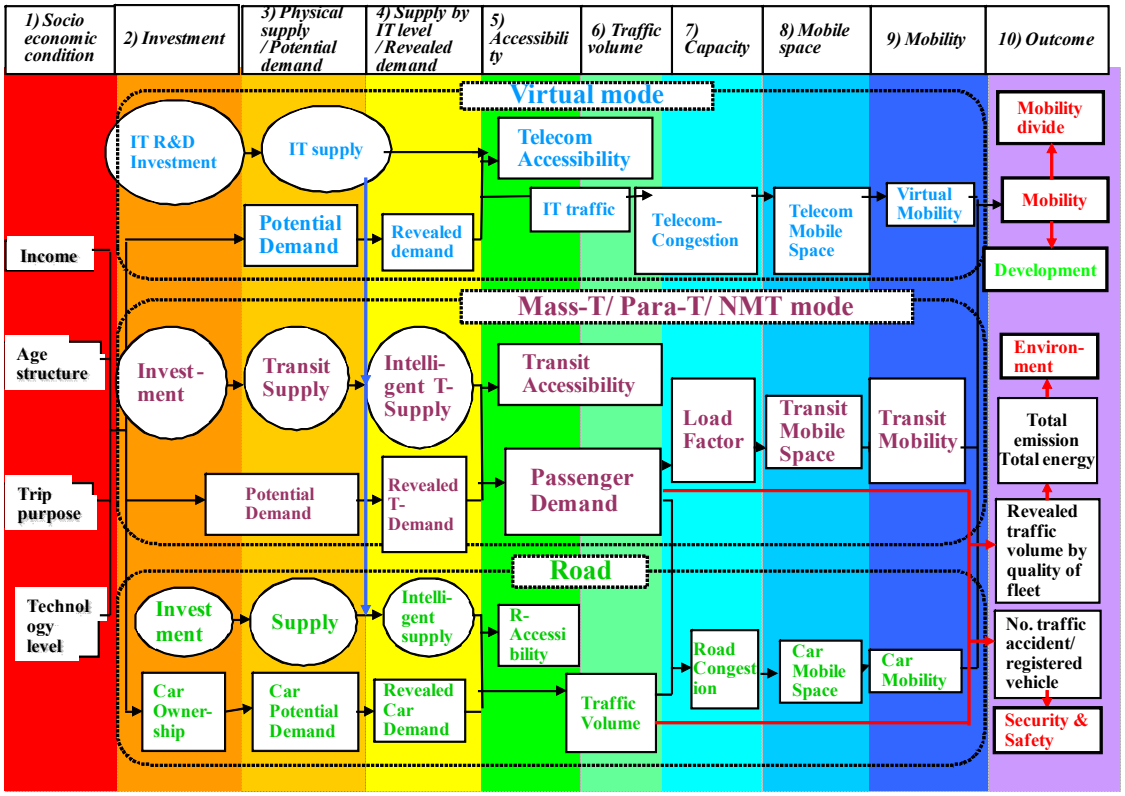


Figure 6.4: Mechanisms influencing mobility between road, public/para-transit and IT

The problem of which mode of transport to choose in a given situation can be clarified with the help of Figure 6.5, which shows how to work out the best mode for priority improvement. More concretely, the question to ask is which policy, A or B, will be more effective for relieving congestion on an existing road. Policy A is to directly invest in increasing the road's capacity from SR01 to SR02, by some means such as road widening or constructing a parallel new artery, etc. This reduces the travel time from tR01 to tR02.

Alternatively, under Policy B, the same amount of budget is invested in adding track to the railway parallel to the road, increasing its capacity from SRA1 to SRA2. This allows the railway to increase its passenger volume from VRA1 to VRA2. If the equivalent increase in passenger volume can actually be attracted to the railway, the demand on the road will be reduced from DRO1 to DRO2, allowing a reduction in travel time from tRO1 to tRO2.

It may seem paradoxical that the reduction in congestion on a different alternative mode, namely the railway, should have a greater effect for the relief of road congestion than a direct investment on the road would have done, but in fact it is not a paradox at all but plain common sense. It is simply that the marginal cost in raising the capacity of the railway to carry one more passenger is lower, under a

sufficiently enough pressure of demand. The steeper the demand curve, the greater the effect that can be expected.

