

## Challenges of urban transport in developing countries- a summary



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(This document has been compiled based on different sections from the Sourcebook on sustainable transport for policymakers in developing cities, freely available from [www.sutp.org](http://www.sutp.org) – [www.sutp.cn](http://www.sutp.cn))

1	Introduction .....	4
1.1	Transforming Urban Mobility .....	4
2	Urban transport and urban development: a different model .....	5
2.1	A city for people.....	6
2.2	Problems of urban transport and one strategy to solve them: sustainable transport (Green transport).....	7
2.3	Consequences of unrestrained car use .....	14
2.4	Restricting automobile use.....	16
2.5	Transport in China and India.....	18
3	Economic instruments for sustainable transport.....	20
3.1	What are the policy options?.....	21
3.2	Getting started in economic instruments.....	23
3.3	Some examples of economic instruments .....	26
4	Examples of Mobility Management strategies .....	29
4.1	Transportation market and pricing reforms .....	29
4.2	Freight transport management (for details see new module on Urban Freight from November 2010) .....	31
4.3	Parking management (for details see new module on Parking Management) .....	31
5	Land use and transport: problems and solutions.....	33
5.1	Land use for transport purposes .....	34
5.2	Interaction between land use patterns, transport and the environment.....	35
5.3	Managing conflicting demands for urban space .....	35
5.4	Design and implementation of land use plans .....	36
5.5	Smart growth – land use management strategies .....	36
6	Two- and three-wheelers and urban transport systems .....	38
6.1	Two- and three-wheelers in developing Asian cities .....	38
6.2	Public transport issues .....	38
6.3	Road safety issues .....	39
6.4	The problem of two-stroke engine emissions.....	40
6.5	Types of emissions.....	40
6.6	Factors exacerbating emissions.....	41
6.7	Impacts of emissions.....	42
7	Mass Rapid Transit options and BRT .....	43
7.1	Choosing a Mass Transit system .....	44
7.2	Benefits of a BRT system over other systems .....	45
7.3	Barriers to implementing a BRT .....	45
7.4	BRT in China .....	46
7.5	Public Transport Integration- A Win-Win Strategy (experience from Germany and other European countries).....	46
8	Non-motorised transport and its benefits .....	50
8.1	Non-motorised transport planning .....	50
8.2	Rationale .....	51
9	Creating a safer road environment .....	53
9.1	Changing attitudes and road safety education.....	55
9.2	Enforcing safer road user behaviour .....	56
10	Attitude/Behaviour change interventions: Three types of actions.....	57
10.1	Informative messages: hard facts .....	57
10.2	Persuasive messages: comfort and well-being.....	58
10.3	Specific Activities: moving with sustainable transport means .....	58
10.4	All three actions are crucial .....	59

11	Economic impacts of an improved transport system: research findings.....	59
11.1	Transport and GDP growth- general.....	59
11.2	Economic costs of road safety.....	60
11.3	Environmental problems have great economic impact.....	61
11.4	Fuel costs due to increased dependence on oil (or other fuels).....	62
12	Overview of the GTZ Sourcebook for Policymakers in developing countries.....	62
12.1	Background.....	62
12.2	Objective.....	63
12.3	The target audience.....	63
12.4	Putting the Sourcebook to use.....	63
	Sourcebook translations.....	68
12.5	Complements to the sourcebook.....	68
12.6	Other Highlights on Transport.....	70
12.7	Future directions for the Sourcebook.....	72
13	Basic references and resources.....	74
13.2	Other resources.....	74

## 1 Introduction

China is one of the fastest growing countries of the world, and it is also one of the countries with greatest development improvements in a short time. This development has important implications in terms of social, environmental and economic repercussions at a world level. In terms of transport, there are two major policy decisions that have to be acknowledged: the first is the decision to prioritise the automobile industry further. The second is the decision to improve the urban public transport network. These two decisions, apparently contradictory, must be developed coherently to arrive at an improved public and private transport situation for its cities, while not hampering its industry's development. According to a World Bank study, the urban transport problems have been associated with globalization, urbanization, fiscal decentralization and an economic transition. There are also growing concerns such as suburbanization of homes and consequent longer trips. Also, it should be noted that there is a lack of technical capacity and practical experience in strategic planning in transport. Finally, there is few public participation in planning processes and there is a tendency towards technological improvements rather than modified policies, priorities of sustainable means of transport or demand management techniques to improve transportation.

As a response to the needs in China, this document (and the training courses which complements it) will provide descriptions of a people-centred transport where all citizens have access to transport, improving the harmony in the Chinese population as a whole. A Chinese initiative is exemplary in this extent, as described by AP: "Qiu Baoxing, a vice minister with the Ministry of Construction said it was important that China retain its title "kingdom of bicycles," according to a report by the official Xinhua News Agency". The idea of this document is to reinforce knowledge on urban transportation based on the principles outlined above. All information provided in this document is based on scientific research and carefully tested analysis of economical, social and environmental factors related to transportation and urban development.

### 1.1 Transforming Urban Mobility

As the world changes and governments increasingly become decentralised, cities are becoming more assertive hubs for development driven by knowledge, diversity and curiosity. Cities are becoming distinctive brands trying to attract the brightest brains and investments. By transforming into places of higher lifestyles, cities are offering high quality living areas, excellent education facilities, green areas and ever-changing cultural attractions. Complementing these features with innovative, efficient and sustainable mobility solutions is the aspiration of mayors and city dwellers. However, presently many cities are plagued by seemingly endless congestion, grave air pollution, alarming accident rates and lengthy travel times to work. As if these weren't enough, other recent challenges have been given great attention in media and policy: climate change and energy consumption.

Urban transport is interlinked with most (if not all) sectors of the urban setting. As such, it poses one of the most complex conundrums, when trying to improve it or solve its problems. Strategies have been sought as early as the beginning of the twentieth century. However, some strategies have been more harmful than business-as-usual scenarios: great investments on infrastructure (i.e. roads), high dependency on technological "fast" fixes and "magical solutions" have proven their ineffectiveness in the long term. Lessons from the oil crisis 2007/2008 have again shown that quick fixes are not available, but sustainable approaches are needed.

The good news is that smart solutions are available: During the past few years a wealth of best practices and easy-to-implement solutions for urban mobility have been developed with positive impacts in both the short and long term. In general, these solutions consist in "reduction of vehicle

energy consumption, strategies of non-transport alternatives, modal shift to more environmentally-friendly modes, and increased use of renewable energies in the sector”.

How to achieve this change of paradigm in urban mobility? The answer lies in the hands of the policy-makers. Political will, continuity and constant enhancement of projects, creating capacity among government staff and providing them with the appropriate tools have proven effective in changing a city’s transport situation and in making sustainable urban mobility a driver for overall advancement.

As advocates of sustainable urban mobility, GTZ’s Sustainable Urban Transport Project (SUTP) works to improve urban transport of cities by providing materials, trainings, peer-to-peer exchanges, assessments and targeted project implementations. The flagship publication “Sustainable Transport: a Sourcebook for policy-makers in Developing Cities” compiles most international practices and provides access to numerous other resources. Materials are complemented by training courses targeted to policymakers, planners or engineers in cities, regional entities and on governmental level.

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## 2 Urban transport and urban development: a different model

- *This section is adapted from Module 1a of our Sourcebook*

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***“The way cities are built affects to a large degree how people will live for hundreds of years to come.”***

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The task for everyone involved in creating environments where many generations will live is not simply to create a city that functions efficiently. It is to create an environment where the majority of people will be as happy as possible. Happiness is difficult to define and impossible to measure; but it should not be forgotten that it is what our efforts, collective or individual, are about. Over the last 40 years the environment became an issue of deep concern to all societies. So much that today any 8 year old is worried about tropical forests and the survival of mountain gorillas. Curiously, a similar interest in the human environment has not yet arisen. There is much more clarity in our time as to what the ideal environment is for a happy gorilla or a happy whale, than what the ideal environment is for a happy child. We are far from having a shared vision of an ideal human environment; much less of the transportation system for it. However, arriving at a people-centred transport policy and practice is something that can be achieved when focussing on the crucial components of a transport system: for example, moving people instead of vehicles.

Transport differs from other problems developing societies face, because it gets worse rather than better with economic development. While sanitation, education, and other challenges improve with economic growth, transport gets worse. Transport is also at the core of a different, more appropriate model that could and should be implemented by Third World developing cities. More than a socio-political model, the model which will be described is a model for a different way of living in cities; but it has profound social and economic implications. A true commitment to social harmony, environmental sustainability and economic growth needs to espouse a city model different from the one the world has pursued over the last century and up to now.

## 2.1 A city for people

The other structuring element of the new city model is abundant high quality pedestrian public space. As has been correctly addressed in various Chinese cities, there should be at least as much public pedestrian space as road space. Physically protected bicycle paths, large, exclusively pedestrian avenues and greenways should crisscross the city in all directions. No child should grow farther than 3 blocks from a park. Large tracts of land around cities should become parks; cross country pedestrian and bicycle paths through the adjacent countryside should readily permit all citizens a contact with nature; all waterfronts should have public access and have the basic infrastructure for it.

Peñalosa, the former mayor of Bogotá have pointed his opinion in his discourse:

*We were made walking animals: pedestrians. As a fish needs to swim, a bird to fly, a deer to run, humans need to walk, not in order to survive but to be happy. A bird can survive inside a small cage and even bear descendants. But one suspects the bird would be happier inside an enormous cage the size of an auditorium and even more flying free. While a person could survive inside an apartment all of his life, he would be much happier if he could walk and run about, as freely as possible.*

*The importance of pedestrian public spaces cannot be measured. It cannot be proven mathematically that wider sidewalks, pedestrian streets, and more or better parks make people happier; much less measure how much happier. However if we reflect, most things that are important in life cannot be measured either: Friendship, beauty, love, and loyalty are examples. There is a curious difference between parks and other public investments. If people lack transport, running water, or other traditional public services, they will feel very unsatisfied. But if they do have those services, they do not get much satisfaction out of it. On the contrary, if they lack parks or other pedestrian spaces, they will not be particularly dissatisfied. But if they do have them, they will derive out of it ceaseless satisfaction. It is so, because most government services are means to a better life; while pedestrian spaces are an end in themselves; they practically ARE a better life in themselves.*

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***“A city is more civilised not when it has highways, but when a child in a tricycle is able to move about everywhere with ease and safety.”***

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At first it may seem that in developing cities with so many unmet needs, high quality pedestrian spaces would be a frivolity. On the contrary, in places where citizens lack so much in terms of amenities and consumption, it is quicker and more effective to distribute quality of life through public goods such as parks, plazas, and sidewalks, than to increase the personal incomes of the poor. It is impossible to provide citizens certain individual consumer goods and services such as cars, computers, or trips to Paris. It is however possible to provide them with excellent schools, libraries, sidewalks, and parks. Low-income privations are not as evident during work time. It is during leisure time that the difference with upper income groups is most felt. While upper income people—increasingly turning to large, enclave-style gated communities and housing estates with freeway access near the edges of large developing cities—have cars, go to clubs, country houses, theatres, restaurants and on vacations, for the poor public space is the only leisure alternative to television and walking around in shopping malls. Parks, plazas, pedestrian streets and sidewalks are essential for social harmony. High quality sidewalks are the most basic element of a people-centred city. It is frequent that images of high-rises and highways are used to portray a city's advance. It would be useful to reflect on this point based on previous or current experiences in Chinese cities: who are they built for and how?

In fact, in urban terms a city is more civilized not when it has highways, but when a child in a tricycle is able to move about everywhere with ease and safety.

Parks and public space are also important to a harmonic society, because they are the only places where people meet as equals. In our highly hierarchical societies, we meet separated by our socio-economic differences. The Chief Executive Officer perhaps meets the janitor, but from his position of power. In walkways and parks everyone meets as equals.

For all of these reasons Peñalosa (in line with governmental priorities and policies) concentrated an enormous effort during his term as Mayor of Bogotá in the creation of public pedestrian spaces: Hundreds of thousands of square metres of tree-lined walkways, more than 300 km of bicycle paths, a 45 km greenway connecting rich and poor neighbourhoods, more than 300 small parks proposed and built by poor communities themselves, a total of 1123 new or reconstructed parks. Two blocks away from the Presidential Palace, in the city core, more than 600 houses were demolished in a severely degraded area that had become perhaps the world's largest crime centre and a 20 hectare park has been built there. It is supposed to become a magnet for residential development. One of downtown's main streets was converted into a pedestrian street. A 17 km long pedestrian street lined with trees, lamps, and benches was built, through some of the poorest neighbourhoods in Latin America, where most motor vehicle streets are not yet paved. The political battles were not easy. This mayor was almost impeached for getting cars off the sidewalks. Bogotá changed from being a city intensely resented and rejected by its inhabitants, to one loved by its now proud citizens.

## 2.2 Problems of urban transport and one strategy to solve them: sustainable transport (Green transport)

\* This section is drawn from an unpublished mission report by Dr. Axel Friedrich, former Head of Division at Umweltbundesamt, for GTZ SUTP, January 2000 and also included in the overview module of our sourcebook

Mobility of people and of goods is an essential part of all social and economic activities. In most countries of the world, even developing countries, passenger cars and trucks have become the most important transport modes. In many developing cities high growth of the vehicle fleet has taken place in recent years. Non-motorised transport, which up to recently was the common way of linking together places of activities, has to a large extent been substituted by the car in daily mobility, and by trucks, for freight movement. The result of this process has also been a significant change in land use patterns.

This process began during the 1920s and 1930s in the United States and spread in the wealthier countries initially, but subsequently all over the world, including to developing cities. The shift towards motorised private road transport reduced the share of other modes. The growth of road traffic overwhelmed the development of the city structures and the supply of sufficient infrastructure. Therefore in developing cities more than in developed countries the transport system is inefficient, unsafe, causes environmental problems, and disadvantages healthy city development.

Some common problems of the transport sector in big conurbations are congestion, fatalities and injuries due to traffic accidents. Furthermore, an increasing demand for mineral oil fuels, severe air pollution, increasing noise levels, and a loss of urban liveability and green spaces due to transport activities adversely affects city development. In particular the high growth of the transport related CO<sub>2</sub> emissions – compared to other economic sectors (see Section 2.4 below) – are causing concerns and demand further action. These developments discourage the attractiveness of cities and their economic well-being. From the social point of view the trend towards individual motorisation causes unequal mobility chances and disparities in burdens and advantages, for example burdens for those who cannot drive or cannot afford ownership of a private car. The transport system demands large investments and thus imposes economic burdens on public budgets, which are difficult to afford for developing countries. This leads to the conclusion: high per-capita transport activities in terms of passenger kilometres and ton kilometres, done mainly by passenger cars and trucks, not only indicate economic progress and welfare but also cause severe problems.

The 1992 Earth Conference in Rio adopted *Agenda 21*, underlining the principle of sustainable development. The June 1997 Special Session of the General Assembly of the United Nations recalled the need for sustainable development, further reinforced in the Johannesburg Summit of 2002, and promoted the need for changing the current patterns of transportation in order to avoid unfavourable environmental and health effects. The threats and damages to human health and to the natural environment make current transport structures unacceptable in the light of the ideas of

sustainability. In this context different international approaches following the Rio Earth Conference started to transfer the principle of sustainable development to the transport sector. In very simple terms we can differentiate between the environmental, social and economic goals that have to be satisfied by a sustainable transport system:

- **Environmental:** rate of use of non-renewable resources should not exceed the rate at which renewable substitutes are developed; the rate of pollution emission should not exceed the assimilative capacity of the environment; biodiversity should be protected.
- **Social:** access to all activities necessary to participate in social life has to be guaranteed as far as possible; air quality and noise should not exceed the health standards suggested by the WHO (World Health Organization); accident risks should be minimised
- **Economic:** mobility of persons and of goods necessary to achieve prosperous economic development has to be provided, avoiding congesting, and without over-burdening the financial limitations of the public and private budgets.

As a practical consequence of these (and similar other) criteria for sustainable transportation, the transport sector in China may need focussing on its status quo and seeing which components are useful. Priorities of a harmonic transport system that can be described as follows:

- Decrease the demand or at least mitigate the increase of demand for motorised transport of people and goods, for example by establishing transport avoiding spatial structures, by applying fiscal incentives and other policy instruments to promote short distance access.
- Shift transport demand from unfavourable transport modes (in terms of environmental, social and economic impact) to those with less negative impact on people and nature.
- Ensure the use of best available technology (BAT) both for the transport vehicles and for the management and communication tools in transport.
- Promote responsible behaviour of individuals and responsible decisions by enterprises.
- Integrate environmental and social considerations into transport policy.

### 2.2.1 Poverty

#### A multidimensional problem

*Poverty is hunger. Poverty is lack of shelter. Poverty is being sick and not being able to see a doctor. Poverty is not being able to go to school and not knowing how to read. Poverty is not having a job, is fear for the future, living one day at a time. Poverty is losing a child to illness brought about by unclean water. Poverty is powerlessness...* ([www.worldbank.org/poverty/mission/up1.htm](http://www.worldbank.org/poverty/mission/up1.htm))

Poverty has many faces and aspects, involves in general terms lack of access to the resources needed to participate in the everyday life of society. The multidimensional nature of poverty can be conceptualised in various aspects relating to urban transport, access, and exclusion:

*The "income poor" make fewer trips, and more of their trips are undertaken on foot. For most purposes they are restricted to whatever services (usually poor) can be accessed within walking distance, making them "accessibility poor". The journey to work may be relatively long. Even if it is not, it will use slow modes and may be very time consuming, so they are also "time-poor." For poor people, and particularly for women, children and the elderly, trip making is often discouraged by their vulnerability as pedestrians both to traffic accidents and to personal violence, making them "safety poor." Finally there is evidence that long walking distances and times also creates a tiredness and boredom ... adding an "energy-poverty" dimension to their deprivation (World Bank 2002).*

When developing transport policy measures to alleviate poverty it is important to consider the multidimensional nature of poverty, and not simply to focus on economic indicators such as the proportion of income spent on transport or the time spent travelling. In Bogotá, for example, one of the most effective measures for helping the urban poor was the dramatic improvements to public spaces in the city. During 1998-2000, public space improvements in Bogotá included:



- 285,500 square metres in walkways, green space, road dividers, sidewalks
- 3,149 neighbourhood parks
- 323 pocket parks
- 11 metropolitan parks.

As former mayor Enrique Peñalosa argues (see Module 1a from the GTZ Sourcebook: *The Role of Transport in Urban Development Policy*) pedestrian streets and ample sidewalks make a more humane city. They also make a city more people-centred, as public spaces such as sidewalks and parks help integrate rich and poor neighbourhoods, and provide one of few avenues of recreation for the urban poor.

Although poverty is multidimensional, we can still consider in broad terms absolute indicators such as the “income poverty line”, which was set out in UNDP’s Human Development Report 2009. Income poverty line refers to the percentage of the population living below the specified poverty line: US\$1.25 a day and US\$2 a day. This indicator gives an appreciation of the extent of poverty in developing countries. According to this report, almost 16 per cent of China’s population are still living below US\$1.25 a day and more than 36 per cent below US\$2 a day. In this context, there is also a substantial difference between the urban and rural values. (UNDP 2010, P. 177)

In order to alleviate poverty, it is essential to develop an understanding of the dimensions of poverty and impoverishment, and through this understanding to develop strategic ways of approaching and addressing poverty alleviation. It is now accepted that it is not sufficient to merely focus on indirect – so-called ‘trickle down’ – benefits for the poor. This consensus is reflected in approaches of multilateral institutions such as the World Bank. Strategy documents such as the *Urban Transport Strategy Review* now acknowledge that urban transport improvements directed at ‘improving the efficiency of the transport system as a whole’, are not sufficient. In addition to system-wide increases in efficiency, targeted interventions to achieve poverty alleviation are required. Multilateral and bilateral aid and development agencies are developing increasingly sophisticated tools to understand – and alleviate – poverty. These include, for example, toolkits, websites, guidelines and manuals in the “References” section of this module.

### Focusing on the modes used by the majority of citizens

The transport needs of the poor and the great majority must be understood properly. These groups typically make 20 – 30% less trips, and rely much more on non-motorised and public transport. They have a more limited range of destinations, being much more focused on core destinations such as work places, schools, markets, places of worship and health clinics.

In developing cities land values often reflect accessibility of an area to key destinations. The poor are faced with a complex trade-off between residential security, travel time, and travel mode. A survey of pavement dwellers in Madras, for example, showed that 59% walked to work at zero cost. At the other extreme, those opting for a degree of residential security on the outskirts of cities pay a high price in terms of access costs. The urban poor in Lima and Rio de Janeiro for example are driven out to cheap dwelling space in remote locations, 30 or 40 kilometres out of the employment centre; average commuting time per day for the poorest group in Rio de Janeiro exceeding three hours (World Bank 2002).

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***“Eradicating poverty is the greatest global challenge facing the world today and an indispensable requirement for sustainable development, particularly for developing countries.”***

***United Nations, Report of the World Summit on Sustainable Development, Johannesburg, 2002***

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Much attention in the form of international events, seminars, conferences, training materials and so on, is devoted to issues of vehicle and fuel technologies. While this high level of attention to technology is understandable and helpful in addressing tailpipe emissions, it often does not address the most direct transport needs of the urban poor in developing countries. We often hear of seminars and workshops elaborating the results of the latest comparison of CNG versus clean diesel, or even trials of fuel cells or electric vehicles. But seldom do we hear of a high profile international seminar focusing on walkway design, or non-motorised transport in developing countries. This is despite the fact that in many developing cities, car-owners are still a small minority of the population. Public transport users, pedestrians and cyclists represent a large majority in many developing cities, ranging from Belgrade to Metro Manila to Bogotá to Shanghai. Private motor vehicle ownership is beyond the reach of the urban poor, with the possible exception of motorcycles in cities such as Denpasar and Ho Chi Minh in which public transport provides less than 5% of trips.

The poor in developing cities cannot afford cars. They rely primarily on walking, cycling and public transport for gaining access to jobs, services and social events. The poor rely on walking, cycling and public transport much more so than the non-poor.

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**“Low income people [in the Surabaya study area] are forced to use motorised travel even for extremely short trips.”**

GTZ SUTP/ITDP, 2000

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For instance, GTZ and ITDP showed in a pilot project in Surabaya that even in poor neighbourhoods, some 60% of trips between 1 and 3 km were undertaken by motorised means, due mainly to the very poor conditions for walking, cycling and pedicabs in Surabaya. Perhaps even more surprisingly, 20% of trips less than 1 km in length were made by motorised means, despite the fact that both areas of the pilot projects were low income neighbourhoods. One conclusion of the study was that:

Even low income people are forced to use motorised travel even for extremely short trips, leading to conditions where the working poor spend an estimated 20% of their household income on transport. Improved conditions for non-motorised travel in the study area would yield \$250,000 in benefits to these low income families each year. (GTZ SUTP/ITDP 2000)

### **Public finances, and equity considerations**

#### **Opportunity costs of transport investments**

Urban transport policy has major implications for city government finances. City government spending in turn carries major opportunity costs. Scarce development funds spent on expensive rail-based mass transit systems, for example, could be spent on more cost effective approaches such as bus rapid transit, with the resulting savings invested in health, public space and educational facilities to benefit the urban poor. Possibly even worse than ill-advised mass transit system investments, spending on new road infrastructure, as well as being regressive in that it benefits primarily the richest (car-owning) portion of the population, may actually worsen urban transport conditions through induced traffic and sprawl.

Private sector participation in urban transport infrastructure provision can be an effective method for developing city governments to provide infrastructure and services. Advice is provided on this topic in Module 1c of the GTZ Sourcebook: *Private Sector Participation in Urban Transport Infrastructure Provision*.

The city of Bogotá, Colombia provides a recent example of the effective use of public finances to benefit the urban poor, to improve social integration, to enhance air quality, to improve the productivity of the city, and to enhance the quality of life of all citizens. The example of Bogotá –

and the policy underpinning it – is elaborated by the man who inspired it, former mayor Enrique Peñalosa, in Module 1a: *The Role of Transport in Urban Development Policy*.

Bogotá is also an example of a city which has leveraged the potential of economic instruments as a way of achieving multiple transport objectives including provision of funds, reduced congestion, progressive taxation, and environmental improvements. Advice on the use of economic instruments including road pricing, fuel taxation, parking, vehicle taxation, environmental trust funds and other measures is provided in Module 1d: *Economic Instruments*.

### **Equity and transport in developing cities**

Equity considerations dictate that transport planners in developing cities should favour modes of walking, cycling, and public transport. In wealthier cities the urban poor are often a minority. Although equity considerations are important in all cities, in wealthy cities these considerations are often focused on politically justifying urban transport subsidies of public transport systems used by only a minority of the population. In many developing cities, on the other hand, the urban poor represent the majority of the population. This is reflected for example in vehicle ownership data. In low income developing countries car ownership rates are typically less than 100 cars per 1000 people, and even in higher income developing cities car ownership is generally less than 200 per 1000 people. This compares to car ownership rates of around 400 per 1000 people in Europe, and more than 500 per 1000 people in many cities in North America and Australia.

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***“We will spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty, to which more than a billion of them are currently subjected.”***

***United Nations Millennium Declaration, Sept. 2000***

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### **The road environment**

One area requiring further research concerns the exposure of urban poor to transport-related air pollution, road accidents, and noise. The following general observations, however, can be made:

- The urban poor make up a significant proportion of the road-side workers in developing countries, resulting in a likely higher exposure to roadside air pollution (see more in Module 5a: *Air Quality Management*).
- The urban poor have less means to protect themselves against pollution, and less means to mitigate the results of pollution. The urban poor are also often forced to accept trade-offs between residential cost and ambient noise levels. The effects of noise on health, and policies for mitigation, are described in Module 5c: *Noise and its Abatement*.
- The urban poor are much greater users of non-motorised transport modes than the non-poor, and users of non-motorised modes (including pedestrians) represent a high proportion of road crash victims in developing cities. The problems of road safety, and policy recommendations in this area, are elaborated in Module 5b: *Urban Road Safety*.

