

# **MOBILITY AND SUSTAINABILITY IN DEVELOPING COUNTRIES: BANGALORE CASE STUDY**

*Pelin Alpkokin, Assistant Professor, Faculty of Civil Engineering, Istanbul Technical University, Turkey*

*Hirokazu Kato, Associate Professor, Graduate School of Environmental Studies, Nagoya University, Japan*

*Yoshitsugu Hayashi, Professor, Graduate School of Environmental Studies, Nagoya University, Japan*

## **1. INTRODUCTION**

Mobility is one essential condition for economic and social development. However, one of the most crucial issues today is whether, and how well, less developed and developing countries and regions can make good use of the merits of mobility while overcoming or minimizing its drawbacks. 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. 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. 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. 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, economy and environment within the context of sustainability (for example, see, Annema et al., 1999 for a method for evaluating and ranking the public investments by their economic, social and ecological impacts).

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 transport (for example, see, Wheeler and Beatley, 2004 for an extensive review of the historical development of 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.

For example, Maclaren (1996) 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 (Hall and Pfeiffer, 2000). It is particularly crucial in developing countries to provide the decision-makers with guidelines for the design of future urban development 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.

It was with these problems in mind that the World Business Council for Sustainable Development (WBCSD) launched a new project entitled Mobility for Development (M4D) in 2006, 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. Under this project, Bangalore, the case area of India, was examined in a research project funded by Toyota Motors Corporation and conducted by our team at Graduate School of Environmental Studies of Nagoya University.

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. 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 this paper, we summarize some important findings of this report. We first outline our understanding of sustainable mobility through its associated key definitions such as accessibility, mobility divide and QoL and then suggest a triangular framework for the evaluation of mobility for sustainable development. Our framework is in the similar context to the one European Union has earlier implemented. It consists of three pillars of sustainability, the so called three Es of Economy, Environment and Equity and represents the broadest orientations of sustainable development policy goals. However it is unique in its applicability to the developing countries and its focus on social dimensions in these countries through employing QoL as a key indicator to represent the individual perceptions, and to interpret the degree and extent of equity in the context of social sustainability and urban planning. Because, 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 and one way to

pursue this is through the idea of QoL which was a concept first born in the 1960s (see, WHO-Quality of life Group, 1993).

In our assessment of QoL, we propose a structural set of input indicators classified under accessibility, amenity and safety & security (or social hazard). The changes in the QoL indicators over the whole city area and among different socio-economic groups provide an indication of the degree of spatial and social equity. In this context, we designed a survey to allow comparison of the different weights of importance placed on different indicators by different socio-economic groups. This survey, which was completed in September, 2007, was based on a modest sample of 215 respondents. In the light of results from this small-scale survey, we interpret local people's perceptions of relevant components of QoL from a mobility and urban development perspective.

We have initiated and completed the work on Bangalore case summarized in this paper, hoping that our broader framework and application of QoL approach for social dimension of sustainable policy aims in urban studies will lead a way to more applications of better mobility evaluations especially in developing countries. In section 2, we start with reviewing the sustainability and mobility, with the associated key definitions and introduce a framework for the evaluation of mobility for sustainable development. Section 3 defines the QoL approach and designs the survey sheet and section 4 presents the discussion of QoL survey results for the Bangalore case and finally section 5 makes concluding remarks.

## **2. MOBILITY AND SUSTAINABILITY: A POLICY CHALLENGE**

Mobility is a widely acknowledged concept in the service of social and economic development in urban and regional planning. 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 (2002) defines it more particularly in association with accessibility which is potential for movement, ability to get from one place to another and ability to move around. The OECD emphasizes the inclusion of the environmental sustainability (OECD, 2002) and the European Union also seeks for sustainable mobility at the European level (for example, Banister et al., 2000 looks at sustainable mobility issues at the European level transport policies).

Although the advanced countries and regions have managed to utilize the advantages of mobility while overcoming and minimizing its drawbacks, 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 framework in which to explore ways of facilitating mobility and setting relevant indicators such as the mobility divide under sustainable conditions.