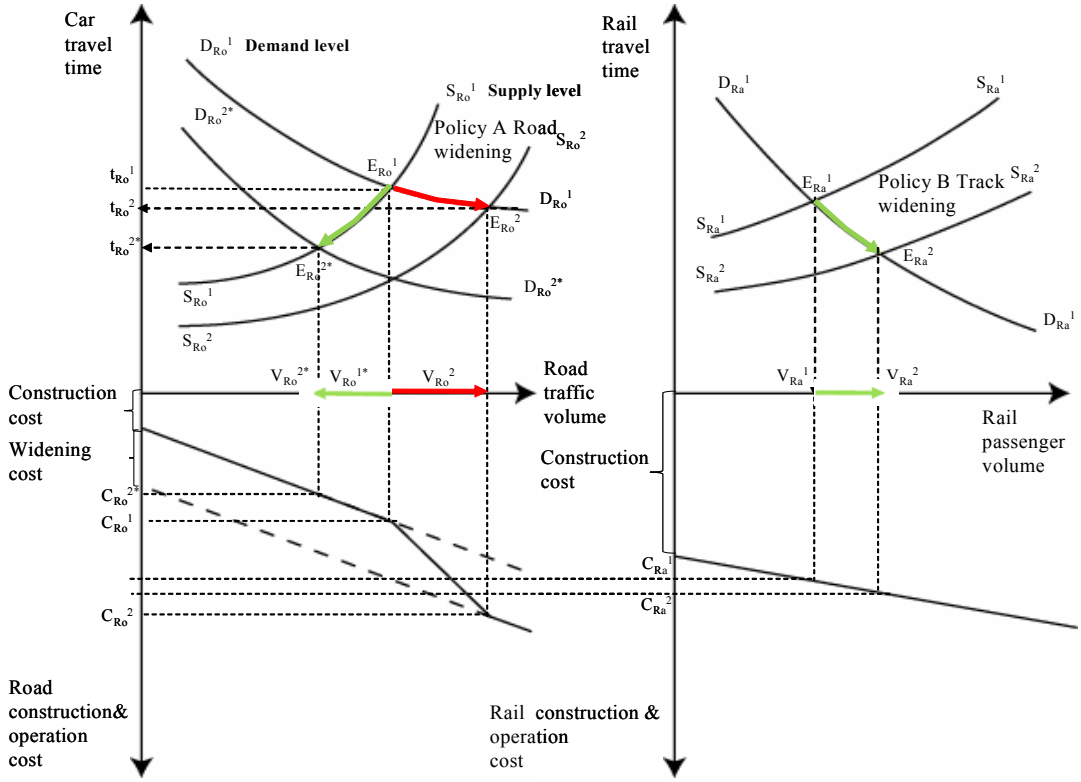


Figure 6.5: Theoretical basis for choosing the more effective mode for investing in

The effect will not always be achieved in a matured city where the demand pressure is less high and the demand curve correspondingly less steep. But under conditions of high demand in an area such as a developing mega-city, we can be confident that most passengers will shift because that is the only way they have of achieving a smooth ride.

The figure also shows that the incremental amounts of investment needed for increasing capacity on the railway (CRA2-CRA1) and on the road (CRO2-CRO1) can be compared, provided we estimate the cost curves in advance.

And it does make sense to use indicators and do sums in this way to judge the right balance of investment between roads and railways. In Bangalore, it will then probably work out reasonable to construct railways parallel to the main highways between the city center and suburban townships, to absorb the worst of the congestion. This will also be a useful way of ensuring that a certain capacity is left over for heavy duty trucks engaged in industrial activities.

7. CONCLUDING REMARKS

7.1 Recommended Strategies for a Better Integrated Land Use Transport System

Considering present conditions in Bangalore, the following main strategies are recommended:

a) Promotion of a balanced polycentric urban structure, with a linked ring of new suburban townships based on automobile and IT industries, preserving green belts between the city center and the suburban satellites.
b) A complementary dual system of railways and roads between the city center and the satellites, while a dual system of para-transit vehicles and small transport firms can be expected to emerge and develop in the city center and surrounding areas.