### **Employment**

The urban transport sector is a significant employer in developing cities. Initiatives taken to greatly improve the livelihood of urban bus drivers in Bogotá are described in Module 3b: *Bus Rapid Transit* and initiatives to improve the livelihood of pedicab drivers in Indian cities are described in Module 3d: *Preserving and Expanding the Role of Non-motorised Transport*.

## Involving the poor

Sustainable urban transport measures will not succeed without the support of the local people. Many of the modules in the *Sourcebook* describe various forms of participatory planning processes.

Information campaigns, as described in Module 1e: *Raising Public Awareness about Sustainable Urban Transport*, are essential. It is necessary to create awareness about the transportation system the people of a city deserve for existing and future generations. This is a way for projects to become “owned” by the community. In this way participation of the local people can be increased, resulting in greater benefits and making projects politically, socially and financially feasible.

### 2.2.2 Global warming

#### The scientific basis

The “Greenhouse Effect”, which rose to prominence on political and research agendas in the 1990s, refers to the warming which occurs when certain gases allow sunlight to penetrate to the earth but partially trap the planet’s radiated infrared heat in the atmosphere. Some such warming is natural and necessary, but increasing concentrations of these ‘greenhouse gases’ are causing serious climate changes.

Carbon dioxide (CO<sub>2</sub>) is by far the most important greenhouse gas. Scientists can study the composition of air in the past by examining air trapped in Antarctic ice. Analysis of these bubbles shows that CO<sub>2</sub> concentrations are now higher than at any time in the past 420,000 years. In fact, it is likely that the concentration today is higher than it has been for 20 million years. The current rate of increase of carbon dioxide is greater than at any time in the past 20,000 years. According to various scenarios outlined in the Intergovernmental Panel on Climate Change (IPCC) reports of 2007, the global atmospheric concentration of CO<sub>2</sub> increased from a constant pre-industrial value of about 280 parts per million (ppm) to 379ppm in 2005. The annual CO<sub>2</sub> concentration growth rate was larger during the last 10 years (1995-2005 average: 1.9ppm per year) than it has been since the beginning of continuous direct atmospheric measurements (1960-2005 average: 1.4ppm per year), although there is year-to-year variability in growth rates.

The rise in greenhouse gas emissions, and especially in CO<sub>2</sub> emissions, has a direct impact on global temperatures.

#### Effects of global warming\*

\* This section is adapted from IPCC 2007

Projected climate change will have beneficial and adverse effects on both environmental and socio-economic systems, but the larger the changes and rate of change in climate, the more the adverse effects predominate. When considered by region, adverse effects are projected to predominate for much of the world, particularly in the tropics and sub-tropics.

Climate change is projected to increase threats to human health. The health status of millions of people is projected to be affected through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrhoeal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas related to climate change; and the altered spatial distribution of some infectious diseases.

Climate change is expected to exacerbate current stresses on water resources from population growth and economic and land-use change, including urbanisation. On a regional scale, mountain snow pack, glaciers and small ice caps play a crucial role in freshwater availability. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability, hydropower potential, and changing seasonality of flows in regions supplied by meltwater from major mountain ranges (e.g. Hindu-Kush, Himalaya, Andes), where more than one-sixth of the world population currently lives.

Climate change can also affect other sectors such as industry, human settlements and society. The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources and those in areas prone to extreme weather events, especially where rapid urbanisation is occurring. Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas.

### The transport sector and global warming

\* This section is adapted from GTZ Sourcebook on Sustainable Urban Transport, module 5e: Transport and Climate Change ([www.sutp.org](http://www.sutp.org))

The transport sector is responsible for around a quarter of global CO<sub>2</sub> emissions from fossil fuel combustion; a share which is growing. CO<sub>2</sub> emissions in developed countries have been stabilised in most sectors, with the exception of emissions from transportation.

Over the past three decades, carbon dioxide emissions from transport have risen faster than those from all other sectors and are projected to rise more rapidly in the future. From 1990 to 2004, the carbon dioxide emissions from the world's transport sector have risen by 36.5%. For the same period, road transport emissions have risen by 29% in industrialised countries and 61% in the other countries (mainly developing countries or countries in transition, IEA, 2006).

At present industrialised countries are the main sources of transport emissions. However, the proportion of emissions being produced in developing countries is increasing rapidly, particularly in countries such as China, India and Indonesia. World CO<sub>2</sub> emissions from the transport sector are projected to increase by 140% from 2000 to 2050, with the biggest increase in developing countries.

Transport is proving to be one of the most difficult sectors in which to reduce greenhouse gas emissions as there are numerous small emission sources (i.e., vehicles) and, additionally, there is a seemingly close relationship with economic development.

However, there is an emerging consensus on how to effectively tackle CO<sub>2</sub> emissions from the transport sector in developing countries, as outlined in the following section.

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***“Integrating climate policies in broader development policies makes implementation and overcoming barriers easier.”***

***IPCC, Climate Change Synthesis Report, 2007***

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### Achieving greenhouse gas emission reductions from transport in developing cities

Carbon dioxide (CO<sub>2</sub>) mitigation has a negative connotation in many developing countries, where city governments are faced with many urgent demands. Averting increasing contributions of transport to GHG emissions requires an integrated package of reforms. In all developing cities, the question is how to get such policies implemented. The approach favoured by GTZ and applied in Surabaya ([www.sutp.org](http://www.sutp.org)), and recommended by a range of recent studies, is to focus on short to mid-term measures which are low cost and "win-win," with the highest impact on CO<sub>2</sub> mitigation at the same time leading to local economic, social, and environmental improvements in the form of reduced congestion & local air pollution, and a more liveable, efficient, harmonic and prosperous city. As the WB UTSR (2001, draft) argues:

*The suggested key ... is both to link GHG mitigation to policy initiatives to goals that are perceived to be of immediate relevance and to try to uncouple, or at least “flex” the link between economic growth and GHG emissions from the transport sector.*

There is now an established consensus, exemplified by the shift of the Global Environment Facility funding from technology upgrades to projects promoting modal shifts, that the best way to reduce greenhouse gas emissions from urban transport is to strategically focus on urban transport issues

which are regarded as being of immediate importance to policy-makers in developing cities (especially congestion, local air pollution, and uncontrolled motorisation) which will give rise to a range of policy initiatives which simultaneously have the effect of drastically reducing greenhouse gas emissions.

Local and global (chiefly in the form of reduced greenhouse gas emissions) benefits are achieved through such policies. In this sense this approach amounts to a sustainable urban transport policy approach focusing on city-level problems and aiming to meet local and global needs.

A report from the Washington-based Pew Center on Global Climate Change (Sperling *et al.* 2002) recommends policies which should be pursued in developing countries in order to reduce greenhouse gas emissions from transport. Which policy approaches are recommended? The report notes that many of the strategies required have substantial local as well as global benefits, and states that:

*Key strategies include increasing the relative cost of using ... private cars and enhancing the quality and choices of alternative transportation modes.*

The challenge for all concerned with climate change mitigation and reducing emissions from the transport sector, of course, is to help see such policy approaches through to implementation.

### 2.3 Consequences of unrestrained car use

Urban transport is a political rather than a technical issue. The technical aspects are relatively simple. The difficult decisions relate to who is going to benefit from the models adopted. Do we dare to create a transport model different from that in the so-called advanced world cities? Do we dare create a transport system giving priority to the needs of the poor majority rather than the automobile owning minority? Are we trying to find the most efficient, economical way to move a city's population, as cleanly and as comfortable as possible? Or are we just trying to minimise the upper class's traffic jams?

A people-centred city should have a high population density, in any case around or maybe more than 120 inhabitants per hectare (12,000 per square kilometre). Relatively high population density is desirable for several reasons:

- low cost, high-frequency transit systems will be viable;
- shorter travel times are achieved;
- mobility for non-drivers—the vast majority in developing cities—is enhanced, including mobility of the poor, children, and the elderly;
- an abundance of people will fill public pedestrian spaces;
- rich cultural offerings are provided;
- more efficient land use and infrastructure provision is achieved;
- lower expenditures on road construction and maintenance will result. (cities with low densities require much more infrastructure investment).

For these reasons and more, urban experts around the world concur on the desirability of relatively high density. However, unrestricted car use inevitably breeds suburban development and lower densities. First it brings about traffic jams. Traffic jams in turn create enormous pressure to invest in more and bigger road infrastructure, which in turn stimulates suburban development.

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***“Unrestricted car use inevitably breeds suburban development.”***

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This process will occur regardless of availability of mass transit. Paris is the best example of growing car use and suburbanisation despite a beautiful central city and top quality public transport. It is important to understand what features draw people to suburbs, so that these features can be provided in central areas.

Ironically, it seems that one of the main attractions of suburbia is a relatively car-free environment, for children to play and ride bicycles safely. Greenery and green spaces also pull people to the suburbs. The new city model outlined here can provide ample exclusive pedestrian streets and green spaces which cater to these forces driving suburbanisation. And contrary to what is often supposed, a high density city needs not have very high buildings: Five-story buildings can easily yield high population densities.

The unsustainable nature of car-based transport is illustrated by the fact that the problem gets worse as societies grow richer. Unless car use is severely restricted, as in Singapore, or in cities such as Tokyo and Hong Kong which provide a very low level of Central Business District parking spaces, society will be worse instead of better off with economic progress due to the following:

- more traffic jams;
- more noise;
- more air pollution;
- more health problems;
- more low density city expansion and suburban development;
- more regressive public expenditure on road building and maintenance that benefits primarily car-owning upper middle classes.

It should be noted here that the goal is not to ban all car sales and stop citizens from buying these vehicles, but rather to rationalize the use of cars (e.g. use them only when strictly necessary, while using public transport, bicycles and walking for most trips in urban areas). One example is the following: The Netherlands, with a very high per capita car ownership, has a very considerable mode share of cycling and public transport. In a city where the poor do not use cars excessively, road building, and road improvement in order to relieve congestion is very regressive. It takes up very scarce government resources leaving the needs of the poor unattended. This leaves us with some questions:

- Does a country really need high vehicle use?
- Do people need to ride a car for every trip they take?
- Are modes such as bicycles, walking and using public transport as efficient or more than cars in the urban setting?
- Is a society harmonic if roads are built for a reduced portion of the population, or is it better if a city prioritises the needs of the majority of citizens who do not use a car?

Car use in developing cities is very regressive: It absorbs massive public investments for road infrastructure building and maintenance, taking resources away from the more urgent and important needs of the poor; creates traffic jams that hinder the mobility of the bus-riding majorities; pollutes the air; makes noise; leads to accidents; creates obstacles to lower income pedestrians; and leads to a progressive invasion of scarce pedestrian spaces by parked vehicles. There clearly are contradictory interests between motor vehicles and human beings: The more a city is made to accommodate motor vehicles, the less respectful of human dignity it becomes, and the more acute the differences in quality of life between upper income and lower income groups. The poor and vulnerable—again, a large majority of the population in developing cities—are particularly alienated by increasing motorisation and the processes that come with it. Women are often particularly disadvantaged, as their trip-making pattern in developing cities is often characterised by shorter, more frequent trips that rely on non-motorised modes.

International experience has made it clear that trying to solve traffic problems by building more and bigger roads is like trying to put out a fire with gasoline. In the United States time lost in traffic increases every year, despite an enormous density of highways (this figure has risen 56% from 1991 to 2003, according to Pew Research, 2005). A new highway stimulates new development around it and particularly at its extremes and thus generates its own traffic.

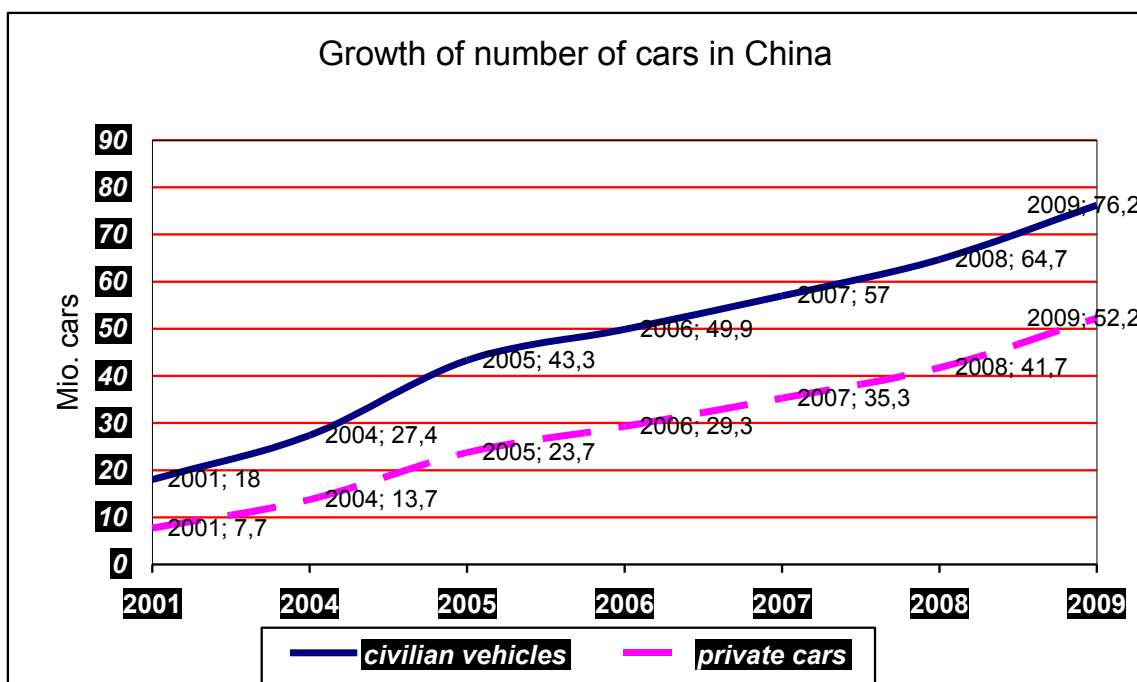
Consider the case of a new 10-lane highway from the centre of a city to any location in its outskirts. Immediately after it is completed, or even before, new housing projects, shopping malls, and

factories are built around the new road and in the countryside near its extremes. The new road stimulates urban expansion, lower densities and longer trips. In addition, new roads have been shown to generate more traffic. Ten years after a road is built, traffic jams are worse than ever. But now average trips are longer. For traffic considerations, doubling the number of vehicles is the same as having the same amount of vehicles travel twice the distance. For all these reasons, building new road infrastructure in order to solve traffic problems is not only regressive and dehumanizes a city, but it is also useless. Los Angeles, perhaps the archetypal experiment in building a car-oriented city and seemingly the role-model for some developing cities such as Bangkok, has found that road-building cannot solve congestion problems. The city now focuses on transit-oriented investments including Bus Rapid Transit, light and heavy rail, and car-sharing.

Yet despite overwhelming evidence that the road-building approach is regressive, inappropriate, and unsustainable for dense developing cities, it is an approach which continues to be followed throughout the world.

#### 2.4 Restricting automobile use

The only sustainable solution is to have people move by public transport, walking and bicycles rather than by individual automobile. Some propose high user charges in order to restrict automobile use: Tolls, vehicle registration fees, gasoline taxes, or varying road charges according to type of road and hour of the day. Such schemes however have deficiencies: Charges never adequately cover the immense costs society pays in terms of road space; real estate value; noise and air pollution; road accidents; road construction and maintenance; policing; roads as obstacles to pedestrian life and sources of danger for children. Road user charges may create a situation where a few upper income drivers have the street network all to themselves. In the case of China, automobiles have increased in great numbers, as the graph below shows.



Source: China statistical yearbook 2001, 2004, 2005, 2006, 2007, 2008, 2009

While industrialised cities have higher levels of motor vehicle ownership, developing cities have much lower levels of car ownership. In doing a differentiation between North American & Australian cities, one finds the highest rates of motor vehicle ownership (often more than 700 per 1000 people), followed by European cities (generally less than 550 motor vehicles per 1000 people), and



Asian cities with the lowest levels of motor vehicle ownership. Yet motor vehicle ownership and use in dense developing cities is growing rapidly—sometimes more than 10% per year, in Beijing daily 1000 more vehicles are registered, annually 20% more private vehicles are plying the roads.

Unchecked, the combined effects of population growth and motorisation will create ever more severe problems of quality of life and equity in developing cities. A clear understanding of the consequences of unchecked motorisation is needed. And they should be able to vote on it, for example mandating a ban on car use during rush hours. Is there any doubt that the majority of the population that does not drive a car would only gain from such a restriction? It would result in shorter travel times as traffic from cars does not slow buses down; cleaner air; less noise; a more egalitarian relationship with car-owners; more public resources available for priority investments; a more humane, less dangerous environment for children to grow in; and less high velocity arteries destroying neighbourhoods. The fact that such a measure is not adopted is yet more evidence that the priorities of the political and economic systems are not to solve the needs of the poor, or even to benefit the majority of the population, but rather to favour the ruling upper income groups.

In October 2000, the majority of the voters of Bogotá approved a referendum asking them whether they wanted all cars off the streets every weekday between 6:00am and 9:00am and 4:30pm and 7:30pm from January 2015 onwards. Constitutional interpretations later demanded a higher voter turnout for the referendum to become a legal mandate. Nevertheless it proved that it is possible for people to conceive different, perhaps better for them, ways of organising city life and city transport. Beyond the environmental advantages of a city that moves basically without cars, the economic implications are significant. The private savings in garages, vehicle depreciation, and fuel, can be spent on other goods.

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***“Such a city would become extremely attractive to highly qualified professionals and investors.”***

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A city may follow a more timid approach and simply structure an excellent bus-based transit system on exclusive lanes and not restrict automobile use. But why should the rest of society tolerate the car-using minority that imposes so many noise, air pollution, accidents, and other costs on society?

The public savings in road construction and maintenance, traffic police, and hospital costs of people hurt in vehicle accidents or suffering from air pollution, can be used not only to provide excellent public transport, but also for schools, libraries, and parks, to mention only a few. Of course people could always own cars and use them during off-peak hours, or travel to the countryside on weekends. Or they could simply rent them when required. Freed from the pressure to find ever more room for cars, authorities can concentrate on more civilising endeavours, such as creating more public pedestrian space.

A city such as that proposed in this chapter would become a world example of sustainability, quality of life, social justice, and social integration. And it would become extremely attractive to highly qualified professionals and investors. If in the past capital investments were attracted with subsidies of different sorts, in the new knowledge economy perhaps the most crucial competitive factor is urban quality of life.

Imagine that 1000 wealthy individuals in a large city decide to use private helicopters for their daily transport. Helicopters are very loud. Why would the rest of society forego its silence, if that natural resource belongs to all? Why should the majority suffer great noise for the benefit of a few? Yet the car-using minority generates much more costs for the majority than helicopters would. Cars destroy the common silence; pollute the air; and require extremely costly road space and infrastructure that absorbs scarce public funds. The most important point illustrated by the helicopters example is that it is possible for a few hundred people to use helicopters for their transport; but it would be impossible for everyone in a city to do so. The same happens with private cars. While only an upper middle class minority uses cars, despite enormous costs and injustice,

the system works. But it would not be possible for every citizen to use a private car for his or her mobility; otherwise jams would be massive and high velocity roads would destroy the human qualities and structure of the city. Many developing cities are moving in this direction. Bangkok, Manila, Cairo, Kuala Lumpur and other cities are already notorious for severe traffic congestion, despite relatively low levels of motorisation.

Since 1974 Bogotá has had a tradition of Ciclovía, the closing of main arteries to motor vehicle traffic for 7 hours every Sunday. The city recently doubled the kilometres closed to traffic: now 120 kilometres of main city arteries are closed to motor vehicles so that people can use them for bicycling, jogging, and getting together. More than 1.5 million people come out there every week end in a marvellous community building celebration. A new tradition was initiated, closing the same 120 kilometres each night close to Christmas, for citizens to come out and see the Christmas lights. Almost half the city's population, nearly 3 million people of all ages and social standings, come out. The exercise builds a sense of belonging and of community.

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***“Bicycle paths are a symbol of respect for human dignity and of a more egalitarian city, as are high quality walkways. Both show that a city is for its people, and not for the motor vehicles of its upper classes as is so often the case.”***

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Another collective adventure launched in Bogotá was a city-wide car-free day. On a Thursday in February 2000, the city's nearly 7 million inhabitants went to work leaving all cars at home. It worked well. 98% of people went to school and work as usual, by bus, bicycle or taxi. People enjoyed the adventure. Afterwards in the referendum of October 2000, nearly 64% of voters approved establishing a car free day on the first Thursday of February every year. Polls taken the day after the 2002 Car Free Day found that 83% of the population supported it. The importance of the exercise, going beyond transport or environment, has to do with social integration. People of all socio-economic conditions meet as equals on their bicycles or in public transport.

More than 300 km of protected bicycle paths were built. There has been a remarkable increase in cycling in the city in a short period. Cyclists have gone from 0.5% of all trips in 1998, to 5% a few years later. Moreover, bicycle paths are a symbol of respect for human dignity and of a more egalitarian city, as are high quality walkways. Both show that a city is for its people and not for the motor vehicles of its upper classes as is so often the case. Bicycles can also be very efficient feeder systems to mass transit.

## 2.5 Transport in China and India

- This section is adapted from Module 3e of our sourcebook

Few regions of the world epitomise the concerns over the global consequences of mass motorisation as Asia, and particularly the nations of China and India. At present, vehicle ownership level in China is still less than 40 vehicles per 1000 inhabitants according to the statistical year book 2009 from the National Bureau of Statistics of China. In comparison, the United States has 769 vehicles per 1000 inhabitants while the average for Western European is approximately 430 vehicles per 1000 inhabitants (Whitelegg and Haq, 2003). In 2004, China's annual growth in vehicle ownership reached 75% (Economist, 2005). China's motorisation rate has gained another boost with the country's admission into the World Trade Organization (WTO). Tariff protection for automobiles was reduced to 25% on July 1<sup>st</sup> 2006 (Xinhua Net, 2006).

While countries such as China and India are starting from relatively low ownership levels, both are entering the income zone of heightened vehicle purchasing. If China was to reach an ownership level equal to that of the US, the global vehicle fleet would grow by approximately 1 billion. If India was included in this scenario, then another 740 million vehicles would be added to the global fleet. Even at European ownership levels, China is still adding nearly 550 million vehicles. The automobile is officially touted as a symbol of progress and modernity for both China and India.

Ultimately, the policy may deflect investment from more pressing development needs. Chinese government surveys indicate that families are likely to be prepared to spend two years of income for a car (Gakenheimer, 1999).

The trends in car ownership are spurring a spending-spree on road-based infrastructure as well. At the end of 2004, China had 34,000 kilometres of motorways, more than double the 2000 figure; just 21 years ago, the nation had no motorways (Ministry of Transport of the PR China, 2005). By the end of 2009, China has almost doubled the length of its motorway again. China is effectively attempting to replicate 80 years of US-styled motorisation in the span of just a few decades. The following table shows the construction volume of the new motorways between 2005 and 2009 in China:

Year	Construction of the new motorways (km)
2005	6,457
2006	4,325
2007	8,059
2008	6,433
2009	4,391
Total 2005-2009	29,665

Source: China statistical yearbook 2005-2009

In cities such as Shanghai and Guangzhou the promotion of local automobile manufacturing is resulting in a discernible lack of emphasis on bicycles. In Shanghai mode share has gone from 33% in 1995 to 27% in 2000; in Guangzhou mode share has fallen from 33% in 1995 to less than 20% in 2002 (Hook, 2002). The impact on air quality has been profound. Shanghai officials, though, have become alarmed at the extreme growth rate of cars in the city, and have implemented a system to ration vehicle registration. A monthly auction system has been in place for several years. Nevertheless, the permitted number of registrations is being increased on a regular basis, which has no effect on tackling motorization. Even as the auction price becomes quite costly, even by developed-nation standards, there does not seem to be any slowing in the demand:

“The profusion of cars has launched a new cultural revolution, transforming Chinese life and society in ways that bear surprising resemblance to what happened in America 50 years ago... In Shanghai the bridges and tunnels crossing the Huangpu River are so congested that a cab ride from one side to the other can be an hour-long ordeal” (Chandler, 2003).

Many major Chinese cities have been also actively discouraging bicycle use through priority measures for automobiles and through the neglect of non-motorised infrastructure. A few Chinese cities have actually even banned bicycles from large sections of the urban area. The capital, Beijing, has also followed this trend:

“In Beijing, non-motorised vehicles are increasingly being squeezed by motorised vehicle parking in physically segregated non-motorised vehicle lanes and the reallocation of space in wide non-motorised vehicle lanes to through motorised vehicle traffic. On the Second Ring Road, the outside half of the non-motorised vehicle lane has been reassigned to motorised vehicles and the nearside half is used by buses and taxis. Non-motorised vehicle parking at work is increasingly being moved to distant inconvenient locations to provide more convenient space for motorised vehicle parking. A recent high-profile closure in Beijing of a commercial street at Xidan to non-motorised vehicles epitomizes current practice” (World Bank, 2001, p. 134).

However in recent years awareness is raising in many Chinese cities, that nmt- facilities should be preserved and extended. Te recent bike sharing systems in many Chinese cities are also encouraging.

Despite government efforts to prioritise industrial policy towards automobile manufacturing, the bicycle industry still employs a greater number of persons. The sector also generates over US\$1 billion a year in foreign exchange earnings (Hook, 2002). In 2001, of the 97 million bicycles manufactured worldwide, 51 million (53%) were manufactured in China. This production level represented a milestone by being “perhaps the first time ever that one nation has supplied more than half of global output” (Worldwatch, 2003). Unfortunately, the vast majority of this production, nearly 70%, is destined not for domestic use but rather for export (Worldwatch, 2003).