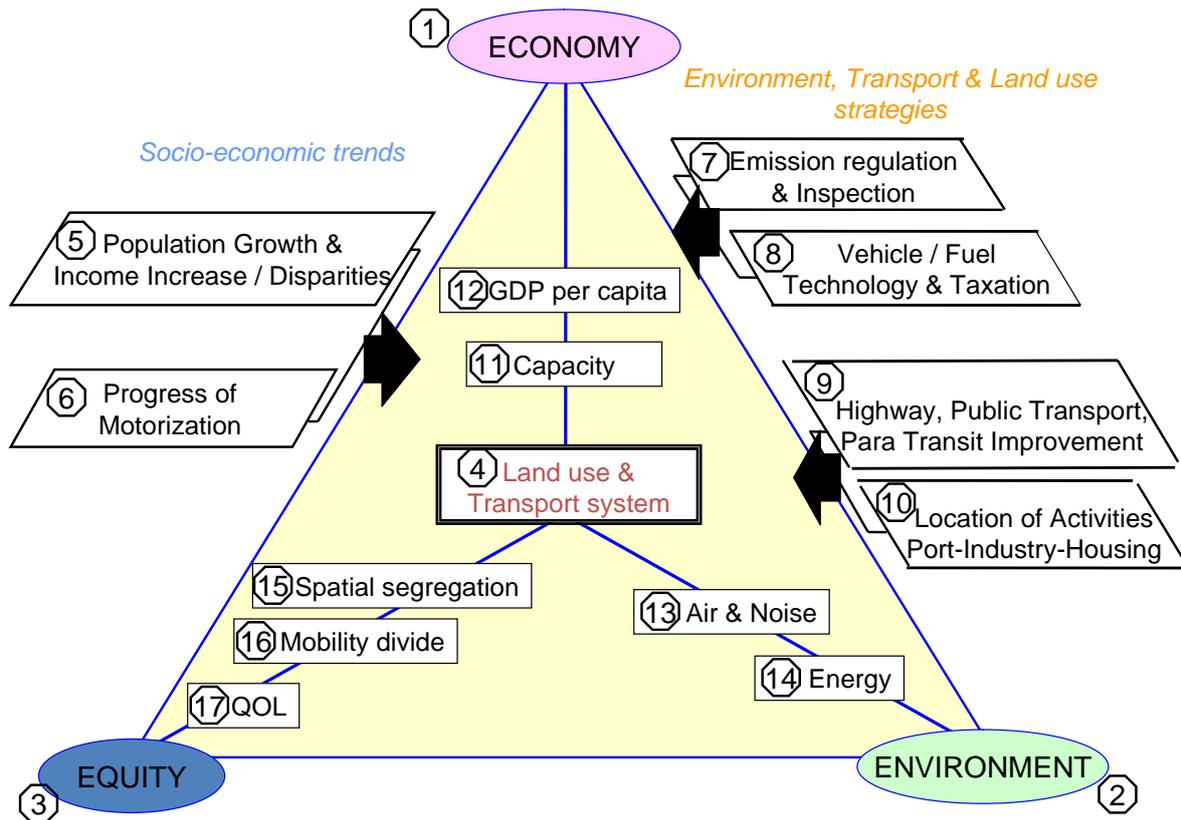
## **2.1 Mobility Divide**

Before proceeding to describe the proposed framework for sustainable mobility, we will first explain our way of understanding the mobility divide which 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. Therefore, mobility divide is an important policy measure that should necessarily be contained in the policy aims and policy evaluations especially in the developing or less developed countries.

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.

## **2.2 Framework to evaluate mobility for sustainable development**

In practice, mobility has been 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. 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 (Wegener and Fürst, 1999). Therefore, we suggest 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. Similar to the European approach, we set up three pillars representing Economy, Environment and Equity, as shown in figure 1 and they represent the broadest orientations of main policy goals.



**Figure 1: Triangular framework to evaluate mobility and sustainability**

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). Accessibility or access to variety of urban amenities is the determinant factor for mobility and therefore should be well combined with mobility enhancement policies (Geurs, 2006).

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. 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. 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 by better utilization of existing system through applications of management or transportation demand management

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 of the environmental policies in the 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 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”.*

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. 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. In this context, 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 and already discussed in the previous sub-section.

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. 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 components and integrating them into a definition of QoL set in the context of urban planning. These components are selected to represent QoL taking into account of both common and case specific evaluative measures and are utilized to discuss the positive and negative effects of implementing various policies for the enhancement of mobility. When mobility is enhanced, each of these components may increase or decrease. As a result of mutual trade-offs among the components, the value of QoL will then change, supplying an answer to the question of whether this particular way of mobility enhancement has been beneficial or not overall in terms of social development and social equity aims in urban policy designs.