7.2 Recommended Policy and Technological Instruments

To promote these main strategies, the following instruments are recommended:

1) Financing of transit systems

- Value capture is a suitable financing system in a growing economy.
- A special account should be secured through vehicle and fuel tax revenues to cope with the future increasing demand for road transport.
- A fiscal fund from post office savings would be a useful source from which to stabilize the budget for infrastructure improvement from one year to the next. This was a key hidden instrument used by Japan avoid serious development bottlenecks.
- Green taxes on fuel and vehicle registration would be a way of encouraging people to buy low-emission vehicles.

2) Compact city space through Transit Oriented Development (TOD)

- To minimize future the maintenance costs of infrastructure, it would be wise to minimize the extent of built-up areas and to introduce a preferential inhabitant tax proportionate to per household public expenditure in small districts.

3) Accustoming citizens to the use of railways

- It is essential that citizens should come to regard it as common sense to use railways as the most eco-efficient means of transport. Railway services must be made reliably available and should be superior to car transport in the suburbs.

4) Intelligent integrated transport systems

- As Bangalore has one of the strongest concentrations of IT industries in the world, it ought to be possible to develop innovative IT support systems for integrated transport, including the future subway and BRT as well as para-transit.

5) Seamless and hierarchically integrated public/para-transport

- An integrated transport system like the one traditionally associated with Manila is ideal. The Manila system is a seamless, hierarchically integrated system of public transport (LRT, buses) and para-transit (jeepneys, tricycles, paddy-cabs, etc.). Western consultants have long maintained that this is a bad system. But the system as such is perfect. What have been the problems with it are the low-quality engines and fuel of the para-transits and the road manners of the drivers who disrupt other traffic by weaving abruptly across to stop at the roadside for potential passengers.

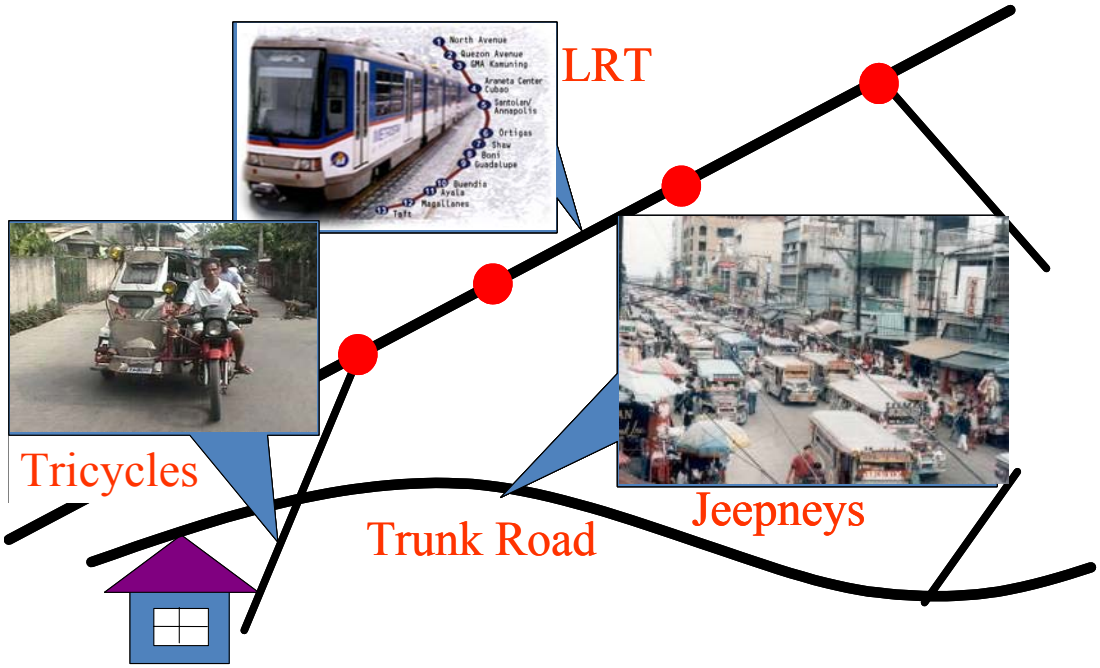


Figure 7.1: Hierarchical transport system in Manila

6) Enhancement of mobility

- It is important to develop transport systems in ways that preserve mobile space on roads.
- Problems should be solved by thinking in terms of "Factor 4," that is to say, conversions should be made four times more efficient by doubling people's affluence while reducing consumption of natural resources by half (Weizsaecker *et al.*, 1997).