#### Political commitment

- *This section is adapted from Module 3d of our sourcebook*

Politically, it is often easier to implement an extremely expensive metro or highway project than even the simple improvement of a sidewalk. This is because any large construction project has large interests which stand to make a lot of money if the project is implemented, and therefore are willing to push government officials on a regular basis to ensure it is implemented. Politicians also stand to gain by being identified with the completion of public works. Even though basic improvements like the construction of sidewalks may do more to alleviate traffic congestion and road accidents than other projects costing hundreds of times more, the very low cost nature of these improvements makes it difficult to find a political constituency to ensure their implementation.

Historically, these sorts of projects have come about because someone with political power, money, and perseverance made them happen. The most recent large-scale non-motorised transport improvement was done in the city of Bogotá. In Bogotá, improving the city’s transportation system in this way was a major campaign promise of Mayor Enrique Peñalosa who was convinced of the importance of such measures. Support for the NMT improvements from the NGO community existed, but it was clearly the Mayor’s office which pushed it forward. Similarly, the pedestrianisation of downtown Curitiba, Brazil, was also pushed through by an enlightened Mayor (see Module 1a: *The Role of Transport in Urban Development Policy*). The prioritisation of bicycle use in the past in China was a decision by the highest levels of the national government and party, just as today the restrictions against bike use are being pushed through national level political pressure.

In other locations, pressure from bicyclists, NGOs, and international funding agencies has proven critical. The bike facilities in most large US cities, in Western Europe, in Central Europe (Krakow, Budapest, etc), in Bangkok, and the dramatic improvement in pedestrian facilities in Seoul clearly resulted from pressure applied to governments by NGOs and cycling federations. In Accra and Tamale (Ghana), in Tanzania, in Marikina, Manila (Philippines), Lima (Peru), Gdansk (Poland), Yogyakarta (Indonesia), and Santiago de Chile, new bike and other NMV facilities were given a strong push by international organisations such as the World Bank or UNDP, and often more specifically committed individuals within these institutions.

Other factors critical to ensuring implementation are good public education efforts through the media. If the Mayor fully supports the plans, he can use his access to media to push them forward. NGOs can also make clever use of the media to win popular support for NMT improvements.

Involving all the relevant stakeholders both inside and outside the government in the planning process from the outset, and letting them take ownership of the plans, is also likely to reduce significant obstacles to implementation.

### 3 Economic instruments for sustainable transport

- *This section is adapted from Module 1d of our sourcebook*

Economic instruments have a long history – both in developed and developing countries. Transport has always been used to generate state revenues. Many instruments that will be discussed in this

document, in fact, can be found in various forms of horse ownership charges, and road and bridge tolls in many countries' economic histories. Economic instruments thus are not new transport policy "tools." Yet they are under-utilised. They should be applied to help meet current economic, social and ecological challenges as has been started in some Chinese cities (Beijing annual fees, Shanghai plate restriction).

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*"... in no other major area are pricing practices so irrational, so out-dated, and so conducive to waste as in urban transportation."*

*William S. Vickery, 1996 Noble Prize laureate in Economics (quoted from ICLEI 2000)*

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Economic instruments have been mainly implemented in OECD (Organisation for Economic Cooperation and Development; a grouping of industrialised nations) countries. Increasingly, however, non-OECD countries recognise the potential of economic instruments. It enables them to both pursue development goals and to raise public revenues while simultaneously helping guarantee mobility in increasingly congested cities. It is crucial for policy-makers in developing cities to have a grasp of international experience with economic instruments and understand their potential contribution to sustainable development in their cities.

### 3.1 What are the policy options?

#### Approaches to regulation

Four different elements of an approach to regulation can be discerned:

- **Regulatory and planning instruments:** The regulatory approach administratively sets standards, restrictions, administrative procedures, and so on. Regulatory instruments follow a command-and-control approach.
- **Cooperation agreements:** Cooperative approaches try to get all the people engaged in a specific issue involved in a process of voluntary communication and negotiation.
- **Economic instruments:** Market-based approaches use economic incentives and/or disincentives to pursue a policy goal. The price mechanism serves as a vehicle for policy enforcement. Two basic instruments exist:
  - **price instruments** have an immediate influence on commodity prices, e.g., by imposing a tax on specific goods;
  - **quantity instruments** restrict the availability of a good and leave the formation of prices to the market. Auctions and bidding schemes are examples of quantity instruments in effect.
- **Information instruments:** Information about transport issues can serve as a basis for more rational transport decisions of transport users and suppliers. The choice of transport modes, the acceptance of policy measures and the use of vehicles can be improved through moral suasion and transport-related education. Information instruments include behaviour change campaigns, public information procurement and public acceptance monitoring.

Increasingly, policy makers are supplementing widely used regulatory instruments with cooperative agreements and economic instruments; these instruments allow them more flexibility in their pursuit of sustainability and are more efficient. In particular, direct price instruments, such as taxes and charges, are becoming a major policy focus. However, quantity instruments such as auctions are also being applied, as is the case with the Singapore vehicle quota systems and the auctioning of new car licenses in Shanghai.

#### Which types of economic instruments exist?

There are three basic types of economic instruments in transport policy:

- **Charges and taxes** should be levied as a means to reduce transport demand in general, discourage the use of certain modes of transport, or certain transport technologies. Charges are normally directly linked to the public provision of services (such as road use charge, parking fees, etc.), whereas taxes do not have this direct link to any particular service. Rather, they are seen as specific sources for the general budget. In many countries charges, fees, surcharges and so on can often be imposed by city governments, while taxes and excises can only be applied by the national level of government. This is for example the case in Indonesia, even after extensive city government fiscal autonomy was implemented in 2001.
- **Subsidies** aim at decreasing the cost of certain transport modes, such as public transport. That is, financial incentives encourage switches towards more favoured transport modes such as public transport, walking and cycling.
- **Auctions and bidding schemes** are used to put a price on transport in a regime that quantitatively restricts access to transport. When the number of cars is restricted, auctioning can assign licenses or certificates to those market participants with the highest willingness to pay.

Economic instruments can be applied in various forms and ways, the following table shows economic instruments in the OECD:

Implementation on...	Federal level	Local level
Differentiated fuel taxes (promote cleaner fuels)	✓	✗
Vehicle taxes (purchase, use, waste)	✓	✓
Property taxes, development levies	✗	✓
Road pricing (differentiated according to emissions, time, day, area, etc.)	✓	✓
Parking charges, taxes for parking	✗	✓
Subsidies for clean cars or for conversion	✓	✓
Fiscal incentives to remove older cars	✓	✓
Promoting/subsidizing public transport	✓	✓

Source: GTZ 2009, Transport Demand Management, [http://www.sutp.org/index.php?option=com\\_docman&task=cat\\_view&qid=97&Itemid=54&Itemid=196](http://www.sutp.org/index.php?option=com_docman&task=cat_view&qid=97&Itemid=54&Itemid=196)

### Why should economic instruments be used?

Economic instruments are characterised by their use of market forces, i.e. the price mechanism, to achieve policy objectives. Their use can be beneficial in developing cities for a number of reasons:

- **Revenue generation.** Price instruments usually generate additional revenues. In many countries fuel and vehicle taxes play a major role for state funding and financing of transport policy programs.
- **Market-economy compatibility.** By using the price mechanism as a vehicle for cost internalisation, market allocation processes are not distorted.
- **Enforcing the user-pays principle.** By charging for the use of infrastructure and vehicles, as well as for indirect costs such as congestion, pollution, noise and accidents, travellers pay for the costs of their transport.
- **Incentive-based transport policy approach.** As part of demand side management, economic

instruments can contribute to reducing transport demand, change the modal split by inducing substitution (e.g., in favour of public transport) and change transport behaviour. On the supply side, economic instruments can enable fair competition among the transport modes and induce incentives for technical change and higher efficiency of vehicles, transport infrastructure, and mass transit systems.

- **Dynamic incentives.** Economic instruments can set dynamic incentives for substitution, technical change and the research and development of pollution abatement technologies. An example is provided by the refinery upgrade process in Germany and Hong Kong. Normally a switch to refinery technology allowing production of ultra-low sulphur (< 10 parts per million) diesel would take more than a decade, but with tax incentives in place the upgrades in Germany were implemented in around three years.
- **Greater flexibility.** In general, economic instruments offer more flexibility than regulatory instruments as individuals and firms can more flexibly adapt to economic incentives than to administratively set restrictions.

### What are the limitations of economic instruments?

There are several drawbacks that possibly reduce the appeal of economic instruments in certain situations:

- **Initial public antipathy.** Perhaps the major obstacle to applying economic instruments is that politicians and the public tend to react negatively to new charges and fees.
- **Uncertainty about the right level of prices.** Correct prices require information about the level of internal and external costs. Due to valuation problems this information may not be adequately obtained, thus making it difficult to set levies at the “right” level. Furthermore, policy objectives can only be reached indirectly as economic instruments only set up a framework within which each individual makes his or her own decision. Such market reactions cannot be exactly predicted; hence the use of economic instruments may require several readjustments in order to reach a certain policy objective.
- **Uncertainty about the reaction lags.** Reaction times of market participants may be long. Increases in fuel prices, for instance, show only little reductions in fuel demand (so-called small elasticities) in the short run, but greater elasticities in the long run (*cf. Oum et al., 1990*).
- **Unpredictable and unstable revenues.** Despite their large potential to create revenue, economic instruments may sometimes provide a shaky basis for revenue generation. This is particularly the case with environmentally motivated price increases, which trigger substitution, technical change and a reduction of environmental use. This successful decrease in environmental use will thus correspond to a decrease in revenue.

Taking the above concerns into account, economic instruments should always be embedded in a broader policy strategy for sustainable transport. Economic instruments can be implemented in a step-wise manner as medium to long term policy measures to:

- improve the efficiency of the transport system, and reduce congestion
- set economic incentives for technical changes
- raise start-up capital for public transportation.

Economic instruments should be adjusted frequently and in a predictable manner.

### 3.2 Getting started in economic instruments

Implementing economic instruments within a sustainable transport framework requires strategic actions and decisions. The following steps are particularly important:

- 1 Set economic, environmental and social objective(s)

- 2 Conceptualise a comprehensive urban transport strategy
- 3 Evaluate feasibility of economic instruments
- 4 Choose the appropriate economic instrument and its specifications
- 5 Determine institutional requirements for implementation and control
- 6 Determine funding, financing and revenue allocation
- 7 Determine adjustment period and schedule for implementation (“action plan”)
- 8 Create and/or raise knowledge among citizens and acceptance.

### Step 1: Set economic, environmental and social objectives

In the first step the requirements for sustainability are broken down to the specific needs of the country or local community. Therefore, it is crucial to initiate a discussion process involving representatives of the major groups from decision makers in the administration and the public and those affected by transport and transport measures. Typically a working group consisting of the main stakeholders will be formed, including:

- several **public authorities** (including road transport office, legal office, public works office, press/public relations office, treasury/finance office, taxation office, parking office, traffic police, planning boards, environmental offices) and parliamentary representatives,
- **transport market participants** (e.g. private transport users, public transport associations),
- **Non-government organisations** (NGOs) with interest in environmental and social issues,
- the **press and electronic media**.

In order to avoid conceptual mistakes it is crucial to get all major stakeholders together and involve them in formulation of proposals from an early stage.

### Step 2: Conceptualise a comprehensive road transport strategy

Experience shows that transport policy is most effective when measures are taken as part of a comprehensive transport policy mix. To avoid conflicts between goals set in Step 1, measures must complement each other. Although there is no “blueprint” for ideal policy packages, general guidance can be drawn from recent experience.

As a first step towards a concept of a sustainable road transport policy it is important to analyse the existing policies and conditions, and to identify economic instruments already in use. Therefore, it is important to know and identify the special conditions in a country or community. For example, many “master plans” already include requirements for parking areas and zoning.

### Step 3: Evaluate the feasibility of economic instruments

The third step towards the use of economic instruments is the evaluation of their feasibility in the given transport policy context. Within this process the following questions have to be answered:

- **Appropriateness.** Are economic instruments appropriate to achieve the goals derived from Step 1?
- **Technical feasibility.** Is there a working price mechanism available? What kind of equipment and technical knowledge is required?
- **Financial feasibility.** What does it cost to implement and operate systems based on economic instruments (e.g., costs of technical equipment such as road toll booths, maintenance costs and staff)?
- **Institutional feasibility.** Are there sufficient institutional capacities to pursue set-up, implementation, enforcement, management and control of economic instruments?
- **Public acceptance.** Is there strong public resistance to economic instruments?

For most developed countries economic instruments are widely used, since in these countries sufficient institutional capacities are generally available.



Many developing countries, however, have little experience with economic instruments in urban transport policy. All countries have tax authorities and, hence, some institutional experience with economic measures. This experience can and should be used as a basis for the introduction of economic instruments, as is the case with some Chinese cities.

#### Step 4: Choose the appropriate economic instruments and their specifications

When choosing an economic instrument the following issues should be considered:

- **Type of instrument.** Which type of instrument shall be implemented? Which kind of incentive/disincentive structure shall be created? What is the object of regulation (emissions, fuels, vehicles, city entry, road use, technology, etc.)?
- **Specifications.**
  - Which burden/subsidy shall be levied/granted? Shall there be differentiated rates, and what kind of differentiation?
  - Who has to pay, or: who is eligible for subsidies?
  - How shall revenues be raised (time of payment(s), charging mechanism, etc.)?
- **Introduction.** What is the time-frame for phase-in procedures and the timing of strategies?

Any transport framework based on economic instruments should have the following key characteristics:

- **Comprehensibility and transparency.** Any instrument's pricing structure should be understood by users whose behaviour it is meant to influence; no undue transaction costs to identify the appropriate information should exist;
- **Stability and foreseeable development.** Measures should not fluctuate or be altered arbitrarily or in unpredictable ways, phase-in and/or phase-out periods should be carefully designed and well communicated;
- **Measurability, cost effectiveness and objectivity.** The data required to calculate charges etc. should be objectively measurable, cost-effective to collect and unambiguous to apply;
- **Cost recovery.** The costs imposed by the pricing scheme should reflect the real costs of transport;
- **Political and institutional support.** Political commitment is crucial for the implementation of economic instruments and for the setting up of institutions for their enforcement.

#### Step 5: Determine institutional requirements for implementation and control

In Step 5 several crucial institutional decisions should be taken:

- **Lead agency for setting up the program.** The lead agency is responsible for a successful planning, implementation and management of the project. Potential lead agencies include state agencies, local and regional agencies, new public entities, and private companies. The selection depends on various factors, including jurisdictional power needed for implementation, level(s) of government involved, public participation, the possibility that new authorities might better administer new programs, and experience and capacities of existing bodies.
- **Operation authorities.** Which kind of institutional body is necessary for the management and operation of economic instruments as part of a sustainable transport strategy? How many different state and private authorities are involved? In many developing and developed countries, however, a major obstacle to a comprehensive transport strategy is the division of powers among many different institutions and a lack of coordination between these authorities.
- **Involved jurisdictional bodies.** The third institutional issue corresponds to a clear understanding of which level of government has the jurisdictional authority and the administrative power to set up economic instruments.

### Step 6: Determine revenue allocation

A highly controversial issue is the allocation of revenues from economic instruments such as taxes and charges. Revenue allocation is a crucial factor for public acceptance of transport measures. There are five options for revenue allocation:

- Addition to the general budget. In this case economic instruments serve as an additional source of consolidated revenues.
- Earmarking for transport sector investment. The earmarking of revenues constitutes the basis for a self-financing of the transport sector. Revenues from the transport sector are dedicated to specific expenditure items in the transport sector.
- Earmarking of revenues for transport sector investment increases public acceptance of economic instruments. Revenues can serve as a basis for making alternative transport modes more attractive. Charges on individual car use make that mode of transport less attractive (push factor), whereas facilities for non-motorised transport and comfortable and reliable public transport at reasonable prices offers a promising alternative (pull factor). This approach is therefore often referred to as “push-and-pull” strategy.
- Many Eastern European countries, including Bulgaria, Hungary, Latvia, Lithuania, Poland, Romania and Slovenia, have Road Funds or earmarked schemes to allocate revenue from transportation charges to finance road maintenance, public transport and road safety measures.
- Revenue-neutral redistribution. In order to lower the overall tax burden on society as whole, additional revenue from economic instruments in transport policy can be rebated.

### Step 7: Determine adjustment period and schedule for implementation

Usually, before phasing in economic instruments, there is an extensive testing phase to determine and evaluate how a specific transport market reacts to the introduction of economic instruments. As a general approach, the introduction of economic instruments follows a multi-stage approach:

1. **Political plan of action, discussion and design** of economic instruments;
2. **Trial period** with selected testing areas, and evaluation of results;
3. **Redesign of economic instruments** according to evaluation results, and plan of action for actual phase-in procedures;
4. **Phase-in with modest rates and speed**, long adjustment periods, step-wise increases of rates;
5. **Evaluation of first results after some years**, cut-off point or redesign if necessary;
6. **Full implementation of measures**, and coordination of economic instruments with other measures;
7. **Control and readjustment of measures** for the time of use of economic instruments.

### Step 8: Change attitudes and generate acceptance

Successful implementation of economic instruments ultimately depends on political support and public acceptance. Any (additional) levy on private car or motorcycle ownership or use will be opposed if it is “sold” to the public merely as an additional charge instead of a contribution to improve the (city) environment, economy or social equity. For more details please see Module 1e: *Raising Public Awareness about Sustainable Urban Transport*.

## 3.3 Some examples of economic instruments

### Cordon / area pricing

#### Singapore’s Area Licensing Scheme and Electronic Road Pricing

Singapore introduced the Area License Scheme (ALS) in 1975, with the goal of reducing traffic during peak periods in the central business district. The system was based on vignettes and

proved highly successful. In 1998 the ALS was 'upgraded' into an Electronic Road Pricing (ERP) system introduced to cover the Central Business District and several large nearby expressways.

ERP is simply an electronic system of road pricing. It is designed to automate the road pricing system. The main difference is the pay-when-you-use principle. This is a fair system as the motorist is charged only if they pass the ERP gantry.

With ERP, motorists are more aware of the true cost of driving.

- Charges are levied on a per-pass basis and vary according to time and congestion levels.
- With this system of charging, a motorist will be encouraged to choose whether to drive, when to drive and where to drive.
- They may choose a different route, mode, destination, time of travel, or not to travel.
- They may decide to car-pool or use public transport.
- Those who choose to pay and stay on the road enjoy a smoother ride.

The advantages of ERP as a form of Mobility Management are that it is:

- *Fair*: Charges are based on usage so those who contribute more to congestion pay more, and those who use the roads less frequently or who travel during non-ERP hours pay less or receive larger rebates.
- *Convenient*: No need to buy daily/monthly paper licences.
- *Reliable*: Does not need human enforcement, thereby removing the potential for human error (adapted from <http://www.lta.gov.sg>).

Such applications are feasible for developing cities. Indeed, the Singapore system remains one of the few examples worldwide of a policy instrument which has achieved massive and sustained modal shifts in favour of public transport. Other, more recent experiences are available from London's road pricing scheme and from the 6 month similar experience from Stockholm. All such examples have provoked mode shifts, increased average speeds, and less private car use. The potential relevance of such road pricing instruments as a way of influencing travel demand in developing cities arises because:

- Developing cities often have a low road network density and relatively few roads into the city, which means that relatively few barriers or gantries would be required. In Surabaya, Indonesia for example, a World Bank-funded study (Dorsch Consult, 1998) recommended an Area Licensing Scheme as the only way of achieving the required modal shifts to avoid intolerable congestion in coming years.
- Recent technological improvements in the area of electronic road pricing, smart cards and intelligent transport systems (ITS) may help application in developing cities (for more information, please refer to Module 4e: *Intelligent Transport Systems*). The Philippines, for example, has recently implemented a 'smart card' driver's license scheme. The license includes the driver's name and address, as well as digital copies of a fingerprint, photo image, previous driving offenses, and total points on their record. Chinese cities have similarly showed strong interest in ITS applications and this technology could be applied to road pricing.

### **Trondheim's toll ring**

Although cordon pricing schemes have been proposed in detailed studies in many large cities, including developing cities such as Jakarta, Surabaya, Bangkok and Manila, there remain very few examples of successful applications. One such example is that of Trondheim, Norway, which implemented a toll ring surrounding the city.

Elements of the strategy include:

- 17 electronic toll stations;
- register traffic on access roads;
- electronic payment lanes to avoid queues;
- differentiated tolls;

- cars equipped with electronic tag;
- limited duration of the system (1991-2006);
- contracting-out of toll stations;
- revenues earmarked for transport investment;
- additional funding for road building, public transport, safety and environmental projects.

Features of the rate structure include:

- pay only once per hour on entry;
- basic toll level 1.5 Euro;
- heavy vehicles (> 3.5 t) pay double;
- maximum fee per month: 60 payments;
- free entry after 6:00pm on workdays;
- free entry at the weekends.

Results from Trondheim include:

- Greater road use efficiency: Changes in transport mode (from car to bicycle and walking), traffic reduction during tolled period, traffic increase on evenings and weekends.
- Less pollution.
- *Rise in "living conditions"*: Fewer waiting hours for public transport or in congestion, fewer delays in transport of goods.
- *Revenue creation*.

Lessons learned from Trondheim, which are equally applicable to developing cities considering area restriction schemes, include:

- Importance of public support for success of measure. In Trondheim this was achieved through behaviour change campaigns. Social and business concerns were stressed (traffic reduction for "environmentalists", transport capacity improved for "motorists").
- Acceptance increased as residents gained experience with the system and saw its benefits.
- Contracting out/privatisation is helpful.
- Only a policy mix will be successful, in this case a toll combined with improved public transit service and non-motorised transportation facilities.

### Odd/even schemes and their variations

Another strategy is to use licence numbers to control vehicle use at certain times and locations. Cracknell (2000) surveys experience:

1. Lagos, in the past, used the odd-even number plate applied to the centre of the city but the scheme is no longer operational;
2. Mexico City uses a scheme which prohibits car use throughout the federal district with number plates ending in "1" and "5" on Mondays, "2" and "6" on Tuesday etc. for the 5-day working week ("Hoy No Circula");
3. Bogotá uses a scheme in which 40% of private vehicles cannot operate in the city from 7:00–9:00am and from 5.30–7.30pm in accordance with designated number plates;
4. Santiago de Chile introduced a scheme which operated only on days on which atmospheric pollution reaches emergency levels. In this case, all vehicles except buses, taxis and emergency vehicles were prohibited from circulation in morning and evening peaks on the six principal road axes which connect the outer and centre of the city;
5. Sao Paulo uses a scheme over a wide central area (within the Inner Ring—about 15km diameter) in which 20% of vehicles ("1" and "2" on Mondays etc.) are prohibited from 07:00-08:00 and 17:00-20:00 for weekdays;
6. Manila uses a scheme which prohibits certain vehicles, again identified by number plates, from operating on the main traffic arteries during peak periods.

### Disadvantages of odd/even schemes

An odd/even system may:

- Encourage an increase in the number of vehicles owned, as a means for households to avoid restrictions. This may not be a problem if such vehicle restrictions are implemented just one or two days a year.
- Are vulnerable to fraudulent practices such as fake number plates.
- Generate increased taxi trips if taxis are excluded from the scheme. Taxi oversupply is a problem in Mexico City and Bogotá.
- Does not provide a long term solution as it will be undermined by growth in vehicle ownership over time; and
- May be undermined by concessions and exemptions for special vehicles.

### Advantages of odd/even schemes

On the positive side, odd/even schemes:

- Are often accepted by the public as they show a commitment by government to act to reduce congestion and related air pollution.
- Are less difficult to enforce than anticipated.
- Can provide temporary relief in order to develop something better, such as public transport priority measures.
- Assist road based public transport, at least in the short term, as average travel speeds increase (Bogotá reported a 20% increase in travel speeds after the odd/even scheme inception).
- Can help change behaviour in support of a motor vehicle 'restraint climate'.

## 4 Examples of Mobility Management strategies

- This section is adapted from Module 2b of our sourcebook

This section describes some examples of Mobility Management strategies. This is just a small sample of the full range of potential strategies available. For more specific information see the Victoria Transport Policy Institute's *Online TDM Encyclopedia* (<http://www.vtpi.org>).

### 4.1 Transportation market and pricing reforms

Motor vehicle travel tends to be underpriced: many of the costs of driving are indirect, borne by society in general rather than individual motorists. Many market reforms charge motorists directly for the costs they impose. This gives motorists an incentive to use vehicles more efficiently, and provides a new opportunity to save money by driving less. For example, if parking facility costs are subsidised through taxes or rents, motorists who reduce parking demand by shifting to another mode do not receive any savings. Charging motorists directly for parking lets motorists save when the parking costs they impose are reduced.

Many people assume that low transportation prices help stimulate economic development, but they actually tend to have the opposite effect. Underpricing transportation through low taxes and subsidies encourages inefficient transportation patterns, including use of fuel-inefficient vehicles and increased motor vehicle travel, which reduces overall economic productivity and increases consumption of imported goods. Reforms that reflect basic market principles such as marginal-cost pricing, cost recovery, economic neutrality and improved consumer options tend to increase overall productivity and economic development. This experience was especially made in economies with heavily regulated transport markets and prices, where as a consequent result transport intensities

were much higher compared to economies where market prices in transport were common. Specific market reforms are described following.

### Vehicle tariffs and industrial development

Countries can establish import and industrial policies to favour efficient- less polluting, energy efficient and less space consuming- travel modes. Non-motorised vehicles and buses can have relatively low import tariffs and taxes, while private automobiles and fuels can have relatively high tariffs and taxes to discourage their purchase.

### Road pricing

Road pricing means that motorists pay directly for using a particular roadway or driving in a particular area. It has two general objectives: revenue generation and congestion management.