### **3. QOL AND EQUITY FOR SUSTAINABLE MOBILITY**

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

*“In individual 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 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).

#### **3.1 QoL as a measure of sustainable mobility**

As 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. The two main contexts of equity dealt with in the research project on Bangalore is, 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 (Preston and Rajé 2007). Social segregation and inequity are longstanding issues in the social sciences, and urban planning as a discipline needs to incorporate a description of people living conditions if it is ever to succeed in minimizing the socio-economic gaps in a society. 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.

With this in mind, we have 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. Taking both positive and negative effects into account, we have developed a QoL indicator consisting of the three components of accessibility, amenity, and safety & security (social hazard). 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.

In this interpretation, the feedback on citizens' perceptions of their own needs and desires is bound to provide assistance to urban planners concerned with equity matters (Deichmann and Lall, 2007). For this, a QoL survey as suggested and conducted in Bangalore, which investigates citizens' satisfaction with their socio-economic situations with regard to urban land use and transport development will make an effective input for policy design and evaluation.

### **3.2 Bangalore Case**

In our judgment, 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 for four main reasons.

Firstly, the population has grown rapidly due to natural increase and immigration. Between 1981 and 2001, natural increase and immigration accounted respectively for 22% and 45% of the total increase. The United Nations included Bangalore among the 30 largest world agglomerations in 2015, ranking 29<sup>th</sup> after three other Indian cities: Mumbai 3<sup>rd</sup>, Delhi 5<sup>th</sup> and Kolkata 9<sup>th</sup>.<sup>1</sup>

Secondly, high-technology industries within the global economy have been the growth engine of the local Bangalore economy and one of the driving forces of urbanization, with a rapid emergence of information technology and of industries based on it (Hall et al., 2003; and Shaw 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).

Thirdly, all growing metropolises, whether in developing or developed countries, sooner or later have to face the problem of spatial re-organization (Richardson, 1993; and Dick and Rimmer, 1998). At present, Bangalore is at the stage of extending in all directions: departing from the classical mono-centric 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

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<sup>1</sup> United Nations World Urbanization Prospects: 2001 Revision (2002).

the city core is overloaded and cannot accommodate new schemes. The Bangalore Metropolitan Regional Development Authority (BMRDA) 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.

Fourthly, although Bangalore 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. 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). Therefore, a good deal of attention should be 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.

### **3.3 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 (for example, see, Widgery, 1982). 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.

As noted above, we found it appropriate to categorize QoL on three components. In considering the feasibility of a survey and the extent to which it can properly be analyzed through three components of accessibility, amenity, and safety & security, each can be assessed by four indicator features. These features were initially specified based on a QoL survey conducted in Japan (Kachi et al., 2005) but then revised to reflect the specific issues in Bangalore after our two field inspection trips to Bangalore mainly made to discuss on the urbanization problems with senior urban planners representing important governmental and nongovernmental organizations.

Accessibility is considered either in terms of highway provision or of a public transport network and measured by the trip time (access from home to work, and access to education, health and shopping facilities). This is also closely linked to the number and equally distribution of urban facilities and job opportunities as through a control of spatial development, it is possible to enhance mobility and increase efficient access to basic urban facilities. The second parameter is for the basic amenity needs that should necessarily be provided in an urban life (water and power supply, sanitation and green parks). Finally urban safety & security can be defined as the protection of individual citizens from social hazard or social disruption (air and noise pollution, traffic accidents, and risks of crime).

With regard to understanding 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 2).