7.3 The Roles of Each Stakeholder

To make optimal use of these instruments to achieve better mobility, technological and policy improvements are required as shown in Figure 7.2 in the four strategic areas of "Accessibility," "congestion," "comfort," and "uncertainty." The instruments suited for achieving the improvements in each area, and the stakeholders in the best position for seeing this done, would be as follows:

1) Accessibility, to be increased through:

＊ provision of a road and rail infrastructure by the government

＊ provision of vehicles and services by transport operators

2) Congestion, to be reduced through:

＊ land use management by the government

＊ Intelligent Transport Systems (ITS) and Traffic Demand Management (TDM) by the government and the automobile industry in collaboration

3) Comfort, to be increased through:

＊ better quality automobiles and rolling stock developed by manufacturers

＊ higher quality fuel developed by the automobile and fuel industries

＊ a system of green taxation devised by the government

＊ seamless public transport systems and smart cards devised by IT firms and public transport operators.

4) Uncertainty, to be reduced through:

＊ public and para-transport systems incorporating IT refinements, developed by the IT and automobile industries in collaboration with the government

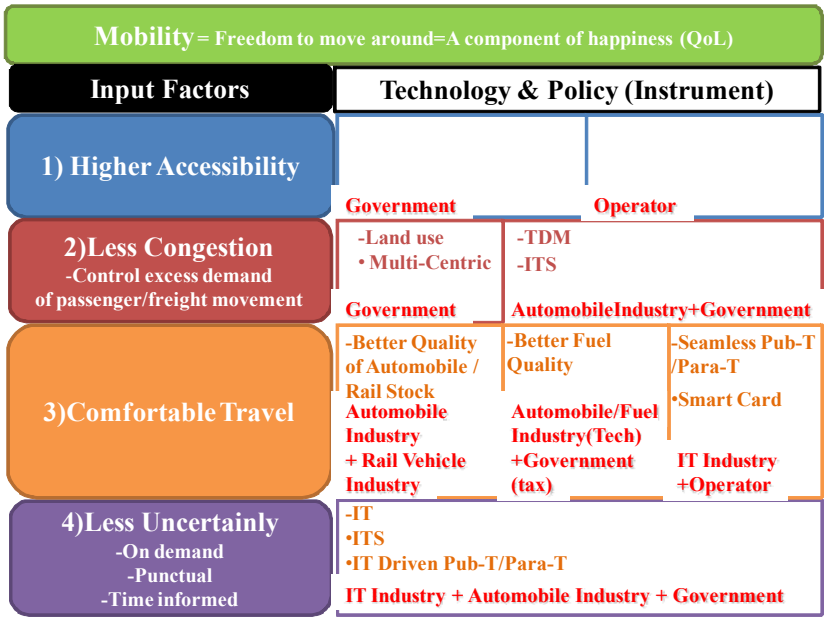


Figure 7.2: Roles of stakeholders in achieving better mobility

The citizens' role in this would be that of watching over the government and the industries, and of making wise choices for a transport system that places less of a burden on the environment and less of a cost on society. To facilitate this, the government should change the rules for vehicle taxes and regulations etc., to reflect citizens' choices and ultimately encourage the private sector to move in the direction of maximizing social benefits while minimizing negative effects. The "greening" of vehicle purchases and ownership taxes in Japan was a classic example of this kind of practice in operation. The base for taxation was changed from the engine size to the emissions level. As a result, consumers' preference quickly changed to low-emission vehicles. This also pushed automobile manufacturers toward developing better quality engines and has contributed to a drastic reduction in pollutants and greenhouse gases without any direct government subsidies to the automobile industry. It is very important that the government should take positive actions in this way to move the market toward an environmentally friendly and low cost society.

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BIBLIOGRAPHY

Agenor, P. and Montiel, P. (1996) *Development Macroeconomics*, Princeton University Press, Princeton.