*Congestion pricing* (also called *value pricing*) refers to road pricing used as a demand management strategy to reduce traffic congestion. Congestion pricing requires time-variable tolls, with higher during peak periods and lower or non-existent when roads are uncongested. Time-variable tolls can be based on a fixed schedule daily and weekly schedule or they can be *dynamic*, meaning that rates change depending on the level of congestion that exists at a particular time. It can be implemented on existing roadways to avoid the need to add capacity. Some highways have a combination of unpriced lanes and value priced lanes, allowing motorists to choose between driving in congestion and paying a toll for an uncongested trip.

Economists have long advocated road pricing as an efficient and equitable way to pay roadway costs and encourage more efficient transportation. However, consumers tend to oppose any new fee, and motorists can be a strong political lobby against road pricing, even in developing countries where they represent a small portion of citizens. Road pricing must therefore be presented as a package that provides a variety of benefits, and as a substitute for other equally unattractive taxes or fees.

It must be noted that road pricing should be implemented in conjunction with improved transportation options, so consumers have viable alternatives (for more details please see Module 1d).

### Revenue-neutral tax shifts

Since governments must tax something to raise revenue, many economists recommend shifting taxes from socially desirable activities to activities that impose external costs. For example, revenue from increased road use charges and fuel taxes could be used to reduce taxes on employment and general sales, resulting in less vehicle travel and more employment and business activity. This can provide multiple benefits, including economic development, environmental protection, and more efficient transportation.

Some developing country governments undertax or subsidise vehicle fuel as a way to minimise transportation costs, but this is poor public policy. It is not scientifically coherent, because most of the benefits accrue to wealthier consumers (because they drive more than average), and it encourages inefficient transportation habits, including larger vehicles and increased driving. Higher taxes on fuel and lower taxes on goods such as basic food products and tools tend to provide greater overall equity and economic development benefits.

### Neutral tax policies

An efficient tax structure is economically neutral. It would not favour automobile expenditures over other transport modes, transport over other consumer expenditures, or transport facilities over other investments. Some current tax policies unintentionally favour car use.

Employee parking subsidies are often exempt from income taxes, and land devoted to parking is often taxed at a lower rate than if the land was used for a building. This creates an incentive for employers to provide free parking as an employee benefit, but without parking cash out policies, employees using other modes receive no comparable benefit.

### Improved transportation pricing methods

Current transportation pricing methods have several problems. Fuel taxes and vehicle registration fees do not accurately reflect many of the costs imposed by a particular vehicle. Fuel tax revenue is likely to decline in the future as vehicles become more fuel efficient and shift to alternative fuels.

### Neutral planning and investment policies

Some current planning and investment practices favour car-oriented transportation improvements over other modes, and favour transportation over other types of public expenditures. (For more information refer to the "Comprehensive Transport Planning" chapter of the VTPI Online TDM Encyclopaedia.)

### How it is implemented

Most comprehensive market reforms require federal or state/provincial legislation. Some tax reforms (such as tighter controls over personal use of business vehicles) can be implemented by government agency administrative action. Road and parking pricing can be implemented at the local or regional level. Parking pricing, parking cash out and distance-based insurance can be implemented by businesses.

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***"Travel impacts are greatest if reforms are predictable and gradual, and if they are supported by other transport and land use reforms."***

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## 4.2 Freight transport management (for details see new module on Urban Freight from November 2010)

Freight transport management includes various strategies of increasing the efficiency of freight and commercial transport. Below are examples:

- Encourage shippers to use modes with lower social costs.
- Restricted delivery times in central business districts.
- Use of small and medium size vehicles with modern emission controls in the central city areas.
- Improve scheduling and routing to reduce freight vehicle mileage and increase load factors (e.g., avoiding empty backhauls), through increased computerisation and coordination among distributors.
- Organise delivery systems so fewer vehicle trips are needed to distribute goods (e.g., using common carriers that consolidate loads, rather than company fleets).
- Use smaller vehicles and human powered transport for local distribution.
- Implement fleet management programs that reduce vehicle mileage, use optimal sized vehicles for each trip, and ensure that fleet vehicles are properly maintained.
- Change delivery times to reduce congestion.
- Improve vehicle operator training to encourage more efficient driving.
- Heavy trucks represent a major share of total traffic on some highways, particularly around major ports, rail terminals and industrial areas. Because of their size, freight trucks impose relatively high congestion, road wear, accident risk, air pollution and noise costs, so travel reductions can provide significant benefits in areas where they are concentrated.

## 4.3 Parking management (for details see new module on Parking Management)

Parking management includes various strategies that result in more efficient use of parking resources. Parking management can help address a wide range of transportation problems, and is important in developing cities where space for parking is limited, and without careful management

vehicles tend to take over all available public space, including areas intended for pedestrians, markets, parks and green space.

## Parking management strategies

### Parking plan

Establish a municipal parking plan that identifies where parking facilities will be provided, how it will be managed and regulated, how public-owned parking facilities will be priced, and how parking regulations will be enforced. Perform parking supply and utilization surveys to identify and address problems.

### Limit parking supply

Cities should minimise the amount of public space devoted to car parking. For example, avoid converting public squares, streets, sidewalks and unused public land into car parking areas. Instead, create municipal and private off-street paid parking. On-street parking should only be provided where roads have sufficient space, it should not block traffic lanes, it should not displace sidewalks, and it should be regulated and priced to give priority to higher-value users (described below).

### Impose parking prices

As much as possible, motorists should pay directly for using parking spaces, with prices set to make the most convenient parking spaces available for short-term uses and to provide revenues for transportation programs. For example, on-street parking spaces, which tend to be the most convenient and so is most suitable for short-term uses such as deliveries and shopping, should have higher prices than off-street parking, which is more suitable for long-term use by commuters and residents.

For example, a strategy used successfully in Bogotá, Colombia as part of the city's program to reduce private car use was to increase public parking fees and to remove limits on the fees that private parking companies could charge. The additional revenue from the higher municipal parking fees is dedicated to road maintenance and public transit service improvements.

Parking pricing typically reduces parking demand – depending on the prices set- compared with unpriced parking. There are cities with very high parking fees, in London e.g. parking a car in the inner city can cost 30 Pounds, and higher, per day. Pricing of commuter parking, and time-variable rates (higher rates during peak periods) is particularly effective at reducing peak use. Charging motorists directly for the parking is more economically efficient and fair (horizontal equity) than unpriced parking that results in cross-subsidies from consumers who drive less to those who drive more than average.

When parking is priced, it is often leased by the month, with significant discounts compared with short-term pricing. This encourages motorists who pay the fee to drive in order to get their money's worth. It is more efficient to rent parking in smaller time blocks (hourly or daily rates), or to prorate monthly leases by days not driven. For example, if full-time parking costs \$100 per month, commuters who only drive 3 days a week should only pay \$60. This gives motorists more choices and a financial incentive to use alternative modes when possible.

### Cash out free parking

Cashing out parking means that commuters who are offered subsidised parking are also offered the cash equivalent if they use alternative travel modes as described earlier in the section on commute trip reduction programs. This can reduce automobile commuting by 15 – 25%, and is fairer since it gives non-drivers benefits comparable to those offered motorists.

### Parking maximums

Some urban areas limit the maximum amount of parking capacity allowed for various types of buildings or within a particular area as part of their Mobility Management programs. For example,



the City of Seattle allows a maximum of one parking space per 1,000 sq. ft. of downtown office space, and the City of San Francisco limits parking to 7% of a downtown building's floor area.

### **Bicycle parking**

Provide bicycle parking. Allow bicycle parking to substitute for minimum automobile parking in zoning codes, maybe even having equal amount of parking spaces for bicycles than for cars.

### **How it is implemented**

Parking management is usually implemented by local governments or individual businesses in response to specific parking and traffic problems. Transportation engineers and planners, either within public agencies or hired as consultants, are usually responsible for performing parking studies, evaluating parking solutions and developing parking management plans.

Below is the typical process for developing a parking management plan:

1. *Define general problems to be addressed (parking congestion, traffic congestion, excessive parking facility costs, poor pedestrian environments, etc.) and the geographic areas to be considered.*
2. *Perform parking study that includes:*
  - A parking supply inventory (how many spaces exist of each type of parking: public and private, on- and off-street, short- and long-term, free and paid, etc.) for each geographic area.
  - A parking utilisation study (what portion of each type of parking is used at various time, particularly peak-periods) for each geographic area.
  - Projections of how parking supply and demand are likely to change in the future, taking into account expected changes in land use, population, commercial activity, travel patterns, etc.
  - Use this information to identify when and where parking supply is or will be inadequate or excessive.
3. *Identify potential solutions.*
4. *Work with all related stakeholders to prioritise options.*
5. *Develop an integrated parking plan that identifies changes in policies and practices, tasks, responsibilities, budgets, schedules, etc.*

## **5 Land use and transport: problems and solutions**

- This section is adapted from Module 2a of our sourcebook

Urban space has to serve a variety of human needs: housing, working, social interaction, leisure, and mobility of persons and goods. Human beings also need nature within their living areas; green spots for recreation and relaxation in a harmonic society. Trees, parks and other greenery helps provide healthy living conditions by cleaning the air of pollutants, absorbing noise, and regulating humidity. Beyond this direct anthropocentric (human-centred) perspective, conservation of natural habitats is necessary for maintaining the functioning of ecosystems of all life on earth.

To create or preserve a liveable urban environment, the requirements of these functions have to be balanced against each other. Land use planning serves this process of balancing competing demands on limited urban space. The aim of the Module 2a of our sourcebook is to provide information and to disseminate experiences in dealing with relationships between land-use structures and transport, and to discuss strategies to support the realisation of more sustainable urban transport by land-use planning. This section introduces several of the key aspects which will be considered in more detail in following sections.

## 5.1 Land use for transport purposes

Mobility, especially in the form of motorised transport requires an increasing share of land, both within cities and in rural areas. Cities in highly motorised countries dedicate much of their urban area for roads; typical figures for US, Japanese and European cities being about 15 to 25 percent while clearly US cities are on the higher margin, whereas less space is dedicated to roads in European and Japanese cities.

Chinese cities, on the contrary, devote only about 5 to 7 percent of their urban area to roads. On a per-capita basis, in Shanghai each person has an average of 9 m<sup>2</sup> of road space (China National Knowledge Infrastructure, CNKI 2005) while a New Yorker has more than 26 m<sup>2</sup>. Thus, there is a clear difference in available road space per person. In the course of their historic development, societies with high rates of automobile ownership have dedicated increasing shares of urban space for automobile use, and at the same time the population density in these cities has decreased. Is this the direction cities in developing countries have to go to, in order to improve traffic conditions? Planners in developing countries often cite these figures in favour of large road network construction programs. For example, Shanghai has increased the length and the area of paved roads from 1991 to 1997 by 18.6 and 41.6 percent, respectively, expanding especially the network of broad multi-lane and elevated expressways. Per capita road area increased from 4.7 to 6.5 m<sup>2</sup>. In light of the international data, this strategy seems to be logical, but it is highly questionable whether building more roads is a scientifically valid solution to provide sustainable improvements of the traffic situation. The amount of congestion on main arteries in New York may be even worse than in Shanghai, as it is in Los Angeles. Although published cross-city comparisons of average traffic speeds indicate that the worst situation is in Manila, Bangkok, Jakarta (and meanwhile Beijing) and that some other megacities in Asia also show unsatisfactory traffic flows, this kind of data is not a valid justification for heavy road construction programs. The interaction between transport and land use, and the dynamics of related developments must be considered. It has been proven that increasing road space will reduce the quality of the urban environment, prevent people from walking and cycling, and force those households who can afford it to move into cleaner and less noisy exurban areas.

North American urban development models in particular do not provide good guidance for densely populated Asian and Latin American regions. The views from Seattle and Singapore demonstrate differences of urban forms and land use for transport. While US development created urban wasteland, Asian as well as European cities show high densities and a variety of functions. There are lower densities in some US cities when compared to rural Java/Indonesia!

Living and transport conditions vary sharply between developing cities. Transport solutions have to be adapted to local conditions and needs. A US city is normally one in which broad arteries provide space for large cars. But this type of road does not reflect the needs of the people living without a car in a non-car environment. What conclusion can be drawn for the priorities in urban transport policy?

The examples show that simple comparisons of average road space between cities do not in themselves justify additional road infrastructure investments. Car ownership rates differ significantly, as does trip demand and travel distances. A car-oriented life-style is out of reach of most people in developing countries. It is true that private car ownership increases at high rates, as well as the demand for other motorised transport services. This leads to overload of existing roads, congestion, and environmental degradation of urban space. But international experience clearly shows that comprehensive construction programs will not be able to cope with the automobiles' demand for road space. Additional road space will be soaked up in a short while with additional vehicles. Induced demand will follow. This can be easily seen in Shanghai and Beijing: with an annual increase of 20% of additional private car registration, there is no way to escape traffic congestion even with the most accelerated road investment program.

Planners all around the world know that car-based urban transport is not a sustainable development path – neither with respect to urban functions nor to the environment. Only public transport can assure mobility in large cities. And only by preserving good conditions for walking and cycling it is possible to maintain a satisfactory level of urban quality.

What kind of urban development and what land use planning support sustainable transport?

## 5.2 Interaction between land use patterns, transport and the environment

The spatial distribution of housing, working, shopping, leisure, and other activities determines average trip distances in urban transport. High population density, as well as a mixture of land uses for various social and economic activities, maintains low distances between origins and destinations of urban trips. Conversely, low-density development and large road areas increase trip lengths and lead to a higher share of automobile trips.

By influencing the spatial structure of locations in the urban environment, land use planning can contribute to a reduction of kilometres driven, and support a high transit share. Dense and mixed-use development helps to keep walking and cycling attractive. These are the most environmentally friendly transport modes. International comparative scientific studies have indicated that there are close links between population density, motor vehicle use and per-capita energy consumption in the transport sector. Given the high specific emissions per kilometre of motor vehicles in developing countries, the amount of traffic generated by unfavourable spatial structures directly affects air quality and urban economy.

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*“A new attitude has risen that the urban planning paradigms of the past need to be changed, and sprawl development needs to be combated.”*

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Further, oil consumption and greenhouse gas emissions will inevitably increase rapidly if transport and land use policies in developing countries follow the kind of spatial transformation which the highly motorised countries have undergone. There is a “vicious cycle” of car traffic leading to deteriorated living conditions, heading to suburbanisation and transforming the rural areas into settlements, in which households are dependent on the private car for daily mobility. Increasing car use again follows the traffic spiral, when more roads are built to satisfy car commuters, transforming precious urban land into wasteland.

In Europe, Japan and even North America a new attitude has risen that the urban planning paradigms of the past need to be changed, and sprawl development needs to be combated. These insights are based on local experiences, on the observation that congestion and travel-times are ever-increasing, and on the monetary burdens caused for private and public budgets.

Additionally, there are the concerns for the local environment, especially air pollution, noise, groundwater pollution from run-off, loss of soil functions, and loss of biodiversity. And then there are the global concerns with respect to energy resources and greenhouse gas emissions that have been discussed above. International climate policy has begun to initiate reduction commitments, which put energy-saving land use policies on the agenda. This has contributed to a critical attitude towards the amount of automobile use – some name it automobile dependency – in Europe and increasingly also in North America. The Kyoto Protocol is just the beginning; future negotiations will require the developing countries to also contribute to greenhouse gas emission reductions.

How can urban land use planning contribute to future responsible mobility with less emissions and energy consumption?

## 5.3 Managing conflicting demands for urban space

Mobility of passengers and of goods is a necessary element of social and economic interaction, forming the basis for progress and welfare by bringing talents and skills together. Division of labour increases productivity, at the cost of increasing transport activities. Migration and population growth causes additional requirements for housing and other land uses. Individualisation of lifestyles and liberalisation of economic activities transform into market forces which compete for scarce urban space. Harmonic cities need to balance economic, social and environmental requirements against limited space. Besides the competition between housing, shopping, green

areas and roads within the traditional urban boundaries, there is the problem of occupying agricultural land by suburbanisation of the various urban functions. Historically, cities have been located in fertile areas where agricultural production could feed the urban population.

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**“Land-use planning should aim at creating transport-avoiding structures.”**

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Even if current agricultural production in developing countries may be sufficient in total quantity, loss of resources for nearby food production increases the volume of goods transported over longer distances. Sustainable regional development, on the contrary, would aim at the preservation of agricultural production within close proximity to the urban population. In general, regional manufacturing would provide opportunities for less transport activities, but under current transport price conditions other cost factors dominate the spatial decisions, resulting in larger production and distribution networks.

Although market pressures in most countries work in favour of low-density, space-consuming settlement decisions, land-use planning should aim at creating transport-avoiding structures. Involvement of the public may support this concept, and back the decisions of planners against interest groups.

#### 5.4 Design and implementation of land use plans

Land use planning is necessary to assure sound urban and balanced regional development. European and Japanese municipalities have a long-standing tradition in land use planning, and have made some important achievements in maintaining good urban structures. In developing countries there is an increasing awareness of the need for steering urban development in order to avoid unsustainable structures, but institutional capacities and legal provisions for land use planning typically are weak. Without acknowledgement of the interactions between land use planning, urban growth and transport development, no sustainable transport system will emerge, neither with respect to economic nor to social and environmental criteria. Setting priorities on road network capacity extensions without a clear vision of spatial development has failed to mitigate congestion everywhere in the world. An increase in traffic capacity, especially on commuter expressways in urban areas, results in a rise of traffic demand that erodes much of the capacity-enhanced traffic improvements.

#### 5.5 Smart growth – land use management strategies

*Smart growth* is a general term for scientific land use practices that create more accessible land use patterns which reduce the amount of travel needed to reach goods and services. Smart growth is an alternative to urban sprawl.

It must be noted that land use and urban planning paradigms in China are different from the European paradigms described throughout this document. There are crucial elements such as the great conversion of rural lands for urban development, which should be thought-over critically. Thus, an alternate approach must be developed for China, though taking into account the key principles outlined below. Smart growth includes a number of individual policies and practices, such as those listed below. Objectives and strategies differ depending on whether an area is urban, suburban or exurban. Land use planning and Smart growth concepts are discussed in more detail in Module 2a: *Land Use Planning and Urban Transport*.

#### Smart growth practices

- *Strategic planning*. Establish a community “vision” which individual land use and transportation decisions should support.
- Create more self-contained communities. Reduce average trip distances, and encourage walking, cycling and transit travel, by locating schools, shops and recreation facilities in or adjacent to residential areas.

- *Foster distinctive, attractive communities with a strong sense of place.* Encourage physical environments that create a sense of civic pride and community cohesion, including attractive public spaces, high-quality architectural and natural elements that reflect unique features of the community, preservation of special cultural and environmental resources, and high standards of maintenance and repair.
- *Encourage quality, compact development.* Allow and encourage higher density development, particularly around transit and commercial centres. Demand high quality design to address problems associated with higher density.
- *Encourage infill development.* Locate new development within or adjacent to existing urban areas. Encourage redevelopment of older facilities and brownfields.
- *Reform tax and utility rates.* Structure property taxes, development fees and utility rates to reflect the lower public service costs of clustered, infill development, and encourage businesses to locate in accessible locations.
- *Concentrate activities.* Encourage walking and transit by creating “nodes” of high-density, mixed development linked by convenient transit service. Concentrate commercial activities in these areas. Retain strong downtowns and central business districts. Use access management to discourage arterial strip commercial development.
- *Encourage transit-oriented development.* Encourage dense development within walking distance (0.4 to 0.8 km) of transit stops, and provide high quality pedestrian and cycling facilities in those areas.
- *Manage parking for efficiency.* Encourage shared parking, and other parking management strategies. Reserve the most convenient parking for rideshare vehicles (see chapter above on parking management)
- *Avoid overly-restrictive zoning.* Reduce excessive and inflexible parking and road capacity requirements. Limit undesirable impacts (noise, smells and traffic) rather than broad categories of activities. For example, allow shops and services to locate in neighbourhoods provided they are sized and managed to avoid annoying residents.
- *Create a network of interconnected streets.* Keep streets as narrow as possible, particularly in residential areas and commercial centres. Use traffic management and traffic calming to control traffic impacts rather than dead ends and cul-de-sacs.
- *Site design and building orientation.* Encourage buildings to be oriented toward city streets, rather than set back behind large parking lots. Avoid large parking areas or other unattractive land uses in commercial areas.
- *Improve non-motorised travel conditions.* Encourage walking and cycling by improving walkways, street crossings, protection from fast vehicular traffic, and providing street amenities (trees, awnings, benches, pedestrian oriented lighting, etc.). Improve connections for non-motorised travel, such as trails that link dead-end streets.
- *Preserve green space.* Preserve open space, particularly areas with high ecological and recreational value. Channel development into areas that are already disturbed.
- *Encourage a mix of housing types and prices.* Develop affordable housing near employment, commercial and transit centres. Develop second suites, apartments over shops, lofts, location-efficient mortgages and other innovations to help create more affordable housing.

### How it is implemented

Smart Growth is usually implemented as a set of policies and programs by state/provincial, regional or local governments. Implementation often requires policy and institutional reforms, and multi-jurisdictional coordination.

## 6 Two- and three-wheelers and urban transport systems

A detailed discussion of transport system issues relating to two- and three-wheelers is beyond the scope of this module. In this section some of the key issues are highlighted. For details please see Module 4 c of the sustainable urban transport sourcebook

### 6.1 Two- and three-wheelers in developing Asian cities

Two-stroke engine vehicles in developing cities in Asia fall into two categories, two-wheelers and three-wheelers. Two-wheelers include mopeds, scooters, and motorcycles and are used mostly for personal transportation, though in Bangkok and some other cities – including in Vietnam and Indonesia – motorcycles are also used for public transportation or paratransit. Three-wheelers include small taxis such as auto-rickshaws in India, and Sri Lanka, baby taxis in Bangladesh and tuk-tuks in Thailand - usually for carrying three passengers - and larger vehicles such as Tempos in Bangladesh, Nepal and parts of India, which carry as many as a dozen passengers.

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*"Vietnam, Thailand and Indonesia each have motorcycle sales in excess of one million units per year, and a bike is considered family transport throughout the region."*

*Autoasia Magazine, Oct. 2002, p5*

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Two- and three-wheelers play an important role in the transport market in Asia. India, China, Vietnam and Indonesia have a very large number of two-wheelers, which are used mostly for personal transport. Three-wheelers are typically used as short-distance taxis. In Sri Lanka some families are buying three-wheelers for private use, attracted by the lower price of the vehicles relative to passenger cars. More than half of the motor vehicle fleet in China, Thailand and Malaysia consists of two-wheelers; in Indonesia, Vietnam and Taiwan (China) the figure exceeds two-thirds of the fleet. There is a great dominance of two- and three-wheelers in the vehicle fleets of Dhaka (Bangladesh), Ho Chi Minh (Vietnam), Denpasar (Indonesia), and Delhi (India). However, there is not always a close correspondence between the number of vehicles registered and those in use, so it is important to use reliable data in analysis.

Three-wheel taxis are perceived as less compliant with traffic regulations and more accident prone than four-wheel vehicles. They are also more visible, because of their numbers, and contribute to congestion and pollution. For these reasons there is strong sentiment in some countries, notably Bangladesh, against two-stroke engine three-wheelers.

An expert committee appointed by the Government of India completed a scientific study of urban road traffic and air pollution in major Indian cities. This included an assessment of the share of different modes of transport in these cities (Government of India, August 2002, [http://www.petroleum.nic.in/afp\\_con.htm](http://www.petroleum.nic.in/afp_con.htm)). Findings of this study with respect to Delhi, the city with the highest motor vehicle population in the country (around 3.5 million registered vehicles) and among the most polluted cities in the world. Two-wheelers account for more than half of the personal transport and three-wheelers take up a major share of the public transportation in the city. The share of buses, in comparison, is very small.

### 6.2 Public transport issues

In general, in developing cities in Asia motorcycles offer a significantly cheaper and faster mode of travel compared to public transport. Further, due to unattractive public transport services, people tend to use motorcycles even considering the disadvantages of exposure to sun and rain

(especially during the wet season), and the significantly higher risk of accident compared to bus transport.

Cost structures for a typical 8 km trip in Denpasar, Bali, combined with the poor service offered by public minibuses and minibuses, have led to a share of public transport passenger trips of less than 5% in Denpasar. Similar situations apply in other 'motorcycle cities' such as Ho Chi Minh City, where even less than 5% of trips are made by bus.

In the short term high levels of motorcycle usage may not appear to present a problem. After all, motorcycles are efficient users of road space, with an average occupancy in many Asian cities of around 1.5 and average occupancy of motorcycles only slightly less than car occupancy in a city such as Surabaya (TERI, 1993 reported that average motorcycle occupancy in Indian cities was 1.5 and that of cars around 2.6). However, in the medium and long term such 'motorcycle dependency' may lead to intolerable congestion and associated air pollution. Such unsustainable trends are the result of increasing motorcycle and car ownership and usage as incomes rise.

### **The outlook for a motorcycle city**

Forecasts made for Denpasar, Bali by a World Bank-funded study in 1999 illustrate the fact that the 'motorcycle cities' seem to be on an unsustainable path. Future levels and patterns of transport demand were forecasted using a public transport planning model developed by the study (BUIP, 1999).

The numbers of motorcycles were predicted to grow by a modest average of 2.8% per year between 1998 and 2018, and the numbers of cars by 5.2% per year. Even so, by 2018, there will be 72% more motorcycles and 173% more cars on the roads. Between 1998 and 2018, the number of motorcycles per person is predicted to rise from 0.32 to 0.34 and the number of cars from 0.07 per person in 1998 to 0.12 in 2018, reflecting predicted increases in household incomes.

In the absence of any policy to alter the balance between private and public transport, motorcycles' share of all trips will fall from 75.6% to 70.8%, cars' share will increase from 19.9% to 24.9%, and public transport's share will continue at around its present very low level.