Quality of Life is determined by:	Quality of Life depends on:
<p>1. <b>Accessibility</b></p> <ul style="list-style-type: none"> <li>Travel time to work</li> <li>Travel time to education</li> <li>Travel time to health services</li> <li>Travel time to commercial centers</li> </ul>	<p>1. <b>Gender</b></p> <ul style="list-style-type: none"> <li>Male</li> <li>Female</li> </ul>
<p>2. <b>Amenity</b></p> <ul style="list-style-type: none"> <li>Water supply</li> <li>Power supply</li> <li>Sanitation</li> <li>Availability of parks/ green spaces</li> </ul>	<p>2. <b>Age Group</b></p> <ul style="list-style-type: none"> <li>20-29 yrs</li> <li>30-39 yrs</li> <li>40-59 yrs</li> </ul>
<p>3. <b>Safety and Security (Social hazard)</b></p> <ul style="list-style-type: none"> <li>Crime rate</li> <li>Accident rate</li> <li>Air pollution</li> <li>Noise pollution</li> </ul>	<p>3. <b>Occupation</b></p> <ul style="list-style-type: none"> <li>Self employed</li> <li>Employees</li> <li>Students</li> </ul>
	<p>4. <b>Family Income</b></p> <ul style="list-style-type: none"> <li>&lt; 10,000 Rupees</li> <li>10,000 – 30,000 Rupees</li> <li>&gt; 30,000 Rupees</li> </ul>
	<p>5. <b>Ownership of private vehicles</b></p> <ul style="list-style-type: none"> <li>Personal vehicle owners</li> <li>Non vehicle owners</li> </ul>

**Figure 2: QoL components and socio-economic indicator features**

As already mentioned, 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 and is closely linked to the sustainability aims (Bertolini et al., 2005). 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 shopping (or 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 (social hazard) 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 which is already acknowledged as one of the most severe issues in almost all cases of the large cities of Third World countries.

### **3.4 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 and income 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 Rs. a month), 129 in the middle group (10,000-30,000 Rs.), and 22 in the higher group (over 30,000 Rs.). 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.

## **4. RESULTS AND DISCUSSIONS**

One of the project aims of Bangalore case study was to analytically examine the individual QoL perceptions in connection with the urban planning and development. Our literature review has identified that there are hardly any analytical work that has explored the relation between urban policy-making and QoL in developing countries through conducting surveys which provides citizens' feedback on urban problems. Sub-sections 4.1 to 4.4 present the results of the above survey, on a simple statistical assessment where the focus relies on accessibility and mobility connected safety and security issues among the other components, and for different socio-economic profiles mainly grouped by income, occupation and vehicle ownership (car or two-wheelers). We do not provide here any modeling work with parameter estimation but rather prefer to discuss the current state of urbanization problems in Bangalore based on the results of this social perception survey.

### **4.1 Impact of income disparity on mode choices**

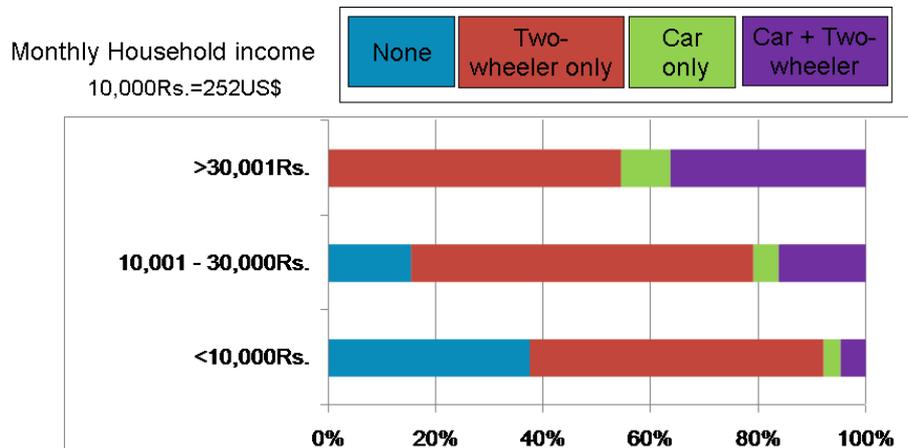
Figure 3 summarizes the results of the survey for the groups of car and two-wheeler owners and across the income groups. Obviously, car ownership is found to be high for higher income groups and low for lower income groups. In one of the recent studies for Bangalore, the average incomes for the use of different transport modes were reported as US\$ 620 for public transport users, US\$ 1320 for two-wheeler users, and US\$ 2170 for car owners indicating clear income gaps between the any type of private vehicle owners and non-owners. In our survey we have found out that around 40% of the lowest income group (less than 10,000 Rs. monthly income per household) does not own any type of private vehicle and mainly depends on public transport. However, 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, which would mean a very wide gap in social equity for mobility and accessibility for such group of people. In other words, the ability to afford different means of transport is the leading cause of the mobility divide.