Alpkokin, P., Black, J., Kato, H., and Hayashi, Y. (2007) 'Poly-centric employment formation in mega-cities: Analysis from APEC-TR collaborative research', *International Conference of Eastern Asia Society for Transport Studies*, 7.

Astorp, A. (1996) *The Urban Travel Behavior and Constraints of Low Income Household and Females in Pune, India*

Bangalore Development Authority (BDA) (2007) *Revised Master Plan - 2015*, *Vision Document*, Volume 1, Bangalore.

Bangalore Development Authority (BDA) (2007) *Revised Master Plan - 2015*, *Vision Document*, Volume 3, Bangalore.

Banister, D., Dominic, S., Steen, P. and Akerman, J. (2000) *European Transport Policy and Sustainable Mobility*, Publisher: Spon, US.

Barat, J. (1990) 'Institutional frameworks for planning transport' in Dimiriou, H.T. (ed) *Transport Planning for Third World Cities*, Routledge, London.

Benjamin, S. (2000). 'Governance, economic setting and poverty in Bangalore', *Environment and Urbanization*, Vol 12, No.1, 35-56.

Bunge, M. (1975) 'What is a quality of life indicator?', *Social Indicators Research*, 2(1), p. 65.

Chan, M.A., Jhabvala, R. and Lund, F. (2001) 'Paper prepared for ILO Task Force on informal economy', *Supporting Workers in Informal Economy: A Policy Framework*, available at http://www.wiego.org/papers/policypaper.pdf accessed on Oct 9.

'Crimes in mega cities' http://ncrb.nic.in/crime2004/cii-2004/CHAP2.pdf

Central Road Research Institute (1999). *Traffic and transportation: Improvement priorities for road corridors in Bangalore*. Karnataka Urban Infrastructure Development and Finance Corporation. Final

Report, New Delhi.

Central Road Research Institute (CRRI, 2003). *Urban Road Traffic and Air Pollution*, New Delhi.

Deichmann, U. and Lall, S.V. (2007) 'Citizen feedback and delivery of urban services', *World Development*, 35 (4), pp. 649-662.

Dick, H.W. and Rimmer, P.J. (1998) 'Beyond the third world city: The new urban geography of South-east Asia', *Urban Studies*, 32 (12), pp. 2300-2321.

Eck, J.R.V., Burghouwt, G.. and Dijst, M. (2005) 'Lifestyles, spatial configurations and quality of life in daily travel: An explorative simulation study', *Journal of Transport Geography*, 13, pp.123-134.

Freestone, R. (2000) *Urban Planning in a Changing World*, R and FN Spon, USA.

Government of Karnataka (2005) *Environmental Impact Analysis,* Bangalore Metropolitan Rapid Transport Corporation, Bangalore.

Gururaj, G. (2005) *Road traffic injury prevention in India*.

Hall, P. (1992) *Urban and Regional Plan*ning, Third Edition, Routledge, London.

Hall, P., Stanley D., Brunn, J., Williams, F. and Zeigler, D. J. (2003) *Cities of the World Regional Urban Development*, Rowman Littlefield Publishers, USA.

Hall, P. and Pfeiffer, U. (2000) *Urban Future 21: A Global Agenda for Twenty First Century Cities*, R and FN Spon, London.

Hayashi, Y. and I. Sugiyama (2003) Dual Strategies for the Environment and Financial Goals of Sustainable Cities; De-Suburbanization and Social Capitalization, Special Issue "The Sustainable City: Transport and Spatial Development", Vol.29, No.1, Built Environment, pp. 8-15.

Handy, Susan (2002) Accessibility vs. Mobility – Enhancing Strategies for Adding Automobile Dependence in the US, ECMT Round Table Report.

Hayashi, Y., Suparat, R., Mackett, R., Doi, K., Tomita, Y., Nakazawa, N., Kato, H. and Anurak, K. (1994) 'Urbanization, motorization and the environment nexus- an international comparative study of London,

Tokyo, Nagoya, Bangkok', *Memoires of the School of Engineering Nagoya University*, 46, pp. 55-98.