The implications are clear: even with all planned roads completed by 2018, there will remain serious problems of traffic saturation and associated environmental deterioration. These problems will occur in the areas least able to cope with them: the historical and cultural heart of central Denpasar and the residential suburbs.

As well as the negative implications of increasing motor vehicle dependency in dense developing cities, we can foresee that prevalence of motorcycles may support more dispersed activities in urban areas, further undermining any future role of a viable public transport industry.

### **6.3 Road safety issues**

The prevalence of motorcycles in urban transport systems in developing cities raises serious safety concerns, in at least two areas:

- Motorcycles tend to drive bicyclists off the street, literally and figuratively. Most clearly in a city such as Ho Chi Minh City, but also to varying extents in other Asian cities, rapid growth of motorcycles has coincided with rapid declines in the use of bicycles. Part of the reason is undoubtedly that bicycles are crowded out by motorcycles, with cyclists more likely to fall in the event of a collision with a motorcycle.
- In the event of an accident, motorcyclists have little protection from injury, especially in developing cities in Asia where road safety laws are often not enforced. In Vietnam, for example, nearly 1000 people are killed each month from road accidents, the vast majority motorcyclists. Road traffic accidents account for over 90 %of accidents in Vietnam ("Road Toll Careers Toward Last Year's Nightmare High", *Vietnam News*, 30 October 2002).

#### 6.4 The problem of two-stroke engine emissions

Air quality is deteriorating in the developing cities of Asia; a by-product of rapid urbanisation. The experience in South Asia is typical of the region. Of the 1.3 billion people living in Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka in 1998, 350 million – 27% of the combined population – lived in urban areas. The average population growth in urban centres, 3.2% a year between 1990 and 1998, was much higher than the 1.3% growth rate for the population as whole.

A major source of air pollution is emissions from the rapidly rising number of motor vehicles. In India the number of registered vehicles quadrupled in 12 years from 10.6 million in 1986 to 40.9 million in 1998, an annual average rate of growth of 12%. The number of vehicles grew rapidly in other countries in the region as well, increasing at an annual rate of 8.2% in Bangladesh (1990–96), 13.5% in Nepal (1990–99), 8.0% in Pakistan (1990–99), and 7.3% in Sri Lanka (1990–97). In the absence of cleaner technologies and stringent control measures, the level of vehicular emissions is expected to increase at similarly high rates.

Two-stroke gasoline engine vehicles are estimated to account for about 60% of the total vehicle fleet in South Asia, however the share is decreasing. The proportion is also high in other developing Asian cities. The large number of these vehicles, their age, poor maintenance, low lubricant quality and excessive lubricant use, and traffic congestion in large cities make two-stroke engine vehicles a significant source of particulate emissions.

Two-stroke engines have several advantages over four-stroke engines. These include lower cost; excellent torque and power; mechanical simplicity (fewer moving parts and resulting ease of maintenance); lighter and smaller engines; greater operating smoothness; and lower nitrogen oxide emissions. They however have serious disadvantages compared with four-stroke gasoline engine vehicles, including higher particulate and hydrocarbon emissions, lower fuel economy, and louder noise.

#### 6.5 Types of emissions

Gasoline engines contribute to air pollution by emitting high levels of particulate matter (in the case of two-stroke engines), lead if leaded gasoline is used, carbon monoxide, nitrogen oxides, and volatile organic compounds. Diesel engines emit high levels of particulate matter, nitrogen oxides, and sulfur oxides (if the level of sulfur in diesel is high).

The pollutant of special concern in developing cities in Asia is small particulate matter because of its high ambient concentrations and documented impact on morbidity and premature mortality. The level of particulate matter with an aerodynamic diameter of less than 10 microns ( $PM_{10}$ ) exceeds internationally accepted standards by several times in a number of cities in Asia. Two major contributors to high ambient concentrations of  $PM_{10}$  in the transport sector are two-stroke engine gasoline vehicles and heavy duty diesel vehicles.

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***“Two major contributors to high ambient concentrations of  $PM_{10}$  are two-stroke engine gasoline vehicles and heavy duty diesel vehicles.”***

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Recent data from scientific tests done in the fall of 2000 at ARAI (the Automotive Research Association of India), indicate that particulate emissions levels of in-use three-wheelers from Dhaka (engine size of 150 cubic centimetres) show that 7-year old vehicles using excess "straight mineral oil" emit particulate matter up to ten times, and that 4-year old vehicles using "straight mineral oil" emit particulate matter roughly two to three times, the typical values obtained in the United States in the 1970s. For both ages of vehicles, particulate emissions are much less if the correct amount of 2T oil, formulated specifically for use in two-stroke engine vehicles, is used.

Since two-stroke engine vehicles emit significantly more unburned gasoline than four-stroke engines, they emit more organic lead if leaded gasoline is used. Organic lead is much more damaging to public health than inorganic lead formed by combustion of lead additives. Lead



emissions are a problem in countries such as Pakistan that still sell only leaded gasoline. Fortunately, Bangladesh phased lead out of gasoline in July 1999, India in February 2000, and Pakistan and Sri Lanka are considering strategies for eliminating lead in gasoline.

## 6.6 Factors exacerbating emissions

Poor vehicle maintenance, the misuse of lubricant, the adulteration of gasoline, and the lack of catalytic converters exacerbate two-stroke engine emissions, resulting in emissions well above applicable standards. In addition, many drivers use lubricants and fuels of poor quality.

### Misuse of lubricant

Both the quantity and quality of lubricant used affect the level of hydrocarbon and particulate emissions from two-stroke engines. Vehicle manufacturers recommend adding 2% lubricant for two-wheelers and 3% lubricant for three-wheelers. But many drivers of three wheelers add considerably more lubricant for several reasons:

- lack of knowledge about the correct amount to add
- lack of knowledge about the adverse effects of excess lubricant
- addition of excess lubricant to gasoline by filling station attendants at the point of sale
- perception that more lubricant will provide greater protection against piston seizure
- perception that more lubricant will increase fuel economy
- lower miscibility of straight mineral oil and conventional motor oils with gasoline compared to 2T oil.

Excessive use of lubricant increases combustion chamber deposits and fouls spark plugs. When pistons and rings are badly worn, excess lubricant may postpone piston seizure for a while. But the adverse social effects of much higher emissions far outweigh benefits to vehicle owners.

Lubricant requirements for two-stroke engines differ from those for four-stroke gasoline engines: good lubricity; piston cleanliness; low deposits, especially in the exhaust system; and low smoke emission. Two-stroke engine vehicles should use specially formulated 2T oil. Because polyisobutene of moderate molecular weight tends to decompose without leaving heavy deposits, polyisobutene thickener in a base stock is increasingly used in lubricant. Japan has taken the lead in developing new motorcycle oils referred to as low-smoke or smokeless lubricants. Many three-wheelers do not use the 2T oil recommended by vehicle manufacturers. Instead they use straight mineral oil or new or recycled engine oil, which results in greater deposit buildup and higher emissions (see margin note). The principal reason for using these oils is their lower cost, although some drivers may be under the impression that these more viscous oils provide greater engine protection. In some countries, such as Bangladesh and Sri Lanka, 2T oil is not readily available at filling stations.

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*"Three-wheelers are driven much more than two-wheelers and require frequent maintenance."*

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Conventional motor oils do not mix well with gasoline. Their use in two-stroke engine vehicles results in insufficient lubrication when oil does not reach the engine and high emissions when it does. Long-term use of conventional lubricants results in premature wear of the engine and higher maintenance costs.

### Inadequate vehicle maintenance

Because they are mostly used commercially, three-wheelers are driven much more than two-wheelers and require frequent maintenance. But drivers often fail to maintain their vehicles

properly. The problem of maintenance is particularly severe when drivers lease their vehicles, because neither the driver nor the owner feels solely responsible for the mechanical condition of the vehicle.

Vehicular emissions are exacerbated by the age of the vehicle fleet and the poor state of vehicle maintenance. A study in the United States found that poorly maintained vehicles, which represented 20% of all vehicles on the road, contributed about 80% of total vehicular emissions (Auto/Oil Air Quality, 1997). Recently three baby taxis in Dhaka, Bangladesh, from four to seven years old were randomly selected for mechanical inspection. The engineers inspecting the engines found evidence of considerable ad hoc, unauthorized repairs and modifications. A combination of inadequate or improper maintenance and repairs by poorly trained mechanics contributes to the poor mechanical state of many vehicles in developing Asian cities.

### **Adulteration of gasoline**

Emissions by all gasoline vehicles are exacerbated by the adulteration of gasoline with kerosene. Kerosene has a higher boiling point than gasoline and is thus more difficult to burn. As a result more deposits build up in the engine and more unburned hydrocarbons are emitted in the exhaust gas. Anecdotal evidence suggests that adulteration of gasoline is widespread in South Asia, for example, because of the significantly lower retail price of kerosene. Limited sampling and testing of gasoline by the World Bank in Dhaka in 1998 also indicated that a significant fraction of gasoline had been adulterated.

### **Lack of catalytic converters**

Catalytic converters – installed in passenger cars in many parts of the world where unleaded gasoline is readily available – cannot be used to convert a high proportion of hydrocarbons in two-stroke engines because current designs result in greater exotherm (heat of reaction) and the sintering of precious metals, which deactivates the catalyst. The tendency of two-stroke engines to misfire under low load conditions further aggravates the problem of catalyst deactivation. Despite these limitations oxidation catalysts – which lower the emission levels of hydrocarbons and carbon monoxide and to some extent reduce the amount of fine particles emitted in the form of oil droplets – have been used in Taiwan (China) to meet increasingly tight emission standards. Beginning in 2000 these converters are installed in all new two-stroke engine two- and three-wheel vehicles in India also to meet the stringent emission standards enforced there.

## **6.7 Impacts of emissions**

### **Health impacts**

Research in various cities and countries has shown that  $PM_{10}$ , and especially  $PM_{2.5}$  (particles with diameters of no more than 2.5 microns, called fine particulate matter), are extremely damaging to public health. These particles are associated with respiratory symptoms, exacerbation of asthma, changes in lung function, and premature death (for more background information see Module 5a: *Air Quality Management*).

The health impact of particulate matter increases as the size of the particle diminishes. Very fine particles – such as those emitted by the combustion of transportation fuels – are believed to be particularly harmful. In addition, the fact that they are emitted near ground level, close to where people live and work, suggests that vehicular emissions are even more harmful than their share in total emission loads might indicate. The health impact of oil droplet-based particles is not well understood. Most health impact studies have been carried out in countries that do not have large two-stroke engine vehicles, where the principal sources of fine particulate emissions are diesel vehicles and stationary sources. In all of these studies, sickness and death are regressed against the overall ambient particulate concentrations measured in terms of total suspended particles or  $PM_{10}$ , not against vehicular particulate emissions. Most of the particulate matter from two-stroke engines is soluble organic matter, whereas particulate matter from diesel vehicles and stationary sources contains a significant amount of graphitic carbon. Their behavior in the atmosphere in terms of nucleation, agglomeration, dispersion, and condensation could be quite different. This area of research merits further investigation.

## 7 Mass Rapid Transit options and BRT

- This section is adapted from Module 3a and 3b of our sourcebook

- Bus Rapid Transit Planning Guide from ITDP ([http://www.itdp.org/index.php/microsite/brt\\_planning\\_guide/](http://www.itdp.org/index.php/microsite/brt_planning_guide/)), a Chinese Version is currently under translation

The distinction between many MRT concepts is fluid, and many different approaches are commonly used to distinguish the different modes and features of various MRT systems. Apart from basic defining features such as cost, capacity, and technology, other features used to delineate MRT systems might include distance between stops, extent of right-of-way, operational regimes, and guidance systems. For the purposes of this module we have distinguished between four general forms of Mass Rapid Transit: Bus Rapid Transit, Metros, Commuter Rail, and Light Rail Transit.

### Mass rapid transit

Mass rapid transit, also referred to as public transit, is a passenger transportation service, usually local in scope, which is available to any person who pays a prescribed fare. It usually operates on specific fixed tracks or with separated and exclusive use of potential common track, according to established schedules along designated routes or lines with specific stops, although Bus Rapid Transit and trams sometimes operate in mixed traffic. It is designed to move large numbers of people at one time. Examples include heavy rail transit, light rail transit, and Bus Rapid Transit.

### Heavy rail transit

A heavy rail transit system is “a transit system using trains of high-performance, electrically powered rail cars operating in exclusive rights-of-way, usually without grade crossings, with high platform stations” (TCRP, 1998).

### Metro

Metro is the most common international term for subway, heavy rail transit, though it is also commonly applied to elevated heavy rail systems. In this module we use “metro” to refer to urban grade-separated heavy rail systems. They are the most expensive form of MRT per kilometre, but have the highest theoretical capacity (in some cases, real capacity of BRTs is much higher than some metros).

### Commuter rail systems

Commuter rail or suburban rail is the portion of passenger railroad operations that carries passengers within urban areas, or between urban areas and their suburbs, but differs from Metros and LRT in that the passenger cars generally are heavier, the average trip lengths are usually longer, and the operations are carried out over tracks that are part of the railroad system in the area.

### Light Rail Transit

A light rail transit (LRT) system is a metropolitan electric railway system characterised by its ability to operate single cars or short trains along **exclusive rights-of-way** at ground level, aerial structures, in subways, or occasionally in streets, and to board and discharge passengers at track or car floor level (TCRP, 1998). LRT systems include tramways, though a major difference is that trams often operate **without an exclusive right-of-way**, in mixed traffic.

## Bus Rapid Transit

Many cities have developed variations on the theme of better bus services and the concept resides in a collection of best practices rather than a strict definition. Bus Rapid Transit is a form of customer-oriented transit combining stations, vehicles, planning, and intelligent transport system elements into an integrated system with a unique identity.

Bus Rapid Transit typically involves busway corridors on segregated lanes—either at-grade or grade separated—and modernised bus technology. However, apart from segregated busways BRT systems also commonly include:

- Rapid boarding and alighting;
- Efficient fare collection;
- Comfortable shelters and stations;
- Clean bus technologies;
- Modal integration;
- Sophisticated marketing identity;
- Excellence in customer service.

Bus Rapid Transit is more than simply operation over exclusive bus lanes or busways. According to a study of at-grade busways (Shen *et al.*, 1998), only half of the cities that have busways have developed them as part of a systematic and comprehensive package of measures as part of the city mass transit network that we would identify as a BRT system.

While Bus Rapid Transit systems always include some form of exclusive right-of-way for buses, the applications we consider are mostly at-grade, street-level busways. Elevated busways or tunnels may be needed for traversing some city centres.

### Bus lane (or priority bus lane)

A bus lane is a highway or street reserved primarily for buses, either all day or during specified periods. It may be used by other traffic under certain circumstances, such as while making a turn, or by taxis, bicycles, or high occupancy vehicles.

Bus lanes, widely used in Europe even in small cities, are increasingly applied in developing cities such as Bangkok, where counter-flow buses can move rapidly through peak period congestion.

### Busway

A busway is a special roadway designed for exclusive use by buses. It may be constructed at, above, or below grade and may be located in separate right-of-way or within highway corridors. Some form of busway system is a feature of many Bus Rapid Transit systems.

## 7.1 Choosing a Mass Transit system

There are few reasons for developing cities to favour rail-based systems where passenger capacities would be less than 25,000 passengers per hour per direction. Unless specific circumstances apply—such as when visual image of the system is quite important and a city is sufficiently wealthy to handle the higher capital and operational costs and has enough time to build one—this kind of rail-based transit for developing cities compares unfavourably with BRT systems on most terms, and especially for key parameters such as cost, flexibility, time frame, and institutional demands.

There is however no single “right” transit solution. The best system for a city will depend on local conditions and preferences and will involve a combination of technologies. Bus Rapid Transit may not be the solution in every situation. When passenger flows are extremely high and space for busways is limited, other options may be better, such as rail-based public transit; although we have seen that BRT can accommodate passenger volumes to match demand even in very large cities. In reality, it is not always just a choice between bus and rail, as cities like Sao Paulo, Brazil have shown that Metro and BRT systems can work together to form an integrated transport package.

It must however be recalled that city investments in Mass Rapid Transit systems come at a high opportunity cost. Funds used to build and subsidise the operation of a limited Metro could be used for schools, hospitals, and parks.

Bus Rapid Transit has shown that high quality public transit that meets the needs of the wider public is neither costly nor extremely difficult to achieve. Many organisations are ready to help municipalities in developing cities make efficient public transport a reality. With political leadership, everything is possible.

## 7.2 Benefits of a BRT system over other systems

BRT is a system that has been replicated in cities such as Quito, Bogotá, Jakarta and Beijing (to name a few). The benchmark for a Bus Rapid Transit system is that of Bogotá (TransMilenio), which has been able to transport up to nearly 40,000 persons/hour/direction in its trunk lines, a number higher than many heavy rail systems in the world are moving and much higher than any light rail transit systems in the world (developed and developing).

A Bus Rapid Transit system is also **cost-effective**, since the costs per kilometer of trunk line can be as low as 500,000 US dollars (the example of Quito), whereas a high-quality kilometer of trunk line such as in Bogotá costs 10 million US dollars. This is by far the lowest price per kilometer of a mass transit system that can carry such volumes of passengers, as having been described above (the lowest costs of a light rail system is 15 million dollars per kilometer, while for heavy rail (mostly underground) costs per kilometer start at 50 million dollars).

It is also noteworthy that **construction time** is also very fast. The first trunk line of a Bus Rapid Transit System can be planned and developed in around 18 months, while another mass transit system takes at least 3-4 years, mostly however even longer.

In terms of **social impacts** and equity of a BRT project, it has increased access to those of lower income and generated jobs during construction and operation. It has also improved safety (in terms of road accidents) and health of citizens (due to reduced pollution), and reduced criminality rates near and inside the system (improved and safe stations, greater lighting inside and near the system, safer vehicles).

Finally, BRT is a mode that improves the **environmental** situation of a city, since it has low emission vehicles mobilizing greater amounts of people than ordinary public transport. Its environmental benefits have been proven in terms of CO<sub>2</sub> reduction, NO<sub>x</sub>, PM and other main pollutants in cities that are hazardous to people's health.

## 7.3 Barriers to implementing a BRT

When measured in terms of economic, environmental and social benefits, BRT's track record provides a compelling case for more cities to consider it as a transit priority. However, as a new concept, there remain several barriers that have prevented wider dissemination of BRT.

Specifically, these barriers include:

- Political will
- Existing operators
- Institutional biases
- Lack of information on the characteristics of BRT
- Institutional capacity
- Technical capacity
- Financing possibilities
- Geographical / physical limitations.

Political will is an important ingredient in making BRT work. Overcoming resistance from special interest groups and the general inertia against change is often an insurmountable obstacle for mayors and other officials. Lobby groups from rail and automobile interests can make for a

powerful political argument against BRT implementation. However, for those public officials that have made the commitment to BRT, the political rewards can be great. The political leaders behind the BRT systems in cities like Curitiba and Bogotá have left a lasting legacy to their cities, and in the process, these officials have been rewarded with enormous popularity and success. Also, there is a great pride in demonstrating that there is a cost-effective solution to transport problems that can be implemented in the medium term with high quality. Reducing the travel times of commuters and increasing average traffic speeds make cities look more efficient, as opposed to a gridlocked city.

While automobiles may represent less than 15 per cent of a developing city's transport mode share, the owners of such vehicles represent the most influential socio-political grouping. The idea of prioritising road space to public transport may appear to be counter to the interest of private vehicle owners. However, in reality, separating public transit vehicles from other traffic may often improve conditions for private vehicles. Since public transit vehicles stop more frequently, the separation of these vehicles from mixed traffic can actually improve flows for all.

Existing transit operators may also prove to be a substantial political barrier to BRT implementation. Such operators may be quite sceptical of any change, especially when the change may have ramifications on their own profitability and even viability. In cities such as Quito (Ecuador), the existing operators took to violent street demonstrations to counter the development of the BRT system. Likewise, in other cities the private transit operators have pressured political officials through recall efforts and intense lobbying. However, it should be noted that the threat to existing operators may be more perceived than real. In most cases, an effective outreach effort with the operators can help dispel unfounded fears. In reality, existing operators can gain substantially from BRT through improved profitability and better work conditions. The existing operators can effectively compete to win operational concessions within the proposed BRT system.

The barriers noted here are mostly "perceived" barriers. In each case, a concerted effort of political officials in tandem with the private sector and the public can overcome these challenges to create a new transit system for all.

#### 7.4 BRT in China

Also in China BRT gains popularity. With less investment costs for MRTs being covered by the central government, and more responsibility being laid to Provinces and Municipalities, more cost efficient solutions are being looked at. Kunming with its bus prioritisation success is a good learning experience for other Chinese cities, and Beijing opened in 2004 its first BRT corridor from Tiananmen Square to South Beijing. Currently, Beijing has already 3 corridors and a total length of 34.5 km dedicated busway.

Also, Hangzhou, Changzhou and Guangzhou have already opened their corridors in 2006, 2008 and 2010. A number of other Chinese cities have also opened BRT systems or are in the planning stage for BRT schemes, often supported by international expertise.

GTZ is providing dedicated BRT training courses, after many courses elsewhere the first such courses in China have been held successfully in 2006, 2007 and 2008 in Beijing. Further training courses in China are foreseen for 2010 (GTZ has been planning the first full BRT in Africa, Rea Vaya in Johannesburg/South Africa, which went into full operation in May 2010).

#### 7.5 Public Transport Integration- A Win-Win Strategy (experience from Germany and other European countries)

(this chapter draws on a paper from Joerg Thiemann-Linden, Koeln and Sonja Klingenberg, Hamburg, 2001)

The needs of public transport users are similar everywhere but the conditions for public transport service offers as well as potential solutions differ between countries.

##### *Interests*

- *Passengers' interest:* Abolition of factors impeding access to public transport through uniform usability of public transport in the region – based on the motto : “One network, one ticket, one schedule”
- *Transport operators' interest:* - Strengthening local public transport as an overall system and strengthening service providers in intermodal competition; synergies in sales, marketing, and operations behind the “user interface”.
- *Public interest:* Necessity of public transport executives (PTEs) based on the knowledge that, given increasing motorisation, customer orientation in public transport is a must in intermodal competition.
- Additional aim of regional integration is strengthening of the economic region in the context of interregional competition (increasing regional orientation of journey destinations resulting from differentiated settlement structures and a high degree of car ownership).

In Germany, PTEs have almost complete territorial coverage: There are around 40 cooperative local public passenger transport services incl. railway integration in Germany (mostly PTEs based around a regional centre). Austria has achieved complete territorial coverage with PTEs. The Netherlands have had nationally valid public transport tickets (excluding railway) since the early 1980s with their ‘National Strip Cards’.

#### *Motivation for establishing PTEs*

- Abolition of factors impeding access to public transport
  - More customer-orientation by way of a uniform ‘user-interface’ of all public transport services in a region is an important measure in the intermodal competition with car transport which knows no fare differences or schedules etc.
- Increase in passenger numbers as compared with the trend
  - It is the aim of the establishment of PTEs to increase the number of passengers and to weaken or break a negative trend.
- Increase in individual distances covered by people
  - Increasing regional orientation of journey destinations as a result of differentiated settlement structures and suburbanisation of settlements, work places, shopping places, and leisure facilities; these are made accessible by way of extending the road network which leads to increased travel speeds in the region and a high degree of motorisation of private households.
- New legal definition of public sector responsibility for local public passenger transport (in Germany and other European countries)
  - With effect from early 1996 the "Passenger Transport Ordinance" (*Personenbeförderungsgesetz*) has been revised pursuant to European directives and has amended the authorities' capabilities and responsibilities in terms of the designing of public transport services at the regional or municipal level, including services outside of the major cities. It has thus provided an institutional basis for municipal PTEs.

#### **7.5.1 Fares**

Car transport has become the yardstick for public transport. The fuel used for the car one gets everywhere – there are no different types of fuel for the national or the local road network respectively.

Hence the standardisation of the fare price system for all public transport operators within a given area is a definitive motive for the establishment of a PTE. This standardisation concerns both the fare system in general and the fare prices charged for individual routes where these are still divergent.

#### *Ticket sales*

A 'growing PTE' as a tiered concept for ticket sales could be envisaged as follows:

- As a first step all tickets are sold at the sales points of all the operators
- As a second step all sales points are given a standardised appearance and agents sell standardised tickets in the region
- The most advanced step then is the intermodal connection with other modes of transport and the establishment of "mobility centres" as information points for various transport and tourist services.

Technological advances in connection with 'plastic money' (PayCard, Credit Card) increase the scope for ticket sales and accounts clearance between transport operators.

Automatic ticketing systems are being tested in many countries but are as yet quite limited in their suitability and require a high degree of financial investment.

The most advanced solution so far is being tested in Switzerland (Basel/Geneva): the 'easyride' ticket contains an active transmitter which is detected every time a passenger boards or alights a bus, tram etc. This route tracing system allows for a detailed appropriation of fares to the transport operators and simple accounting at the end of the month on a 'best-price' basis for the customers. The passengers can stop worrying about tickets and using the public transport system becomes as easy as lifting and putting down a telephone receiver.

### 7.5.2 Coordinated planning of transport services

In this context the question arises as to how far the issues go beyond the question of cooperation and touch on classic transport planning issues in relation to the provision of infrastructure.

For the customers the efficiency of the PTE is the greater the more coordinated the planning of services is, providing the passenger with a complete and consistent service incorporating a variety of means of transport.

At the same time the targeted planning of feeder services and the putting into place of systems to prevent missed connections increases the efficiency of the system as a whole, particularly along the periphery of the area served where passenger numbers are low.

This requires a good knowledge of potential passenger numbers and the actual uptake of public transport service offers by the passengers – up to and including complex spatial model calculations for which there are a number of software solutions available internationally. Private consultancies or university research institutes could play a role in generating such baseline data and in maintaining such datasets.