The graph clearly shows that 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. Individual trips on two-wheelers together with buses dominate the daily travel in Bangalore, as in many other cities in developing countries (the mode shares of motorcycles and buses are 30 % and 42 %, respectively). In a recent report, traffic loads on the major roads of the three cities were estimated and the second highest VKT (vehicle kilometer travelled) load in India was found to be in Bangalore at almost 33 million per day where the share of two-wheelers was predominantly the highest producing 62 % of the total kilometers (the share of cars/ jeeps/ vans is yet 16 %)². The lack of efficient public transport modes has led to a sharp

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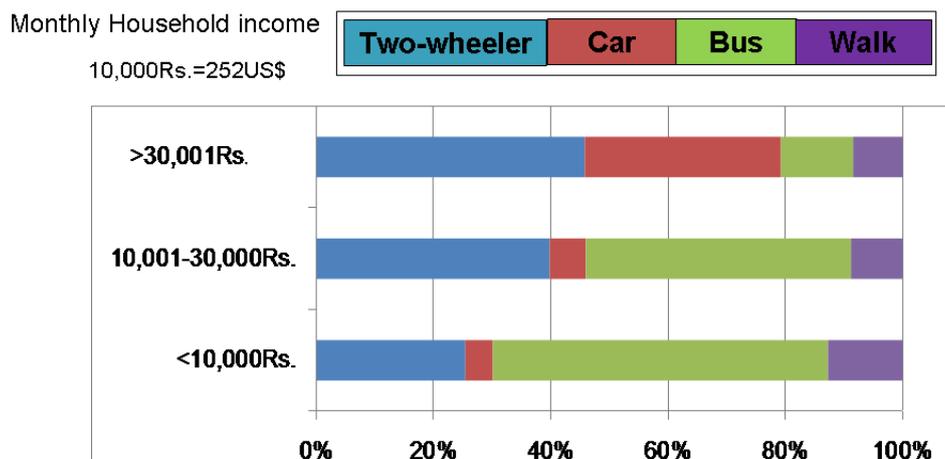
² Central Road Research Institute (CRRI, 2003). Urban Road Traffic and Air Pollution, New Delhi.

increase in the number of personal vehicles, especially two-wheelers, which constitute about 74% of registered motor vehicles (250 two-wheelers per 1000 inhabitants). 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 unless public transport network is developed efficiently.



**Figure 3: Income groups and personal vehicle ownership**

Figure 4 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. Bangalore also has a predominantly road-based public transport system. Bangalore Metropolitan Transport Corporation (BMTC) currently transports 3.15 million passengers per day, representing 55,000 daily vehicle trips on 3800 bus routes.



**Figure 4: Income groups and mode choices for trips to work or school**

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 % (it is approximately

17 % for work and school trips), which is lower than expected (non-motorized trips constitute 35 % of the total trips in Delhi) due to the BMTC being one of the best operators in the country. However, a glaring imbalance still exists between the trip needs and the transportation modes and 10% of public transport trips have been lost to two-wheelers and cars over the past decade. Therefore, given an increase in income, former public transport users are easily and irrevocably encouraged to shift to private vehicles - two-wheelers or car. This may even be more observed in the case of suburban residents or workers unless the public network is developed in line with the extension of urban area (Prevedouros and Schofer, 1991).