Informal Sector in India, Approaches for Social Security, available at http://labour.nic.in/ss/INFORMALSECTORININDIA-ApproachesforSocialSecurity.pdf

Jawaharlal Nehru National Urban Renewal Mission (JNNURM) (2006) *City Development Plan for Bangalore*, available at http://jnnurm.nic.in/toolkit/Bangalore.htm

Kachi, N., Kato, H. and Y. Hayashi (2007) A Computable Model for Optimizing Residential Relocation based on Quality of Life and Social Cost in Built-up Areas, *Proceedings of the 7th International Conference of the Eastern Asia Society for Transportation Studies*, Dalian Maritime University, Dalian, China (CD-ROM).

Maclaren, V. W. (1996) 'Urban Sustainability Reporting', *Journal of American Planning Association,* 62 (2), pp. 184-202.

Meadows, D. H., Meadows, D.L., Randers, J. and Behrens III, W.W. (1972) *Perspectives, Problems and Models*, Universe Books, New York.

Myers, D. (1998) 'Building knowledge about quality of life for urban planning', *APA Journal*, pp.347-359.

Nakamura, H., Hayashi, Y. and May, A.D. (2004) *Urban Transport and the Environment: An International Perspective. World Conference on Transport Research Society and Institute for Transport Policy Studies*, Elsevier, Amsterdam.

Newman, P. and Kenworthy, J. (1999) *Sustainable Cities: Overcoming Automobile Dependence*, DC: Island Press, Washington.

OECD (2002) *OECD Guidelines towards Environmentally Sustainable Transport*, OECD Publishing.

Richardson, H. W. (1993) 'Problems of metropolitan management in Asia' in Cheema, G.S. (ed) *Urban Management: Policies and Innovations in Developing Countries*, Preager Publishers, USA.

Rodgers, L. W. (1977) 'Work status and the quality of life', *Social Indicators Research*, 4(3), p. 267.

Ross, W. (2000). "Mobility and Accessibility: The yin and yang of planning" *World Transport Policy and*

Practice, Vol 6, No.2, pp13-19.

Shaw, A. and Satish, M.K. (2007) 'Metropolitan Restructuring in Post-liberalized India: Separating the global and the local', *Cities*, 24 (2), pp.148-163.

Smith, T., Nelischer, M. and Perkins, N. (1997) 'Quality of urban community: A framework for understanding the relationship between quality and physical form', *Landscape and Urban Planning*, 39, pp.229-241.

Sudhira, H.S. (2007) 'City profile of Bangalore', *Cities* 24 (5), pp. 379-390.

The Energy and Resource Institute TERI, (2007) *Mobility for Development - A Case Study of Bangalore*, Draft Report, Delhi.

The Hindu (2006) 'Travel time has increased around St Mark's Road' http://www.hinduonnet.com/2006/01/11/stories/2006011119750300.htm, online edition, Jan 11.

The Hindu (2007) "The noise is more than you can bear" http://www.hindu.com/2007/07/09/stories/2007070951010300.htm, online edition, July 9.

Tiwari, G. (2003) 'Transport and land use policies in Delhi', *Bulletin of the World Health Organization*, 81(6), pp.444-450.

United Nations Population Division (2002) *United Nations World Urbanization Prospects: 2001 Revision*, available at http://www.un.org/esa/population/publications/wup2001/wup2001dh.pdf

Veenhoven, R. (1996) 'Happy-life expectancy – A comprehensive measure of quality of life in nations', *Social Indicators Research*, 39, pp.1- 58.

von Weizsäcker, Ernst. Ulrich.; Amory. B Lovins,. L. Hunter.Lovins (1997). Factor Four. Doubling Wealth - Halving Resource Use, Earthscan, London.

Wheeler S.M. and Beatley, T. (2004) *The Sustainable Urban Development Reader*, Routledge, New York.

Widgery, R.N. (1982) 'Satisfaction with the quality of urban life: A predictive model', *American Journal of Community Psychology*, 10(1), pp.37.

Wish, N.B.(1986). 'Are we really measuring quality of life? Well being has subjective dimensions, as well as objective ones', *American Journal of Economics and Sociology*, 45 (1), pp.93-99.

WHO-Quality of life Group (1993) 'The importance of including quality of life indices in international social and economic development activities' in Marsella, A.J., Levi, L., Ekblad, S. (eds) *Appl. Prev. Psychol.* 6(2), SPR .