### 7.5.3 Quality management

In its ongoing competition with car transport, the quality of the local public passenger transport service as a basis for successful uptake by the customer can be systematised, planned, and monitored.

As is the case with the database required as a decision-making tool for services planning, quality management also calls for a solid empirical basis. This includes, for example, an assessment of passenger satisfaction (particularly for 'soft' service characteristics such as security, comfort, driving style, friendliness of the personnel, as well as information and communication) and the assessment of further characteristics of the service (particularly the 'hard' factors such as reliability, *i.e.* the actual implementation of the trips, and punctuality) through questionnaires.

#### *The new 'three-way relationship' between passenger, operator and responsible authority*

Information on passenger satisfaction gives the responsible authority an indication of the customers' (and voters') satisfaction with the local public passenger transport service provided by



the operator which is being paid by same authority (municipality, political system). If the customer is happy – whichever way and with whatever creative means the transport operator manages to achieve that – politicians are happy too and are given an endorsement of their policy to invest public funds into public transport.

#### 7.5.4 Financing

The financing of closer cooperation in local public passenger transport is closely linked to the financing system for public transport in general. A PTE as the regional management level appears to be particularly well suited to organising transport service contracts.

The question of gross cost v. net cost contracts (with a corresponding degree of responsibility for fare receipts) is a central issue, as is the financing of the coordination efforts.

Another issue – which is once again openly discussed in the 84 German PTEs – is the regime for the distribution of fare receipts amongst the transport operators. Sometimes the very economic existence of individual operators is at stake, *i.e.* depending on the regime adopted they may or may not survive. In any case the losses resulting from through-ticketing in PTEs are an issue that requires regulation. If a passenger can use a variety of transport modes using a network ticket and pay less than the separate partial journeys would have cost, then there is a loss of revenue which initially needs to be borne communally. In Germany state funding (temporary or permanent) has in most instances been provided to bridge this financial gap, and has thus enabled the establishment of PTEs covering almost the entire territory of the state.

#### 7.5.5 Establishing a public transport executive

A number of different models and political solutions are now available for the establishment of forms of cooperation in public transport.

The first question that needs to be asked is which institution or institutions are the most likely to carry responsibility for public transport in the region, given the current legal framework.

Normally the cooperation is organised through the establishment of a dedicated institution which is politically controlled by the authorities, or the transport operators, or both. Until such time as a contractual basis has been established (which in Germany normally takes a number of years) a “PTE preparation office” can already commence work on practical aspects such as service offers and marketing.

A central question is that of the participating partners and the exact distribution of responsibilities. The standard model for a PTE is the “3 Level Model” with the political level, the management level (the actual PTE office) and the transport operators.

#### 7.5.6 Information and Marketing

In order to abolish factors impeding access to public transport it will be necessary to overcome the dependency on paper schedules. Electronic schedule information systems are able to find suitable connections even for complex journeys and the information can be related to passengers by phone, by internet, or verbally in mobility centres. A number of European countries can now offer comprehensive door-to-door schedule information involving multiple public transport service providers.

More far-reaching than just electronic schedule information is a marketing strategy ‘all of the one piece’ for the entire public transport system in a region. Not just electronic media are of importance

in this regard but also simple print media, the appearance/design of the stops and last but not least the willingness of the PTE staff to assist passengers where these have questions or problems.

## 8 Non-motorised transport and its benefits

- This section is adapted from Module 3d of our sourcebook

### 8.1 Non-motorised transport planning

As has been said by Qiu Baoxing, a vice minister with the Ministry of Construction, it is important that China retain its title "kingdom of bicycles." Thus, there is a favourable policy towards bicycle and non motorised use in the country and advantage should be taken.

*Non-motorised transport* (also known as *active transport* and *human powered transport*) includes walking, cycling, hand carts and animal carts. Non-motorised travel is critical for a diverse transport system. Non-motorised modes are important in their own right, and most transit trips include walking links—non-motorised transport improvements are often one of the most effective ways of encouraging transit use. The quality of the pedestrian environment is important for community liveability and social cohesion. Making streets pleasant and safe for walking allows residents to interact and children to play.

There are many specific ways to improve non-motorised transportation, as discussed in the Module 3d: *Preserving and Expanding the Role of Non-motorised Transport* and Module 3e: *Car free Development*.

Some key strategies are:

- Establish connected walking networks.
- Provide adequate walkway widths. Prevent vendors, pavement dwellers, vehicle parking and other uses from blocking walkways.
- Maintain path surfaces. Establish a system to quickly identify and correct problems.
- Create bike lanes and bicycle boulevards (streets where bicycles have priority and motorists must drive at low speeds) where appropriate.
- Correct roadway hazards to non-motorised transport.
- Improve non-motorised transport facility management and maintenance.
- Accommodate people with disabilities and other special needs.
- Develop pedestrian-oriented land use and building design.
- Use street furniture (e.g. benches) and design features (e.g. human-scale street lights).
- Apply traffic calming, speed reductions and vehicle restrictions.
- Provide bicycle safety education, law enforcement and encouragement.
- Integrate cycling with transit.
- Provide bicycle parking.
- Address security concerns of pedestrians and cyclists.

#### How it is implemented

Pedestrian and cycling improvements are usually implemented by city governments. It usually begins with a pedestrian and bicycle plan to identify problems and prioritise projects.

#### Travel impacts

Non-motorised improvements substitute directly for automobile trips. Walking and cycling improvements also support transit and are critical to reducing per-capita motor vehicle trips.

Nearly all trips involve non-motorised links, often on public rights-of-way, to access an automobile or transit vehicle. Travel surveys and traffic counts usually under-record non-motorised trips, because they ignore or undercount short trips, non-work travel, travel by children, recreational travel, and non-motorised links. For example, trips that are classified as “car” or “transit” trips are often actually “walk-car-walk”, or “walk-bus-walk” trips, yet the walking component is not usually counted, even if it takes place on a roadway.

## 8.2 Rationale

China is blessed with the fact that it has a very high modal share of bicycles. This is one of the key aspects for which it can become one of the most prosperous countries in the world in terms of transport that is efficient and at the same time people-centred. Many developing cities have implemented policies which reduce the appeal of cycling, encouraging people to travel by motorised means even for short trips. However, an increasing number of city governments in developed and developing cities have recently begun actively promoting bicycling and walking, which is something that China should keep engaging, if possible in an increasing extent.

### **Pedestrians, bicyclists, and cycle rickshaw passengers generate no air pollution, no greenhouse gases, and little noise pollution**

Reducing these emissions and noise are critical to slowing global warming, reducing incidents of asthma and other upper respiratory and cardio-vascular disease, and reducing sleep disorders. In both developed and developing countries, upper respiratory illnesses, particularly asthma, are increasing dramatically. While emission standards and cleaner vehicles can greatly reduce certain emissions, reducing carbon dioxide, nitrogen oxides, and ground level ozone through tailpipe-focused measures alone is proving exceedingly difficult. These emissions are growing rapidly in most developing country cities as the use of motor vehicles increases. Sleep deprivation is also a problem of growing seriousness, the medical significance of which is only beginning to be understood.

### **Bicyclists and pedestrians are more efficient users of scarce road space than private motor vehicles, helping to combat congestion**

While fully occupied public transit vehicles are the most efficient users of road space, bicyclists use less than a third of the road space used by private motor vehicles, and pedestrians use less than a sixth. Even cycle rickshaws use considerably less road space per passenger than motorised taxis and single occupancy private motor vehicles.

### **Bicycling and walking are the most efficient and environmentally sustainable means of making short trips**

In most developing cities, average trip distances are extremely short. Often over 60% of trips are under 3 kilometres long. In well planned German cities, over 80% of trips under 3 kilometres would be made by walking or bicycling, generating no pollution and minimal traffic congestion. Surabaya, for example, is only 15 kilometres north to south. This means virtually no trip inside the city is too far for an average healthy cyclist's average commute.

In Bogotá, in 1998 70% of the private car trips were under 3 kilometres. Even though this percentage is lower today thanks to the bike and pedestrian facilities, it is still too high compared to some Northern European cities.

In many Asian cities, however, even with per capita incomes less than one-twentieth of Germany, over 60% of these short trips under three kilometres are made by motor vehicles, usually motorcycle, moped, or paratransit.

Our studies indicate three reasons for this:

1. Few pedestrian or cycling facilities have been provided in many cities. Over 60% of the roads in Jakarta, for example, have no sidewalks, and those that exist are heavily obstructed by telephone poles, trees, construction materials, trash, and open sewer and drainage ditches.

2. Secondly, the traffic system has been designed to increase motor vehicle speeds, at the expense of pedestrian and bicycle safety. Many Asian cities make minimal use of traffic lights with zebra crossings and medians which provide a place for pedestrians to cross safely. As a result, the number of roadway fatalities per vehicle is many times higher than in Europe or the US.
3. Finally, pedestrian barricades and one way streets have been used to facilitate long distance motorised trips but which simultaneously impose huge detours for short distance cycling and pedestrian trips. People wishing to cross a main shopping street often find it easier to take a taxi two kilometres than to walk across the street. In Surabaya, a World Bank financed study estimated that these measures generate an additional daily 7000 kilometres of needless vehicle traffic.

Most people feel that culture and heat are reasons for low levels of cycling in parts of the developing world where cycling is no longer ubiquitous. In terms of heat, average temperatures in Asia are not significantly higher than summer temperatures in Europe and China when cycling trips are at their peak. Streets need to be designed to provide shade and pavements that do not radiate heat. Cultural factors are clearly involved, but cycling culture did not happen overnight anywhere. In Holland the cycling culture has long historical roots, but the dramatic increases in cycling in the last two decades resulted from concerted government efforts. Use of the Mayor's Office as a 'bully pulpit' in Bogotá coupled with the construction of extensive cycling paths has resulted in an increase of cycling from 0.5% of daily trips to 4% of daily trips in only 5 years.

### **Improving the efficiency of non-motorised travel is economically vital**

Virtually every trip begins and ends with a walking or cycling trip, whether between a parking lot and an office building or a home and a bus station. Because walking trips and cycling trips are very slow, inefficiency in making these trips, forcing people to walk or bicycle a long way out of their way, has very high economic cost because of the slowness of travel by these modes. At three kilometres per hour, having to walk a kilometre out of your way adds 20 minutes to a trip. In some countries it now takes as long for people to walk from their homes to the nearest bus stop as it takes to fly from Beijing to Shanghai. Similarly, new studies of modern logistics indicate that the cost of making the last link in the supply chain – namely from the store to the consumer – costs as much as shipping products half way around the world. These studies indicate that the efficiency of short distance travel is much neglected and of critical economic importance.

Full pedestrianisation of downtown commercial areas has been observed in Chinese, Colombian, European, Brazilian, and other cities to dramatically increase the profitability of shops in the area, and led to an increase in land values.

### **Bicycling and walking provides important aerobic exercise which is important to combating high cholesterol, obesity, diabetes, and depression**

Increasing evidence, according to the US Centre for Disease Control, indicates that the global epidemic of obesity, high cholesterol, diabetes, and depression are directly linked not only to diet but also to the sharp decrease in average daily aerobic exercise. Bicycling and walking can help address these issues. Rather than driving two kilometres to use a stationary exercise bicycle in an expensive health club, for example, it would make more sense to make it possible for people to simply walk or bike comfortably to work.

This phenomenon is also evident in developing cities, where poor conditions for pedestrians result in motor vehicle use for even short trips. Health problems associated with lack of aerobic exercise are an important component to be analyzed in transport.

### **Increasing the modal share of bicycling and walking can reduce a country's dependence on imported oil**

Many developing countries are going deep into debt to continue subsidising oil, which is overwhelmingly used by higher income motorists. Recently the Indonesian government spent up to \$6.5 billion annually to prop up these unsustainable fuel subsidies. (These fuel subsidies have been considerably reduced by the current government since early 2002, through a series of price

risers.) The volatility of oil prices, and the risk of diminishing global reserves over the next two decades, makes a reduced reliance on oil critical to avoiding serious exogenous economic shocks to the national economy.

### **Promoting safe bicycling and walking are crucial to improving the accessibility of the poor, and social cohesion**

As will be seen in a later chapter, in some developing country megacities, reaching centres of employment from low income settlements is an arduous journey consuming over one quarter of a family's disposable income and more than 4 hours each day. For trips less than 3 kilometres, the poor of Surabaya are already more dependent on motor vehicles than Germans, who have incomes 40 times higher. This is imposing an enormous, needless burden on the poor, and inhibiting their ability to participate in the workforce, as well as gain access to education and health care. Viable and safe walking and cycling are also crucially important in allowing people to reach public transit facilities, but little attention is generally paid to these access modes.

Investments in walking and cycling facilities are investments for the poor. This creates a new society where people of all incomes can meet as equals on a bike path or a sidewalk. In the developing world where income disparities are often very high, this potential role of non-motorised transport is very important. In Bogotá the safest place in the city is the Ciclovía. On Sundays 120 kilometres of main arteries are closed to traffic allowing about 2 million people to cycle, rollerblade or just jog and walk.

### **Promoting safe bicycling and walking is vital to reducing over 500,000 premature deaths from traffic accidents each year**

There are an estimated 1.1 million traffic deaths globally each year, and among young people in developing countries traffic accidents are the second leading cause of death according to the World Health Organisation. In developing countries, the vast majority of the victims of traffic accidents are pedestrians and cyclists, though with increasing motorcycle use, motorcyclists are fast becoming the majority of highway fatalities in higher income Asian countries. Having a father or mother killed or disabled in a motor vehicle accident, horrible in itself, will almost certainly throw a lower middle class family into destitution.

Bogotá had in 1997 a traffic death rate of 2 to 3 people every day, which is one of the highest in Latin America. Even though it is still very high it has dropped to 1 to 2, due largely to dramatic improvements in cycling and walking facilities.

## **9 Creating a safer road environment**

*- This section is adapted from Module 5b of our sourcebook*

The traffic safety situation in China is serious. Over 100 000 recorded road traffic fatalities annually, with a vehicle population of at present approximately 16 million (year 2004). Although many safety measures have already been taken in recent years, still over 73 000 road traffic fatalities were registered in 2008 (Motorlink, 2009). In Germany for example there are 6 500 road traffic fatalities annually at a road vehicle fleet of approximately 50 million. There are around 530 private vehicles per 1000 inhabitants in Germany.

The process of adapting the layout and use of roads and footways in urban areas to manage the exposure of road users to risk will be in many cases a lengthy one. At every stage in this process, the responsible authorities should be taking all practicable and affordable steps to reduce casualties in the prevailing situations and to contribute to their further reduction in the longer term. Short term measures should address the existing transport system as a whole to reduce the number of collisions and injuries. Longer term measures must consider the planning and development issues surrounding the growth of the urban area and focus on policies that prevent

the creation of new situations in which life and limb are put at risk. All new road proposals should be subject to a safety audit, by independent safety specialists.

For the treatment of black spots and parts of the urban road network which expose users to high levels of risk, low cost measures have shown a great potential in reducing the number and severity of crashes. These measures are easy to implement and often do not need long bureaucratic procedures (also see TRRL/ODA, 1991). Systematic analysis of collision diagrams and crash reports identify the features which should be improved. They often include:

- improvement of traffic signs,
- improvement of road marking and delineation (for example bus, motorcycle or cycle lanes),
- small construction measures which can be integrated in road maintenance activities such as improvement of the road surface.

Some countries report poor performance of road signs and markings, largely because of poor understanding and compliance by road users. Trials can help identify such potential difficulties, and integration with publicity and enforcement may help overcome poor compliance.

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***"Well-designed measures, based on analysis of crash records, have shown a great potential in reducing the number and severity of accidents, often at low cost."***

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It is important that road safety benefits are not arbitrarily ascribed to highway/road proposals or developments without an assessment of their casualty reduction potential. Therefore, all staff involved in the design and implementation of road improvement, maintenance and traffic management schemes should have an understanding of crash prevention principles and easy access to relevant data.

Pedestrians and cyclists are the most vulnerable road users. They are often at risk due to the conflicting use of the same road space by different types of road users, for example pedestrians using the roadway because of the absence of a sidewalk. Measures to benefit non-motorised transport users must be developed within broad traffic, environmental, economic and urban planning objectives (ETSC, 1999). In the UK, the Institution of Highways and Transportation suggest that the following hierarchy of measures should be considered before a design solution is chosen: traffic reduction, speed reduction, junction treatment, redistribution of road space and provision of special facilities such as pedestrian crossing islands or cycle paths (IHT, 1996).

Speed management in urban areas can play a decisive role in the reduction of the number and severity of accidents, since excessive and inappropriate speed is a major problem. The probability of a pedestrian fatality reduces from 85% with an impact at 50 km/h to less than 10% at 30 km/h. Speed management is not simply about reducing speed, but to a considerable extent about planning and designing the road layout and the road network in such a way that an appropriate speed is obtained. One of the key elements is the road and speed classification achieved by establishing a road hierarchy. A framework for the planning and evaluation process was developed in the European Dumas-Project (Report no. 168, published by The Danish Road Directorate) and describes the process from collecting and mapping data, setting targets, forming a speed management strategy, designing the programme, involving the public, and implementing and evaluating the programme.

The two boxes illustrate the economic returns from low cost engineering schemes, from analyses in the USA and the UK. Whilst the results are not necessarily directly transferable to developing world cities, they illustrate the potential which can be achieved by carefully designed schemes which target specific problems, as revealed by analysis of crash records.

Special attention should be given to road construction areas, where the risk of a crash is high. An appropriate arrangement of traffic signs and safety devices, as well as public information, is important to enhance awareness about the specific traffic circumstances.

### 9.1 Changing attitudes and road safety education

Attitude change campaigns have one or more of three goals:

- to inform the public of the nature of problems and to prepare for change (e.g. in the law),
- to change attitudes,
- to change behaviour.

If the general level of knowledge about road safety issues is low then it is important to provide information which both raises awareness of the issues and provides a background against which more specific changes – for example in legislation and/or enforcement – are more likely to be accepted by the general public. Research in the highly motorised, high income countries shows that road safety publicity campaigns, by themselves, have only limited impact on attitudes and behaviour. However, when combined with other activities, especially law enforcement, the combined approach can reduce the number and severity of injuries.

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***"Combined with enforcement, road safety publicity campaigns improve road user behaviour and reduce road crashes."***

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There is little evidence about the impact of publicity campaigns in low and middle income countries, but it seems reasonable to assume that the lower the level of knowledge, the more likely it is that a campaign or education will be of benefit, especially if combined with legislation and enforcement. Also, to generate attitude change towards a safer traffic behaviour takes time and can only be successful if the messages are repeated periodically. Therefore, it is crucial to link attitude change measures to specific problems, and to a target group. It is also important to have a clear objective and to evaluate the impact of the measure.

For example, GRSP has published guidance on road safety publicity campaigns which stress the linkage between campaigns and enforcement. The guidance stresses the importance of clearly defining the problem, setting out the objectives of the campaign and evaluating its impact.

Means of changing attitudes include various public communication tools such as public information in the media, road side information, road safety events, educational measures (driver education, traffic schools for children), "Walk-To-School" events, and so on. Such events often involve a large number of related governmental and civil society organisations. Whilst these activities are widespread, there is debate about their effectiveness. They are rarely subject to evaluation, in part because they usually are part of a package of road safety measures and it is impossible to attribute any changes in crash or casualty numbers to such activities in isolation.

Road traffic schools are used in a number of countries to generate attitude changes about road safety through educating children. They aim to teach school children better traffic behaviour, although there is debate about their effectiveness. In Germany, for instance, they have been used since 1949 in cooperation with the German Shell company, school authorities and the police. This model has been transferred, for example, to the city of Montevideo, where a children road safety school provides theoretical and practical education. Theoretical education on traffic rules and behaviour is complemented by practical exercises in a learning area that is especially prepared for this purpose, usually within the school ground or a nearby property. The main emphasis, however, is placed on the training and testing of the children as cyclists. The system of road traffic schools in Germany is part of the official school traffic education and is included in the curricula of the third and fourth school year. Shell provides the children's traffic schools with bicycles, helmets, traffic signs and, together with the police and the school authorities, is involved in the improvement of the educational program.

The involvement of children in crashes, particularly while travelling to and from school and in the vicinity of their homes, is often the subject of considerable local concern. The development of "safer routes to school" can be effective in improving both children's and parents' awareness and

understanding of road safety problems, and by making journeys to school safer. These kinds of projects are undertaken in cooperation between parents, school staff and local traffic authorities and have been implemented in many countries and cities around the world. Safe routes to school plans are developed to find the roads or pedestrian roadsides which are the safest for children, to provide a context for local improvements to the road and footway network, to provide pedestrian crossings to improve safety and also to identify those parts of the road network which should be avoided. Information concerning the traffic flow, junctions and pedestrian crossings are gathered as well as the location of bus stops and public transport services.

Road safety training can also be beneficial for adult road users. Employers have found that there is both a business and a social benefit in providing training to their employees, particularly those responsible for valuable vehicles carrying valuable cargoes. Major oil companies, such as Shell and BP, have led the way in this respect in low and middle income countries where more employee lives were lost in road traffic crashes than from other types of industrial accident. Training courses have been developed for car, bus and truck drivers as well as for motorcyclists.

In Argentina, a safety course for truck drivers developed by the German Road Safety Council within a German Government funded road safety project was presented, including theoretical and practical modules which were translated and adapted to the local needs. Local authorities (the ministry) have provided an unused airport for the training sessions and Mercedes Benz Argentina (DaimlerChrysler) supported the course by lending two trucks. This kind of course can also be a first step towards the creation of an institutionalised licensing system for truck drivers, which often is lacking in developing countries.

The increased use of seat belts by car, bus and truck occupants has a great impact on the reduction of the severity of the injuries due to crashes. In many developing countries, particularly in Asia, motorcycle use is widespread, and the use of helmets offers substantial road safety benefits.

Use of occupant and rider protection (seat belts, helmets) is an area where the importance of linking publicity, legislation and enforcement is vital to achieve the maximum safety benefit. Unfortunately, however, experience to date shows that decision-makers in most developing cities tend to give insufficient attention to these aspects of road safety, and in particular to protection of more vulnerable road users.

## 9.2 Enforcing safer road user behaviour

Road safety work follows the 4E principle: *education, enforcement, engineering and emergency response*.

As a key component, strong, but fair and targeted, enforcement is critical to the safe and efficient use of urban road systems. A substantial safety benefit can be achieved if road users are deterred from committing traffic offences. The presence of an effective police force which is seen to enforce the law if it is broken, is a primary means of ensuring safe road user behaviour. The examples of seat belt and helmet wearing cited in the previous section are good examples of this. Other critical aspects of behaviour where substantial road safety benefits can be achieved if properly controlled are vehicle speeds and drunk driving.

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***"Traffic law enforcement requires professional skills that are different from other types of police work."***

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The main objective of enforcing traffic regulations is to deter violations and thus ensure road safety, not to maximise the number of infringement notices issued. Police activities should primarily increase road users' perception of the likelihood of illegal behaviour being detected, and of being penalised if they are caught. Traffic law enforcement requires professional skills that are different from other types of police work, so the training of police officers therefore plays an important role.



Detection and deterrence can only be achieved if the law is specific about its sanctions. As urban road legislation varies from country to country, the main strategy should consist of combining enforcement activities (mainly speed and alcohol controls, helmet and seat belt wearing) with information and measures to change attitudes. The involvement of civic and advocacy groups in this area is needed to raise consciousness towards the consequences of drink-driving or not wearing a helmet or seat belt.

Excess and inappropriate speed is a common traffic offence. There is a strong body of evidence which demonstrates that the risk of a crash, and the severity of its consequences, increase with vehicle speed. The development of a speed management strategy is a common strand of road safety policy in cities of high income countries, and law enforcement is a critical element of such a strategy. Two approaches of enforcement have been traditionally used: the stationary enforcement method generally involves an observation unit more or less hidden at the roadside and an apprehension unit, clearly visible, at which point speeding drivers are stopped. The mobile method is the enforcement from a moving unmarked or marked police car. The stationary method is much more cost-effective, and is recommended here. In recent years the introduction of speed camera technology has been highly cost-effective in developed countries, but only if they are used in the right way, which means putting the cameras in high risk locations (ETSC, 1999). Radar detection may be more appropriate in low and middle income countries if they do not have the capacity to make use of the evidence provided by cameras and to bring offenders to court.

Local police authorities should adopt a road safety policy and the operational objectives should be coordinated with local/urban road safety plans. Urban Traffic and Transport Authorities should support the police in the introduction of technological aids for traffic law enforcement. As with many aspects of road safety, the coordination of activities by the various actors is essential for maximum benefits.

## 10 Attitude/Behaviour change interventions: Three types of actions

- This section is adapted from Module 1e of our sourcebook

When the composition of the population at stake is known, one can start an intervention adapted to the people that have to be addressed. To do this, all the information analyzed during focus groups, surveys, interviews and the division of the group into people's level of awareness has to be taken into account.

Now, there are three basic "channels" through which these people can be addressed. The three types of actions are informative, persuasive, and specific activities. This categorization comes from the psychological elaboration of attitudes and how they are subdivided into rational, affective, and motor components. However, it is very important to stress that each of them on their own will have little impact when it comes to achieving a real change in behaviour in the target audience.

### 10.1 Informative messages: hard facts

The first type of action that can be developed during an intervention is one of informative nature. That is, hard facts which show that using public transport, bicycles or walking is actually more sustainable than indiscriminately using a private motorised vehicle for all trips. Information on spatial attributes, environmental impacts or on poverty is basic data that should be taken into account. Also, graphs and other visual media can be used.

The format in which this information can be spread most effectively is through presentations, conferences, modules, and print or digital media that can be diffused. In that sense, modules of the *Sourcebook* are a key tool in terms of informative messages regarding sustainable transport.