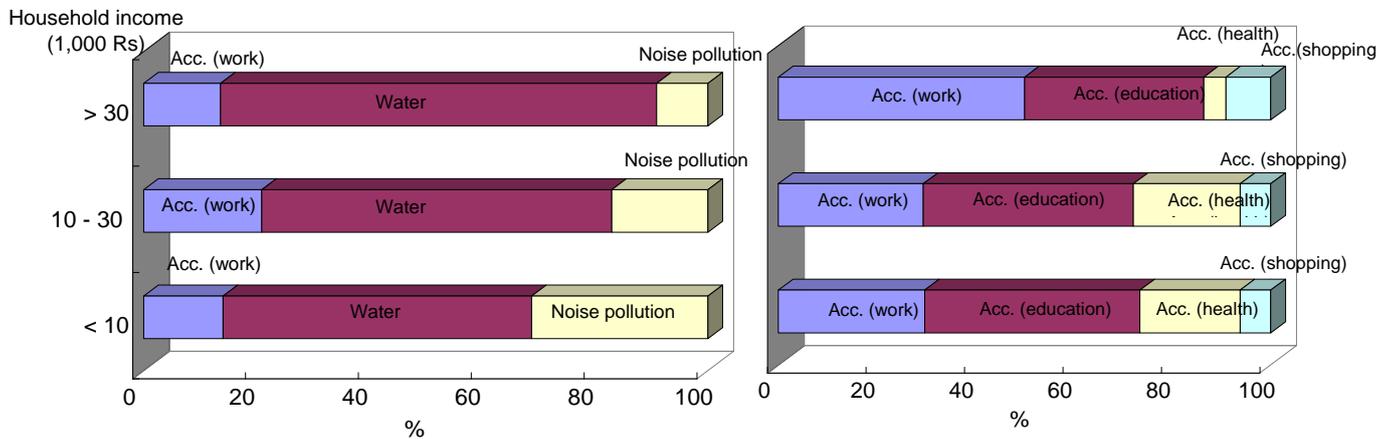
Based on our small sample, we have further computed the mode-specific trip times to consider the mobility bottlenecks in terms of average time spent by two-wheeler, car or bus to access to four destinations of work, school health facilities and shopping in our questionnaire. The journey times by privately owned vehicles did not vary with the type of the vehicle as it was 24 minutes for cars and 22 minutes for two-wheelers. However, the mean trip time of journeys by using the bus network was 43 minutes, as much as 85% higher than the mean trip time by total of cars and two-wheelers. This implies significant difference of mobility or demonstrates another extension of mobility divide between vehicle-owners and non owners despite the existence of an extensive bus network in the city. This is closely linked to the fact that 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.

#### **4.2 Accessibility needs and desires**

In one 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 work from accessibility, adequate water supply from amenity, and noise pollution from safety & security. Figure 5 (a) shows respondents' rankings of the three components of accessibility, amenity and safety & security for the three income groups. Irrespective of the level of income, 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. Almost 70 % of the Bangalore respondents belonging to the higher income class chose water as their first concern and the remainder split at 15% each between access to work and noise pollution. Regarding the other two components, middle income class gave a slightly higher priority to accessibility of work compared with the low and high income classes. Interestingly, the low income citizens rated the noise pollution the highest (by 25%) among the other income classes indicating that noise pollution generated from the transportation received more concern as a factor of QoL than the higher income earners.

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 detractors 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.



**Figure 5(a): Among water and noise pollution      Figure 5(b): Accessibility components**  
**Figure 5: Priorities for accessibility by income groups**

Figure 5 (b) presents the ranking of access to four main facilities (work, education, health and) by respondents of different income groups. In the group of high income earners, access to work means the same level of importance with the total of other three access issues questioned, whereas this drops to 1/4<sup>th</sup> of the total accessibility rates for the lower income earners. In addition, the high income earners did not perceive health facility access as an important QoL factor, whereas the low and middle income classes rated this component importantly in as much as that the ratio of perception for health facilities was 5 times higher than the ratio for high income class.

We have further investigated the accessibility perception among water supply and noise pollution indicators by discussing how it varied across the different occupations. We have found out that company employees attached less value to accessibility issues in comparison with the self employed and student classes. This is mainly attributable to the better level of service provided by the company busses. The emergence of large IT sub-centers (i.e. Whitefield) which have failed to develop mixed land use and to provide affordable housing, the employees of the industrial works and information technology firms have chosen to live in distant neighborhoods and commute around 25 km a day. In Whitefield, 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.

In paying attention to the relation between the vehicle possession and the awareness on accessibility problems, this time the rates of access to shopping facilities were grouped among the water supply and noise pollution for any type of vehicle owners and non-owners. Water supply again was recognized as the most crucial problem by both vehicle owners

(rated by 63 %) and non-owners (rated by 54 %). For the other two components, the ranking changed between the personal-vehicle owners and non-owners as those to whom a personal vehicle available ranked accessibility as the second important factor whereas the non owners chose noise pollution among the three components. This may be a reflection of the fact that private vehicle owners are more affected by the severe congestion problem in the city when they make their shopping trips by their personal vehicles. 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. The three-wheelers which make up the highest share of para-transit trips in Bangalore aggravate congestion by making frequent stops.

### **4.3 Mobility and safety & security relation**

In the perceptions about safety & security (social hazard), 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 6). As an approximate guide to the interpretation of for safety and security issues, the average of the survey results have revealed that mobility relevant such components which are accident, air and noise pollution relate to approximately 60% - higher than the 40% rate of crime - of the QoL recognition of the citizens. This emphasizes the importance of mobility improvement policies in urban planning where one of the important aims lies in securing social sustainability.

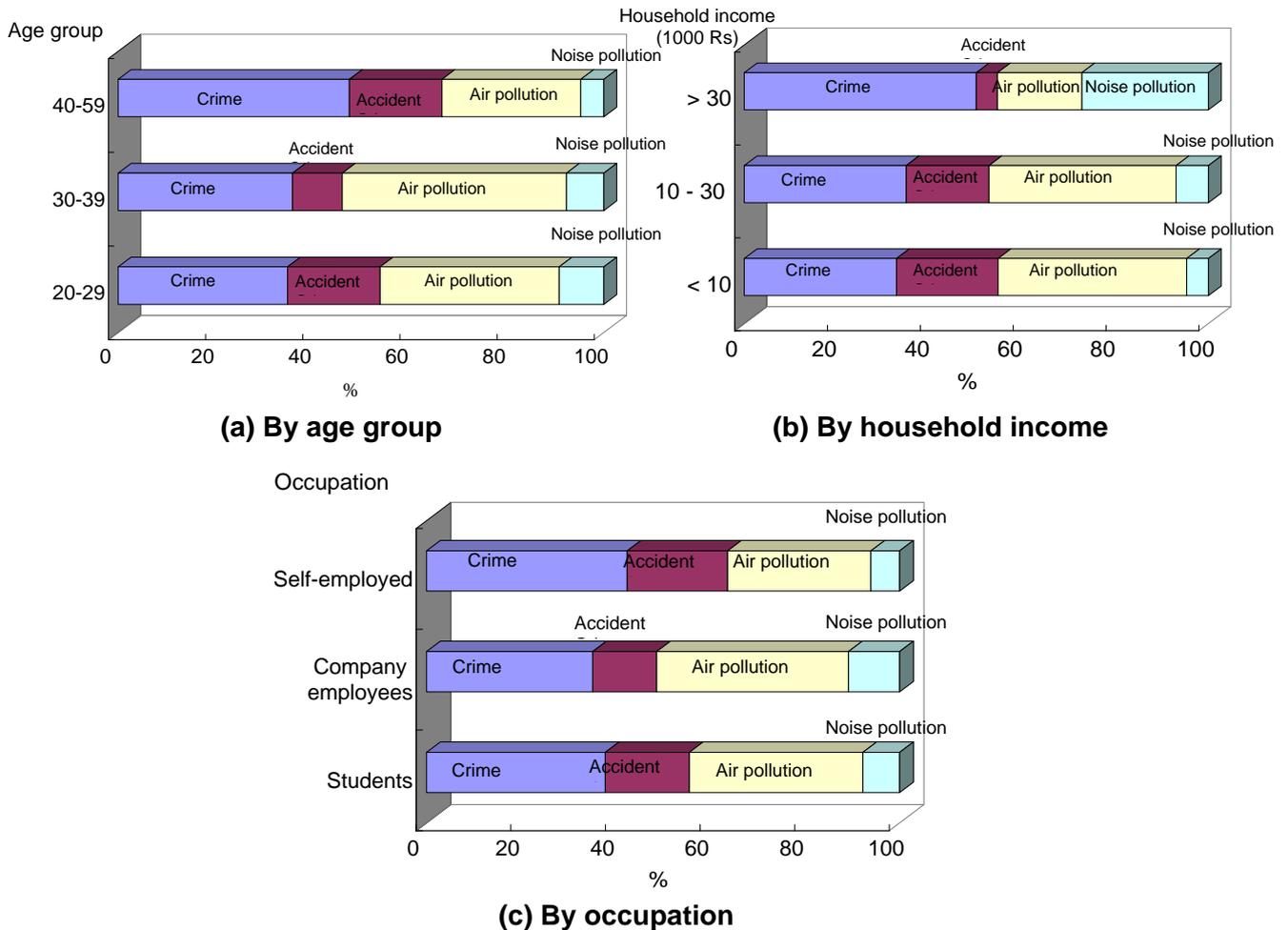
Regarding pollution, the ambient air quality around three busy intersections in Bangalore has been monitored against air quality indices for the period 1997 to 2005 (Shiva Nagendra et al., 2007), with results indicating 'good' to 'moderate' levels of SO<sub>2</sub> and NO<sub>x</sub> for most of the 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.<sup>3</sup>