## 10.2 Persuasive messages: comfort and well-being

The second type of action that can be used to change behaviour in a population is that of an affective nature. That is, anything that actually persuades people to do something because they will feel much better when doing it. In this case, car publicity is very much ahead of sustainable transport promotion. Private motorised vehicles have been associated with pleasure, comfort and even happiness. Furthermore, they are also always shown at high speeds and in extensive highways, never in a traffic jam. In any event, it is also true that cars have been designed to be more comfortable than any other mode of transport, but in detriment of values such as equity and sustainability. In this respect, public transport operators should also take this factor into account when promoting sustainable transport.

However, sustainable transport can also be easily promoted by means of persuasive or affective messages. As mentioned in the Collection of Cycle Concepts, "...the bicycle has a positive image in many ways. It is associated with good experiences, fresh air, sun, and summer. It is regarded as a healthy, sociable, and environmentally-friendly mode of transport that is accessible to everyone." The bicycle is a vehicle that is associated closely with personal experiences of happiness in most places, since it was usually a child's toy or a young person's sports vehicle.

Also, the category of persuasive messages can include all messages related to **moral, values, and ethical standards**. In the situation of sustainable transport, values towards the environment, greater social equity and poverty reduction are closely related to sustainable transport.

Finally, **life quality** can also be taken as an argument for persuasive messages. People will understand that an improved environmental situation, road safety, and use of public space are factors that will influence their quality of life positively.

## 10.3 Specific Activities: moving with sustainable transport means

The third of the types of actions to promote sustainable transport has to do with actually moving, that is, using sustainable transport means. It is very important to promote a sustainable transport system while making people actually use it. Though logical as it sounds, many activities neglect this component. But the main interest of promoting sustainable transport is to make people use public transport or bicycles who have never done so before. Some of the activities to overcome these barriers include the following (this list is not exhaustive):

### 10.3.1 Free rides on public transport

In the case of new public transport systems such as recent BRTs (Bogotá's TransMilenio or Jakarta's TransJakarta), system managers have given the public initially free rides on the system. Jakarta's experience was a system filled with commuters. By giving free rides initially, people had the chance to "try it out" without buying a ticket, and maybe getting somewhere!

### 10.3.2 Bicycle rides

Sometimes people think that riding a bicycle is a dirty, sweaty activity that is impossible to do without sportswear. Also, they feel that riding a bicycle is not an efficient way to get from one place to the other. Once these people are taken on a bicycle ride at moderate speed and covering a considerable distance, they are amazed that the experience is not really the one they imagined. In one example, staff from the Western Cape Ministry of Transport (South Africa) was taken on a bicycle ride through bikeways on a car free Sunday. They immediately came back to their office to formulate a strategy of non-motorised transport for their cities. When Minister of Transport Tasneem Essop was asked about the activity, she responded that she had not ridden on a bicycle since she was 8 years old, and she had forgotten how it actually felt like.

### 10.3.3 Car free days

The idea behind car-free days is very interesting in terms of actions to promote sustainable transport. Since the *Sourcebook* has a complete module on Car-free development, it is only necessary to say that people are forced to use other modes of transport. Therefore, car users are

experiencing other transport modes. However, there are some downsides to “enforced” car-free days: people will feel that they have no other choice and therefore might have a negative perception of the experience. In some cases (due to meteorological reactions) car-free days in polluted cities will result almost surely in rain.

Nonetheless, voluntary car free days are another option to ask people to use another mode of transport by their own will, without legal enforcement. People can choose between their car and other modes of transport to commute that day. This type of car free day, though very new, has shown impressive results.

#### 10.4 All three actions are crucial

It must be very clear that all three actions should be implemented in attitude/behaviour change activities. If people have the information and ride a bicycle once or twice, they will lack the persuasion to ride it convinced that it is the best way to move. They may go back to using a car every day. Similarly, if someone is persuaded and rides a bicycle once or twice, he will lack the arguments to understand why he is riding a sustainable mode of transport. Finally, someone who is convinced that riding public transport is the best way and has been persuaded to do so might still not start using sustainable transport. The person might have little or no opportunity to do so (e.g., no one will go with them on their “first bus ride”). Furthermore, someone who is “preaching” a particular mode of transport without using it does not give great credibility to his or her speech.

However, it is important that there is a strategy to do each of these activities. While there is no strict order, it is recommendable to start with persuasive messages, followed by information and finally the action component. This should also be done almost in parallel, since it will give the strategy a sense of unity.

## 11 Economic impacts of an improved transport system: research findings

All measures described above are conducive to an improved transportation system, which in turn will enhance the city’s equity, harmony if taking people as the centre of the new transport paradigm. It is also worthy to note that these implementations are based on various scientific findings that have been well researched for the latest decades by investigators from urban, economy and social disciplines. This chapter shows some of the most relevant findings regarding transport and economic impacts.

### 11.1 Transport and GDP growth- general

The reigning paradigm for many years was that widening roads and improving access to private motorized transport would have positive impacts on cities. However, a concept known as *induced demand* has demonstrated that, even if more lanes are added to a congested street, a direct consequence will be a greater amount of automobiles on the roads. This will, in turn, generate even more congestion than before at a greater environmental cost.

Congestion has been proven as one of the key issues influencing a nation’s economic development. Congested streets make trips longer, people lose working and leisure time, and it generates stress and depression in people. In economic terms, it has been found that urban GDP can be reduced up to 8% due to congestion, even higher if other external costs, such as pollution, traffic accidents, noise, and other factors are included.. This occurs mainly due to excessive private automobile transport, lack of demand management strategies and lack of mass transit implementation and non motorized transport prioritization (Gorham, 2000).

Table A.2. Estimates of external costs of road transport as a percentage of national/regional GDP

Country/City	Year	Source	Road costs	Land and parking	Congestion	Accidents, net of insurance	Noise pollution	Local air pollution	GHG a'	Other	Subtotal	Revenue from road users	Net subtotal	Others
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)	(xiii)	(xiv)	(xv)
USA1	1989	WRI	1.64 <sup>b</sup>	1.56	-	1	0.16	0.18	0.5	-	5.04	<sup>b</sup>	5.04	0.46
USA2 <sup>c</sup>	1990	NRDC	1.25 <sup>b</sup>	0.43-1.74	0.19	1.71	0.05	2.09-3.83		0.07	5.69-8.84	<sup>b</sup>	5.69-8.84	0.78-2.61
USA3	1991	Lee	1.76	2.41	-	0.24	0.19	0.73		0.26	5.59	0.88	4.71	0.87
EU1	Early 1990s	ECMT	1.75	-	0.75	2.4	0.3	0.6	0.5	-	6.3	1.67	4.63	-
EU2	Early 2000s	ECMT	1.49	-	0.75	1.2	0.3	0.15	0.47	-	4.36	1.67	2.69	-
UK	1993	CSEERGE	0.24	-	3.03	0.46-1.49	0.41-0.49	3.12	0.02	-	7.28-8.39	2.6	4.68-5.79	-
Poland	1995	ISD	1.14	-	0.3	1.6	0.1	0.3	-	-	3.44	2.81	0.63	-
São Paulo	1990	IBRD	-	-	2.43	1.11	-	1.55-3.18	-	-	-	-	5.09-6.72	-
Buenos Aires	1995	FIEL	-	-	3.42	0.5-2.00 <sup>d</sup>	-	0.97	-	-	5.62-7.12	1.01	4.61-6.11	-
Bangkok	1995	Misc.	-	-	1.00-6.00	2.33	-	2.56	-	-	5.89-10.89	-	5.89-10.89	-
Santiago	1994	Zegras	1.37	1.92	1.38	0.94	0.15	2.58	-	-	8.35	1.64	6.71	-
Dakar	1996	Tractebel	-	-	3.37	0.16-4.12	-	5.12	-	-	8.65-12.61	-	-	-

Sources: C. Willoughby, *Managing Motorization*, TWU Working Paper No. 42 (Washington, DC, World Bank, 2000), based on the following: (a) J.J. Mackenzie, R.C. Dower, and D.D.T. Chen, *The Going Rate: What It Really Costs to Drive* (Washington, DC, World Resources Institute, 1992); (b) P. Miller and J. Moffet, *The Price of Mobility: Uncovering the Hidden Costs of Transportation* (New York [New York], Natural Resources Defense Council, 1993); (c) D.B. Lee, "Uses and meanings of full social cost estimates" in D.L. Greene, D.W. Jones, and M.A. Delucchi, *The Full Costs and Benefits of Transportation* (Heidelberg, Springer, 1997); (d) European Conference of Ministers of Transport, *Efficient Transport for Europe: Policies for Internalization of External Costs* (Paris, OECD/ECMT, 1998); (e) D. Maddison, D. Pearce, O. Johansson, E. Calthrop, T. Litman, and E. Verhoef, *The True Costs of Road Transport*, Blueprint No. 5 (London, Earthscan for CSERGE, 1996); (f) Institute for Sustainable Development, *Information Package No. 2 on Alternative Transport Policy in Poland* (Warsaw, ISD, 1997); (g) World Bank, Draft Staff Appraisal Report for Brazil: São Paulo Integrated Urban Transport Project (Washington, DC, 1994); (h) Fundación de Investigaciones Económicas Latinoamericanas, *Financiamiento del Sector Transporte de la Región Metropolitana de Buenos Aires* (Buenos Aires, FIEL, 1995); (i) K. Lvovsky, G. Hughes, D. Maddison, B. Ostro, and D. Pearce, *Environmental Costs of Fossil Fuels: a Rapid Assessment Method with Application to Six Cities* (draft) (Washington, DC, World Bank, 1999); (j) Swedish National Road Consulting AB (SweRoad) and Asian Engineering Consultants Corporation, *Consulting Services for Developing a Road Safety Master Plan and a Road Traffic Accident Information System for the Ministry of Transport and Communications, Kingdom of Thailand* (1997); (k) V.S. Pendakur, "A tale of two cities: Bangkok and Mexico" in OECD, *Towards Clean Transport* (Paris, OECD, 1996); (l) D.E. Dowall, *Making Urban Land Markets Work: Issues and Policy Options*, Working Paper 702 (Berkeley, Institute of Urban and Regional Development, University of California, 1998); (m) C. Zegras, "The

For instance, the implementation of Bus Rapid Transit or other mass transit alternatives has proven to reduce substantially travel times of citizens (e.g. from 2 hours to 30 minutes), in turn reducing the working time losses and increasing the probability of having more time available for leisure for all citizens.

## 11.2 Economic costs of road safety

Also, road safety is one of the greatest problems worldwide in terms of premature deaths and high health costs for injured due to avoidable accidents. The problem is of such a magnitude that the World Health Organization has defined 2004 as the year of road safety, since they have found that, if the trend continues, by 2020 this problem will be the third greatest health problem in the world. There are obvious economic consequences of these problems: greater deaths due to road accidents mean less productive work years for citizens. Also, a greater amount of simple injuries from road accidents implies less working days, less productivity and lower GDP development.

Change in rank order of DALYs for the 10 leading causes of the global burden of disease

1990		2020	
Rank	Disease or injury	Rank	Disease or injury
1	Lower respiratory infections	1	Ischaemic heart disease
2	Diarrhoeal diseases	2	Unipolar major depression
3	Perinatal conditions	3	Road traffic injuries
4	Unipolar major depression	4	Cerebrovascular disease
5	Ischaemic heart disease	5	Chronic obstructive pulmonary disease
6	Cerebrovascular disease	6	Lower respiratory infections
7	Tuberculosis	7	Tuberculosis
8	Measles	8	War
9	Road traffic injuries	9	Diarrhoeal diseases
10	Congenital abnormalities	10	HIV

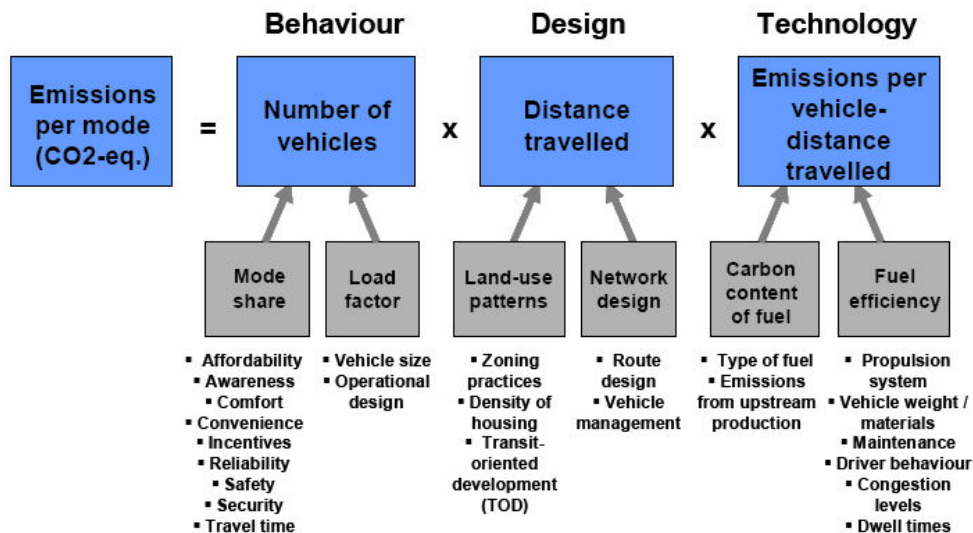
DALY: Disability-adjusted life year. A health-gap measure that combines information on the number of years lost from premature death with the loss of health from disability.

Source: reference 1.

Source: WHO 2004

11.3 Environmental problems have great economic impact

It is also very important to note that environmental costs from transport are directly linked to economic growth. A greater amount of emissions generates a greater risk of lung disease (including child death) and other public health problems (which have a great economic repercussion), as well as global costs from Greenhouse Gas emissions. The figure below (from Wright and Fulton, 2005) shows the basic factors that generate emissions. Based on a careful analysis, it has been found that automobiles are the greatest contributor to greenhouse gas emissions, to such an extent that they alone are responsible for a very significant percentage of emissions that have environmental as well as economic impact on cities and countries.



Source: Wright and Fulton, 2005

### 11.4 Fuel costs due to increased dependence on oil (or other fuels)

As noted above, one great factor related to economic growth and transport is oil dependence. According to a World Bank report, China is the world's second largest oil consumer, with one third of all fuels imported. The fact that oil prices are rising makes it increasingly important to improve this situation. There have been some attempts at improving it by replacing oil with other fuels, but this will only solve the problem in the medium to long term, until the newer fuels are also exhausted and a similar situation arises.

Higher fuel prices can be an important driving force to a low-carbon and energy efficient transport sector. Significant levels of fuel taxation together with other policy instruments and investments in sustainable transport services and infrastructure make walking, cycling and public transport more attractive. Higher fuel taxes encourage the procurement of energy-efficient vehicles as well as their appropriate maintenance. In the long run, high fuel prices encourage the development of dense settlements, often in combination with mixed-use areas that in turn encourage shorter trips. Experiences from countries with high fuel prices reveal that users and providers of transport services and infrastructure often smartly adapt habits and policies. This should encourage countries with low taxation levels to gradually increase taxes on fossil fuels to promote more energy efficient mobility solutions. (GTZ 2009, International Fuel Prices 2009)

Shifting trips from automobiles to public transport, walking and bicycles (and retaining existent bicycle trips) and improving conditions for existing cyclists are ways in which this problem can be altogether tackled in the longer term. This has proven to have a much greater impact on overall economic, social and environmental terms than simply relying on alternate-fuel solutions, without tackling with the problems of mode choice, trip lengths and number of trips. This is also due to the facts outlined above about citizen's health, road safety and other externalities that will not be solved with the switch of automobiles' fuel from oil to another energy source.

## 12 Overview of the GTZ Sourcebook for Policymakers in developing countries

- This section is adapted from the Overview of our sourcebook

### 12.1 Background

Traffic jams; polluted air; dangerous roads; funding crises; absence of parks, walk-ways and public spaces; spiralling car and motorcycle use; ever-greater burdens on the poor; and less liveable cities: these are all increasingly familiar to people living in developing cities. Moreover, transport problems are getting worse, rather than better, with economic development.

Policy-makers in developing cities often seem to approach transport with car-oriented paradigms poorly matched to the needs of the large majority of urban dwellers. Transit is dominated by discussion of rail-oriented mega-projects rather than more reasonably priced bus rapid transit, walking and cycling is neglected, uptake of cleaner fuels and technologies is slow, and scarce road space is given free of charge to a car-owning minority even while cities face severe funding shortages.

Many developing cities are at a cross-road. Policy decisions taken now, while car use is still relatively low and cities retain a relatively transit-friendly, compact urban form, will affect how people will live in their cities for many decades into the future.

Parts of the answer to reversing the deteriorating situation are provided by cities such as Bogotá, which is forming a new paradigm of urban transport; a city for people rather than for cars. A multitude of successful policy tools are available, yet policy-makers and regulators often simply lack access to information about these tools. While an increasing quantity of excellent reference material for developing cities is becoming available on vehicle fuel and technology issues

(including through important initiatives of The World Bank and the Asian Development Bank), other aspects of a sustainable urban transport agenda have often been neglected.

Helping address this lack of access to information in developing cities is a major objective of the *Sourcebook*.

## 12.2 Objective

*Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities* provides a 'toolkit' for transport policy-makers and regulators in developing cities. It addresses the key policy areas which collectively can provide an integrated and modern transport policy framework for a developing city. Through the *Sourcebook*, policy-makers and their advisors can gain access to information about modern approaches and best practices, and to planning and regulatory resources that would otherwise be unavailable to them, or which would require expensive external consultant resources.

GTZ's main experience lies in providing advisory services in complex urban environments and more specifically in issues of sustainable urban transport.

The *Sourcebook* contains 20 printed modules (and at present more than 27 in digital format) in the form of booklets around 20 to 40 pages long, at present translated to various languages such as Spanish, Chinese, Thai, Indonesian, among others. Each module draws upon the experience of GTZ and others in developing cities, and is a collaborative exercise, with generous contributions from contributors who are leading experts in their fields.

## 12.3 The target audience

The *Sourcebook* is for policy-makers and their advisors, and those involved with transport planning and regulation in developing cities. This audience is reflected in the content. The language is not overly technical and links to further resources, mainly via the internet, are provided. Photos, tables and charts are used throughout, and the entire set is printed and bound in an easy-to-read, full-colour format.

Mayors and leading policy-makers in developing cities will not have time to read through long and complicated technical manuals, and for that reason every effort has been made to keep the *Sourcebook* modules down to a manageable length, while still providing the level of detail needed to support regulators and policy-makers. Some modules will be of more relevance to policy-makers than others, depending on their local situation. Most of the modules will, however, be relevant to policy-makers in all developing cities.

As well as capacity development for policy-makers and regulators, the *Sourcebook* can form the basis of a sustainable transport training curriculum in a developing city, and will be a valuable resource to educators, civil society groups and other stakeholders.

## 12.4 Putting the Sourcebook to use

The *Sourcebook* can be used in many ways, ranging from detailed technical manual to a convenient general overview. The modules will be made available to policy-makers and regulators, and to other urban stakeholders.

GTZ has been actively disseminating the *Sourcebook* through various approaches and over an extended period of time. Presentations, workshops, brochures, websites, meetings, word of mouth, provision of materials, audio-visual materials, newsletters, media interviews: all are viable methods of helping ensure that the *Sourcebook* objective of assisting developing city governments is attained.

Inevitably, different cities focus initially on different modules of the *Sourcebook*. To assist in deciding which policy-makers, regulators and advisors should focus on which modules, each module is briefly outlined in the following section.

## **Institutional and policy orientation**

### **1a. The Role of Transport in Urban Development Policy (Enrique Peñalosa)**

This module sets out a 'new vision' of urban transport for developing cities. Written by former mayor Enrique Peñalosa, it draws from the recent experience of Bogotá, Colombia and shows how basic problems of urban transport are political rather than technical. Dr. Axel Friedrich (Umweltbundesamt) contributes to the module, explaining practical working mechanisms to help a city work from conceptual stages through to implementation.

### **1b. Urban Transport Institutions (Richard Meakin)**

This module develops an analysis of urban transport institutional successes and failures in developing cities. It considers several in-depth case studies in a range of countries, explaining how institutional shortcomings have arisen and are manifested. The module draws conclusions from the case studies in the form of recommended policy approaches required for effective urban transport institutions.

### **1c. Private Sector Participation in Urban Transport Infrastructure Provision (Chris Zegras, MIT)**

This module describes benefits and pitfalls of private sector participation (PSP). It provides detailed case studies of PSP in a range of developing countries and concludes with carefully considered policy recommendations for developing cities. The module emphasises that PSP in urban transport infrastructure provision should take part in the context of achieving wider mobility and access objectives, not as an end in itself.

### **1d. Economic Instruments (Manfred Breithaupt, GTZ)**

One of the best ways to influence travel behaviour is through economic instruments. This module surveys successful experiences with fuel and vehicle taxes, road pricing and other instruments, showing that a range of often under-utilised policy options exists for developing cities. The module shows how economic instruments can work toward multiple goals, generating revenues and reducing congestion while improving air quality.

### **1e. Raising Public Awareness about Sustainable Urban Transport (Carlos F. Pardo, GTZ)**

Public awareness, support and information campaigns are crucial to the formulation and implementation of any sustainable transport policy in developing cities. Key components of carrying out a cost-effective initiative to raise public awareness about sustainable transport include determining a target audience, developing a strategic approach, and establishing an effective "Working Group" (with a case study on Bicycle User Groups). This module provides practical advice on all of these matters as well as a section on Car Free Days contributed by Eric Britton of Ecoplan.

### **1f. Financing Sustainable Urban Transport (Ko Sakamoto, TRL)**

Urban transport has historically not received the attention, careful planning and financial support it deserves in order to function in a sustainable manner. As a step to address this issue, this new GTZ Sourcebook module provides detailed information on available options for financing urban transport. It presents different financing instruments and ways in which they can be best used, and how to optimally combine them. This module is dedicated to policy makers, financial sector specialists and urban planners/practitioners working on key challenges related to financing urban transport systems. The sourcebook provides options to close the gap between the ever growing demand for efficient, equitable and environmentally friendly urban transport systems on one hand, and the dwindling financial resources available to state and local authorities on the other.



## Land use planning and demand management

### 2a. Land Use Planning and Urban Transport (Rudolf Petersen, Wuppertal Institute)

Around the world, which cities have succeeded in establishing land use patterns which support the more environmentally-friendly and efficient modes of transit, walking and cycling? What are the benefits of better land use planning for developing cities? What are the key components of a successful land use and transport planning program in a developing city? How should urban transport and land use be organised? What can developing cities do to address increasing problems of urban sprawl and automobile dependency? This module addresses all of these questions and provides policy recommendations, with several case studies from developing cities.

### 2b. Mobility Management (Todd Litman, VTPI)

Mobility management, otherwise known as *transport demand management*, aims to make the best use of existing infrastructure by managing the demand for transport. The starting point for mobility management is that a city's transport system should focus on moving people and goods, rather than vehicles. This differs from the approach currently being taken in many developing cities, which is supply-oriented and involves ever-more road building. This module provides a wide range of policy tools in mobility management for developing cities, ranging from Smart Growth to parking to sustainable tourism and commuter reduction programs.

## Transit, walking and cycling

### 3a. Mass Transit Options (Lloyd Wright, ITDP; Karl Fjellstrom, GTZ)

Choices about a mass rapid transit system are choices about a city's future. This module surveys mass transit systems around the world, and compares the different systems according to key parameters such as cost, construction time, environmental impacts, poverty impacts, speed, passenger capacity and so on. It concludes that although there is no single mass transit solution, for most developing cities bus rapid transit may be the best option.

### 3b. Bus Rapid Transit (Lloyd Wright, ITDP)

Bus rapid transit is a remarkable new phenomenon in the world of transit. This module provides practical guidance on how a developing city can plan, finance, design and implement a world class bus rapid transit system. As a planning template for developing cities, this module can drastically reduce planning and consultancy costs which a developing city would otherwise incur in developing a BRT system.

### 3c. Bus Regulation & Planning (Richard Meakin)

This module provides direction to developing cities on how to break out of a low quality, high-risk, low profit, low investment spiral in which so many urban bus systems in the developing world are now caught. It introduces and outlines the concept of an annual planning cycle, and shows how developing cities can improve bus systems from the viewpoints of operators, drivers, regulators, and passengers.

### 3d. Preserving and Expanding the Role of Non-motorised Transport (Walter Hook, ITDP)

This module starts by outlining the benefits of non-motorised transport (NMT). It considers the different forms of regulation to which NMT is subjected, and describes the non-motorised planning process and the steps involved, drawing from an example pilot study conducted in Surabaya. Successful measures in cities such as Bogotá, and in European cities, is described with a view to application in developing cities.

### 3e. Carfree Development (Lloyd Wright, UCL)

This module describes in great detail the history and background of carfree initiatives and urban redevelopment focussing on this topic. It explains its benefits and structures the basic procedure to implement carfree project, including its conception, development, implementation and evaluation. It

includes many examples of these projects in varying degrees, as well as reflections on their specific impacts and feasibility in particular settings.

## Vehicles and fuels

### **4a. Cleaner Fuels and Vehicle Technologies (Michael Walsh; Reinhard Kolke, Umweltbundesamt)**

Cleaner fuels and vehicle technologies are one of the key components of any sustainable urban transport system. This module, from two leading experts on the subject, provides a detailed evaluation of cleaner fuels and technologies which can be applied in developing cities. Fuel options are evaluated based on cost and practicality. The role of fuel quality standards is also described.

### **4b. Inspection & Maintenance and Roadworthiness (Reinhard Kolke, UBA)**

Another key component of a sustainable transport system is an in-use vehicle testing system. This is essential to ensure that vehicles are properly maintained, from both an environmental (emissions) and safety (roadworthiness) perspective. This module provides advice on the form of inspection and maintenance system appropriate for a developing country, and how developing cities can develop and implement an effective system.