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. As for accidents, road traffic injuries in India result in economic losses of 550 billion Rs., or nearly 3% of GDP, every year. In 2001, Bangalore ranked fifth worst for

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<sup>3</sup> The Hindu (2007) The noise is more than you can bear.

accidents amongst India's fourteen major cities with an estimated 13 deaths per 100,000 population.<sup>4</sup>



**Figure 6: Safety & security priority rates by different socio-economic profiles**

#### 4.5 Further results

Following the first set of questions about accessibility and safety and security rankings, the third part of the questionnaire similarly asked respondents to give priority ratings among four components in urban amenity categories. 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. 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.

The share of answers ranking the water supply first was 40 %, followed by power supply, at 37%. 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

<sup>4</sup> Gururaj, G. (2005) Road traffic injury prevention in India.

minimum required standard. Availability of green space was the item selected by fewest respondents although 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 a similar survey conducted in one of the Japanese cities, 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 developed countries and 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.

## **5. CONCLUSIONS**

Economic growth brings people to expect happiness. However in many cases it brings unhappiness to citizens through serious traffic congestion, wasted energy, air pollution and greenhouse gas emissions. Because, economic development inevitably leads to bottlenecks, social burdens and environmental problems as it is the case 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 such growing cities, it also generates an income disparity that leads to two pressing problems of urban inequity (social and spatial segregation) and mobility divide. 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.

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 mobility and suburbanization with an aim of sustainability. 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 wide spectrum of problems is particularly important in developing countries as congestion is very serious even at a much lower stage of motorization than in developed countries and the traffic is concentrated primarily in larger cities and is stimulated by rapid growth of population and incomes. Equity is the other dimension of the problems which comes out in the assessment of urban development and social sustainability. Income level disparity is very apparent between public transport and private vehicle users and poor public transport is already overcrowded that can not meet the needs of the growing and changing society. In the worst case, however, there is still a considerable size of the population that

can not access or afford public transport and mainly depends on slow modes of walking and cycling even for very long distances. Insufficiency of urban amenity facilities and spatially imbalanced distribution of basic urban facilities is another aspect of the equity problem that should necessarily be paid attention at the development stage of such growing cities.

In this context, one of the purposes of this paper was to discuss the spatial and transport planning concepts and tools through an established framework which would provide highlights for developing countries to progress towards their goals of developing into a sustainable prosperous community and the sort of society in which glaring social gaps in urban planning objectives can be closed. In developing countries, planning 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 and this calls for a significantly deeper and multidimensional attitude toward social design. 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 our case city.

Therefore, the other contribution of this paper would be to develop a definition of QoL consisting of twelve indicators that are of particular importance to an urban planner and to mobility related policy aims in growing cities. This QoL definition was used to design a questionnaire which was further adapted to a real case in order to investigate about the social dimension of urban development, especially mobility enhancement policies for which the overall mechanism was given in the proposed framework.

Our case area, Bangalore has a leading place among the other cities in India. 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. 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. 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. Taking account, also, of economic development forces and the plans for large-scale highway constructions and the automobile industry park, we may expect not only an increase in the total registered number of vehicles but also a shift from two-wheelers to automobiles or from public transport to any type of privately owned vehicles

The results of our small sized QoL survey constituted a basis to better discuss the urban problems in Bangalore with some evidence in line with the social sustainability issues. Here main scopes were the urban development and social equity issues which were raised in terms of attaining minimum social equity in mobility development which is closely connected to the spatial segregation and socio-economic stratification.

Additionally, the simple empirical analysis of the questionnaires of Bangalore provided answers to the general understanding of possible weights that could be attached to twelve

different QoL indicators linked to urban development by the citizens from a rapidly growing city in India, as such empirical evidence hardly exists for developing countries in the literature.

We would like to note that we did not present here any statistical modelling analysis on the survey results although the questionnaire was designed to allow parameter estimations through different methods, but we remained to discuss the results in a more policy sense. We strongly hope that this study will further trigger similar QoL surveys and application of a broader framework to evaluate sustainable mobility in different cases from the developing countries.

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