### **4c. Two- and Three-Wheelers (Jitendra Shah, World Bank; N.V. Iyer, Bajaj Auto)**

Motorcycles are the dominant form of transport in many cities, especially throughout Asia. This module firstly describes how the traffic system implications of such a reliance may be unsustainable. The bulk of the module then considers the problem of emissions from two-stroke two-and three-wheelers in developing cities, emphasising the experience in Asia. It provides policy advice on how to address this problem, considering several case studies.

### **4d. Natural Gas Vehicles (MVV InnoTec)**

Written primarily from a European perspective, this decision-maker's guide to natural gas vehicles is nevertheless relevant to developing cities which are considering use of CNG. It provides a solid grounding in all the basic concepts of natural gas vehicles, including their operation, economic aspects, environmental aspects, refuelling infrastructure, and so on. Case studies from developing cities, including a detailed consideration of experience in Delhi (provided by CSE India), are provided.

### **4e: Intelligent Transport Systems (Phil Sayeg, Phil Charles)**

This module describes the different examples of Intelligent Transport Systems which can be developed to improve transport situations, though particularly focussed on measures directed towards public transport, pedestrians and other sustainable transport modes. It provides details on the ITS benefits, the characteristics of each measure and how to use each in different settings.

### **4f: Ecodriving (VTL, Manfred Breithaupt, Oliver Eberz)**

This module focuses on the improvement of driving techniques in public transport drivers, in order to achieve a more defensive and economical driving style which will provide great benefits to them, their companies and the environment due to the improvements in road safety, fuel consumption, tire wear and consequent environmental benefits.

## Environmental and health impacts

### **5a. Air Quality Management (Dietrich Schwela, World Health Organisation)**

This module serves to assist policy-makers and their advisers in developing countries to determine the best measures to abate air pollution with limited information. It provides advice on developing

legally enforceable air quality standards and simplified clean air implementation plans. The module explains basic concepts of air pollution, sources and types of pollution, major pollutants, WHO and other standards, air quality monitoring, air quality management plans, and emissions inventories. It also briefly introduces topics such as air quality modelling and economic valuation of the health impacts of air pollution.

#### **5b. Urban Road Safety (Jacqueline Lacroix, DVR; David Silcock, GRSP)**

Road traffic crashes result in around 800,000 deaths annually. A disproportionate amount are in developing countries, with the victims often pedestrians and cyclists. This module describes how road safety is organised at a city government level, how it is assessed (including the use of tools such as road crash diagrams), how safer road environments can be created, and the importance of public awareness, enforcement, safer vehicles, and sound financing.

#### **5c. Noise and its Abatement (Civic Exchange Hong Kong; GTZ; UBA)**

Noise is emerging as an insidious problem in developing cities, even though it is not currently perceived as a major problem. A major source of noise in cities is urban road transport. This module introduces basic concepts of measuring noise, describes the health effects of noise, provides recommended noise level standards, and outlines six key policy areas where governments can take action to reduce noise from transport.

#### **5d. The CDM in the transport sector (Jürg M. Grütter)**

Since the advent of Kyoto Protocol in 2005, many countries, both developed and developing, have embraced the concept of CDM in order to reduce their carbon emissions. Clean Development Mechanism or CDM, an innovative strategy introduced by the Kyoto Protocol, is related to projects in developing countries aimed to reduce GHG's which are sold to countries mostly in the developed world. This module discusses the viability of sustainable transport projects to be qualified under the CDM mechanism which will thereby benefit from GHG offset sales. The module also presents a case study on TransMilenio, Bogotá's BRT system which was the first officially registered CDM project for transport.

#### **5e Transport and Climate Change (Holger Dalkmann and Charlotte Braniggan)**

The module summarises the challenges that climate change mitigation has to face in the transport sector and presents the major options and instruments to deal with them. The module is a comprehensive summary of sustainable transport policy options and sketches out their potential for the reduction of carbon dioxide emissions. The module draws on the existing sourcebook modules and thus offers both a comprehensive overview and a thematic entry point to the whole sourcebook. To ease access to more detailed information, the module includes many references to the other sourcebook modules. The authors, Holger Dalkmann and Charlotte Branigan, work at the Centre for Sustainability (C4S) at the Transport Research Laboratory (TRL), UK.

#### **5f Adapting Urban Transport to Climate Change (Urda Eichhorst)**

Many transport decision-makers in developing countries are already confronted with extreme weather events, such as flooding, subsidence and storms, all of which are expected to increase with climate change. In the worst case, transportation systems may not be able to recover between such events, resulting in exponential damages. This module of the GTZ Sourcebook for Decision-Makers in Developing Cities is intended to raise awareness and describes the expected impacts of climate change on urban passenger transport as well as possible adaptation measures.

## Resources

### 6. Resources for Policy-makers (Compiled by GTZ)

This module provides up-to-date, annotated links to internet resources in all the module topic areas, as well as several additional sub-topics.

## Social Issues in Transport

### 7a. Gender and Urban Transport (Mika Kunieda, Aimée Gauthier)

This module addresses how gender should be addressed in transport policy and planning. The authors state that inequitable, inefficient and unsustainable transport can result from a lack of consideration of gender issues. Moreover, transport is often seen as gender neutral — a road or bus system expecting to benefit everyone equally. However, urban transport systems are dynamic and are influenced by society and differences within society must be taken into account. In brief, the objective of this module is to generate greater awareness and knowledge about the relevance of gender in urban transport, and how to address it in a smart and affordable way.

## Sourcebook translations

Since its development, the sourcebook has been translated to various languages. All modules are available in English, Spanish and Chinese. Other languages to which some sourcebook modules have been translated are Bahasa Indonesia, Thai, Romanian, Korean, French, and Vietnamese.

## 12.5 Complements to the sourcebook

### *Training Documents*

#### **Training Documents on Sustainable Urban Transport topics**

To complement the Sourcebook modules, GTZ has also developed training material in longer and more detailed documents, where steps for planning and how to develop different urban transport strategies are explained. As with Sourcebook modules, authors are respected professionals with extensive experience in each topic. Below is a short description of the existent training materials.

#### **Bus Regulation and Planning – Bus Sector Reform by Richard Meakin**

This document describes the characteristics of bus systems in cities of developing countries, together with prescriptions for reform and case studies. The document will be of interest to government decision-makers, transport professionals, and consultants. The document also addresses bus policy issues in the 'second world', the former socialist countries, where constraints are different. Covering all these important aspects of public transport, decision makers will be equipped with important tools for making just and sustainable decisions for their cities.

#### **Cycling inclusive planning handbook by various authors (in cooperation with I-CE)**

This training course documents discusses an inherent aspect of an integrated transport system that is most times neglected: cycling. The document explains the importance of cycling in a city and explains design details of planning for environments that would be friendly to bicycles and, in consequence, to other sustainable modes of transport such as walking. This document provides planners and decision-makers with the tools to develop people-friendly transport systems in their respective cities and how to integrate these

into existent urban transport systems, starting from the policies and stakeholder involvement and getting to design details.

### **Training Course on Mass Transit by Lloyd Wright**

This document, authored by Dr. Lloyd Wright, serves as a course manual for conducting training on choosing between mass transit options in developing cities. The document starts with the basic details of a Mass transit, its importance and how a city can benefit from various kinds of mass transit systems. This provides tools for planners and decision makers so they can carefully reflect on their available options for their cities and thus, selecting and developing the most sustainable mass transit system for their specific case.

### **Non-motorised Transport by Walter Hook**

This training course document discusses an inherent aspect of an integrated transport system that is most of the times neglected: non-motorised transport (NMT). The document explains the importance of NMT in a city and explains design details of planning for pedestrians and bicycles. This training course document provides planners and decision-makers with the tools to develop people-friendly transport systems in their respective cities.

### **Public awareness and behaviour change by Carlos F. Pardo**

This document focuses on the importance of awareness and the necessary tools to initiate a change in the behaviour of the stakeholders for a sustainable transport system. Further, the document explains the various surveying methods for proper data collection. These tools will help planners and professionals in charge of communication of transport projects to diffuse information regarding new transport projects or initiatives to change travel behaviour of citizens.

### **Travel Demand Management training document by Gopinath Menon, Todd Litman and Anna Broaddus**

The training course document describes the rationale of why urban transport measures should be updated in terms of pricing, use of infrastructure and demand-driven rather than supply-oriented policies. Specific measures ranging from fuel pricing to congestion charging and parking policies among many others are described and examples are given where such policies and projects have been implemented. This topic is seldom presented to policymakers and city planners as one of the options to improve urban transport but is as crucial as public transport projects and other measures.

### **Bus Rapid Transit Planning Guide by Lloyd Wright and Walter Hook**

The latest version of the Bus Rapid Transit Planning Guide is the most comprehensive effort to date to provide detailed technical guidance for developing a Bus Rapid Transit (BRT) system. It was a joint development between the Institute for Transportation and Development Policy (ITDP), together with the United Nations Environment Programme (UNEP), Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ), the Hewlett Foundation, and Viva Foundation. In total, there are 20 different chapters in 830 pages covering a broad set of issues. The document can be used as a handbook by cities that are interested in implementing BRT. The guide also lists a range of information sources that can assist a city's BRT planning efforts.

## ***Technical Documents***

### **Induced Travel by Roger Gorham**

"If we build it, they will come": The question of induced travel demand attracts substantial interest from decision-makers, planners and the wider public alike. This technical document is intended as an introduction

to the concept of induced travel demand and the principal arguments and debates surrounding the phenomenon. The module has been written by Roger Gorham, a leading researcher in the field, in an effort to provide greater knowledge to the policy makers on issues related to sustainable urban transport.

### **Social Change and Urban Transport by Dr. Marie Thynell**

Despite the growing awareness of the need of sustainability in transport planning, efforts to work on this topic have focused on the environmental and economic aspects, but there have been few projects and initiatives investigating and working upon social aspects of transport, the third of the main pillars of sustainability. This document describes how transport in its social dimension has many intricacies that should be taken into account when analysing existing policies and developing new ones. It provides a description of the main issues to be tackled, the main stakeholders in the local and international/multilateral levels, indication as to how to implement social change in transport and a brief overview of social impact assessment as an aid to such a process.

### **Public Bicycle Schemes: Applying the concept in developing cities (examples from India) by Chhavi Dhingra and Santhosh Kodukula**

Most cities, especially in developing countries, have overlooked the importance of planning for sustainable transport as a precursor to liveable cities. The bicycle has traditionally been an integral feature of mobility of the masses, and even today, a significant share of commuter trips, especially in developing cities is made on bicycles.

Public bicycle or bike sharing or bike rental systems, where users can pick up and drop off bicycles at certain locations in the city, and use it for a fixed amount of time and cost, have been around for over a century but are rapidly gaining popularity in cities worldwide today, as a clean and healthy alternative for personal mobility. The ultimate goal of bike sharing is to expand and integrate cycling into transportation systems, so that it can more readily become a daily transportation mode. A few countries in Asia like China, South Korea, Taiwan, Thailand and now India have already started to introduce bike sharing programs.

The objective of this technical document is to familiarize city authorities, transport planners, businesses, civil society representatives and policy makers in developing cities with the concept and various components of a public bicycle program, and to provide initial guidance and advice on designing and implementing such a program in Indian cities. This document presents the experience of bike sharing programs from a few cities in Europe and Asia, and analyses the developing country climate (taking India as an example) for encouraging such programs in developing cities. An analysis of the existing bicycle rental programs in India and their challenges validates and reinforces the document's objectives. The document also makes practical suggestions and recommendations for developing cities who want to implement such a program.

### **Transport Alliances - Promoting Cooperation and Integration to offer a more attractive and efficient Public Transport**

This new GTZ technical document summarises the development of the German public transport alliance system, the so called *Verkehrsverbund* that is often regarded as the first and most successful form of Integrated Transport. It offers information on aspects ranging from institutional issues to best practices in introducing an integrated fare system. A final chapter looks at transport alliances in the neighbouring country of Switzerland.

The training document is based on selected parts of the Publication "Transport Alliances – Promoting Cooperation and Integration to offer a more attractive and efficient Public Transport", published by the Verband Deutscher Verkehrsunternehmen e.V. (VDV), VDV-Förderkreis e.V.

## **12.6 Other Highlights on Transport**

### **International Fuel Prices**

Fuel taxes are an important source of revenue for the financing of the transport sector in that they charge road user the costs of transport infrastructure, particularly roads. A suitably framed policy of fuel taxation can yield the financial resources necessary to maintain, manage and develop the road system. Experience

shows that in many developing countries, an approximate tax of 10 US cents per litre is sufficient to cover the long-term financing of the existing trunk road network. As another general rule of thumb, an additional 3-5 US cents per litre can yield a stable source of revenue for the financing of urban roads and public transport.

Furthermore, numerous countries earn revenues through taxation of petroleum products, which can be used for financing transport and providing social services such as better education and healthcare. In addition, fuel taxation can also be used to shift the burden of the indirect negative effects of transport (so-called external costs of transport such as environmental pollution, noise, congestion costs, etc.) onto personal automobile users.

“International Fuel Prices” is a long-time effort of GTZ (German Technical Cooperation) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) to provide decision-makers with data on fuel prices on a global scale. The worldwide transparency and comparability of fuel prices is an important preliminary step towards the national implementation of rational energy pricing policy.

### **International Fuel Prices 2009**

The 2009 International Fuel Prices report provides an overview of the retail prices of gasoline and diesel in more than 170 countries, discusses pricing policies, presents case studies on the impact of high and volatile fuel prices in 2007/2008 in developing countries and provides access to numerous additional resources. (114 pages, over 450 graphs and figures). (authors: Sebastian Ebert, Dr. Gerhard P. Metschies, Dominik Schmid, Armin Wagner).

### **Other transport related resources:**

- AKZENTE- Transport for Growth
- BMZ – Topics Transport and Mobility
- Why Transport Matters
- Clean Air in Cities
- AKZENTE - Clean Air in Cities
- My Clean Air Malaysia
- The Road Safety Cent
- Traffic Safety – The German Experience after the Reunification
- Bangkok Rapid Transit - BRT Bangkok - GTZ Survey

### **Reading Lists are available on:**

- Non-Motorised Transport
- Informal Public Transport
- Public Transport Integration
- Electric Mobility
- Urban Transport and Health
- Road Safety
- Public Bicycle Schemes
- Mobility concepts for major events

## 12.7 Future directions for the Sourcebook

### Dissemination

GTZ recognises the importance of devoting resources to the active dissemination of the *Sourcebook*, to try to ensure that the modules are actually used and applied in developing cities. This active dissemination consists of several activities, one of which is the Sustainable Urban Transport Project in Asia, Latin America and Africa.

### SUTP

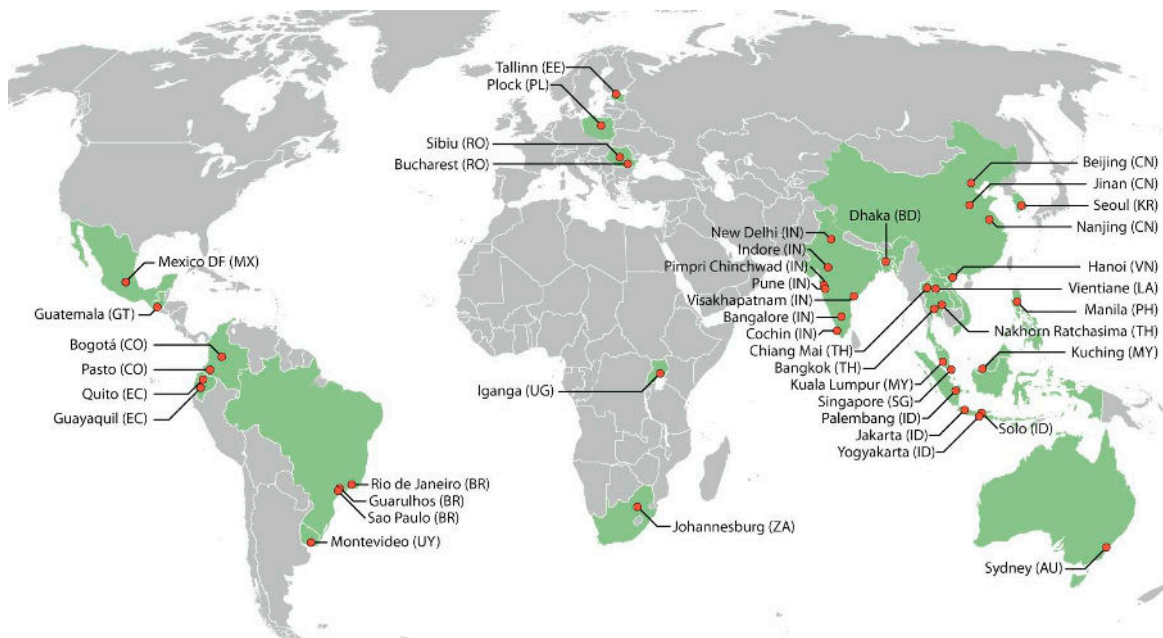
The Sustainable Urban Transport Project, called SUTP, is one of the partnerships and initiatives which is a platform for the active dissemination and ongoing development of the *Sourcebook*. This project commenced in early 2003 with initial German Technical Cooperation funding. The Project has an Asia and a Latin America & Caribbean division. SUTP-Asia is a partnership between the German Technical Cooperation (GTZ), the Bangkok Metropolitan Administration (BMA, CITYNET and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), while SUTP-LAC is partner to Corporación Andina de Fomento, ARPEL and TransMilenio and is based in Bogotá (Colombia). It so works with institutions in the regions such as CAI Asia, Embarq, I-ce, ITDP and Chinese institutions such as Tsinghua University.

The Project aims to help developing cities in these two continents achieve their sustainable transport goals, through the dissemination of information about international experience and targeted work with particular cities.

### Training courses

One of GTZ-SUTP's key activities has been the design, development and delivery of training courses on various topics related to sustainable urban transport in Asia, Latin America and Africa. Until October 2010, GTZ-SUTP conducted over 70 courses which included over 3000 participants. Topics have varied from general issues such as Sustainable Urban Transport to specific issues such as Travel Demand Management, Planning for Mass Transit and Non-Motorized Transport systems, etc.

### Training courses held by GTZ SUTP until October 2010





## Training materials

GTZ in cooperation with key partners has further developed the *Sourcebook* into training materials on sustainable urban transport. These training materials consist of various components according to an internationally standardised methodology of high quality training material provision.

Components include, for example:

- instructors' notes
- participants' notes
- overheads / slides / projector material
- facts sheets & briefings
- training exercises and review questions
- support audio-visual and multimedia materials
- advice on how to plan for and implement an effective training program based on the *Sourcebook*.

Training documents have already been published on Mass Transit, Bus Regulation and Planning, Bus Rapid Transit, Non-motorised transport, Attitude/behaviour change, TDM and Financing Urban Transport.

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***“<http://www.sutp.org> is the companion website to the *Sourcebook*, as well as an information source on sustainable urban transport.”***

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Future directions for the *Sourcebook* and SUTP-Asia include further updates of the modules (incorporating feedback from users), and additional modules – for example induced travel, urban transport financing, and participatory planning – and the development of more training materials based on the modules.

## The *Sourcebook* companion website

The SUTP website, [www.sutp.org](http://www.sutp.org) (in Chinese [www.sutp.cn](http://www.sutp.cn)), is the companion website to the *Sourcebook* as well as an information source on sustainable urban transport. It contains news of training events, workshops and other events, news items, related GTZ initiatives, and other information. Additional resource materials such as transport photo CDs, links to other material and websites are available.

and distribution. You may also order via [transport@gtz.de](mailto:transport@gtz.de).

### Comments or feedback?

We would welcome any of your comments or suggestions, on any aspect of the *Sourcebook*, by e-mail to [transport@gtz.de](mailto:transport@gtz.de), or by surface mail to:

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## 13 Basic references and resources

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### 13.2 Other resources

#### 13.2.1 Sustainable development

- Global Environment Facility, [www.gefweb.org](http://www.gefweb.org). GEF funds defray the added costs of making planned projects environmentally friendly (with a focus on global issues such as climate change, in the transport sector).
- Organization for Economic Cooperation and Development, Sustainable Development section, [www.oecd.org/EN/home/o,,EN-home-21-nodirectorate-no-no--21,00.html](http://www.oecd.org/EN/home/o,,EN-home-21-nodirectorate-no-no--21,00.html), and the Environmentally Sustainable Transport section, [www.oecd.org/EN/home/o,,EN-home-518-nodirectorate-no-no-no-25,00.html](http://www.oecd.org/EN/home/o,,EN-home-518-nodirectorate-no-no-no-25,00.html) provide numerous resources on sustainable development
- United Nations Commission on Sustainable Development, [www.un.org/esa/sustdev/csd.htm](http://www.un.org/esa/sustdev/csd.htm). The UNCSO was established in 1992 following the UN Conference on Environment and Development
- United Nations Development Programme, [www.undp.org](http://www.undp.org). UNDP’s mission is to help countries achieve sustainable

human development by assisting them to build their capacity to design and carry out development programs, giving first priority to poverty eradication

United Nations Environment Programme, [www.unep.ch](http://www.unep.ch). UNEP is charged with the implementation of global and regional environment conventions, providing policy responses to existing and emerging environmental concerns and raising awareness about how peoples actions negatively affect the environment.

[www.unep.ch/conventions/geclist.htm](http://www.unep.ch/conventions/geclist.htm) provides links to various multilateral agreements and conventions

World Bank, [www.worldbank.org](http://www.worldbank.org). The world's largest source of development assistance

World Business Council for Sustainable Development, [www.wbcsd.ch](http://www.wbcsd.ch). WBCSD aims to develop closer co-operation between business, government and all other organizations concerned with the environment and sustainable development, and to encourage high standards of environmental management by business.

### 13.2.2 Transport and poverty

DFID Transport Resource Centre, [www.transport-links.org/rcs](http://www.transport-links.org/rcs). The TRCS is a world-wide consortium of groups and individuals with specialist knowledge in the field of transport research. Site includes the Rural Transport Knowledge Base

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Documents available for download include the "Monterrey Consensus"

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United Nations Centre on Human Settlements/HABITAT, [www.unchs.org](http://www.unchs.org). Habitat's activities focus on promoting housing for all, improving urban governance, reducing urban poverty, improving the living environment and managing disaster mitigation and post-conflict rehabilitation

United Nations Millenium Development Goals, [www.developmentgoals.org](http://www.developmentgoals.org), UN Millenium Declaration, September 2000

World Bank PovertyNet, [www.worldbank.org/poverty/mission/up1.htm](http://www.worldbank.org/poverty/mission/up1.htm) provides many resources on poverty, including a "Literature of Poverty" section.

### 13.2.3 Transport and gender

Transport and Society Research, [www.geocities.com/transport\\_research](http://www.geocities.com/transport_research). Deals with the two main topics of social exclusion & transport, and gender & transport

World Bank Gender and Transport, [www.worldbank.org/gender/transport](http://www.worldbank.org/gender/transport), Includes various studies, tools and resources

[www.geocities.com/transport\\_and\\_society/ruralinclusion.html#topics](http://www.geocities.com/transport_and_society/ruralinclusion.html#topics). This website, prepared by Margaret Grieco, Professor of Transport and Society, Napier University, Edinburgh, includes an annotated list of links to a large number of resources on gender and development, including best practice guidelines in various sectors. Includes a paper on *Gender, social inclusion and rural infrastructure services*

[www.ifrtd.gn.apc.org/issues/cc-gen.htm](http://www.ifrtd.gn.apc.org/issues/cc-gen.htm), includes a section on Gender in Rural transport issues, and links to various resources

### 13.2.4 Transport and global warming

ARIC, [www.doc.mmu.ac.uk/aric/arichome.html](http://www.doc.mmu.ac.uk/aric/arichome.html). ARIC provides research & education in atmospheric & sustainability issues

Center for Neighborhood Technology, [www.cnt.org](http://www.cnt.org). Contains a number of sub-web sites on various transport

topics

Environmental Defense, [www.environmentaldefense.org](http://www.environmentaldefense.org). US non-profit organization representing more than 300,000 members

Exhaustion: A Guide to Transportation Emissions, [www.ec.gc.ca/emission/toce.html](http://www.ec.gc.ca/emission/toce.html). Easy-to-read fact sheets mainly on fuel-related topics, with a Canadian focus

Global Environment Facility, [www.gefweb.org](http://www.gefweb.org). GEF helps developing countries fund projects that protect the global environment. Site provides a list of projects worldwide, information and application forms.

GTZ Climate Protection Program, [www.gtz.de/climate/english](http://www.gtz.de/climate/english).

Helio International, [www.helio-international.org](http://www.helio-international.org). HELIO's goals are to assess, monitor and publicise the contribution of energy systems to sustainable development. Links to individual country reports.

International Council for Local Environmental Initiatives, [www.iclei.org](http://www.iclei.org). ICLEI is an international association of local governments implementing sustainable development

International Energy Agency, [www.iea.org](http://www.iea.org). Multinational agency dealing with energy issues.

Intergovernmental Panel on Climate Change (IPCC), [www.ipcc.ch](http://www.ipcc.ch). An intergovernmental body that provides scientific, technical and socio-economic advice to the world community

Organisation for Economic Cooperation and Development, [www.oecd.org/env](http://www.oecd.org/env). Environment Directorate resources include the Environmentally Sustainable Transport (EST) program.

Sierra Club, [www.sierraclub.org](http://www.sierraclub.org). Campaigns include sprawl and global warming

United States Environmental Protection Agency, [www.epa.gov](http://www.epa.gov). Many resources, particularly strong on AQM. Also advocacy, fuels, TDM, and global warming resources

Wuppertal Institute, [www.wuppertal-institut.de](http://www.wuppertal-institut.de). The work of the Wuppertal Institute is interdisciplinary and oriented to solving problems in the area of applied sustainability research.