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RISING AUTOMOBILE DEPENDENCY: HOW TO BREAK THE TREND?

(EST Session 3B of the Provisional Programme)

Final Draft

This background paper has been prepared by Santhosh Kodukula, Urban Transport Specialist, Sustainable Urban Transport Project (SUTP), German International Cooperation (GIZ), for the Sixth Regional EST Forum in Asia. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

Division 44
Water, Energy, Transport

Rising Automobile Dependency

How to break the trend?

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1. Introduction

Cities in developing countries are at a crossroad. The policies they implement now will determine their transport options and land use development patterns, which affect travel pattern, and will have various economic, social and environmental impacts, as illustrated in Figure 1. Many current policies are likely to create automobile dependent transport systems, which tends to increase future costs and risks. This report describes policy reforms that can help create more efficient and diverse transport systems that will provide significant economic, social and environmental benefits, particularly over the long term.

Policy decision impacts

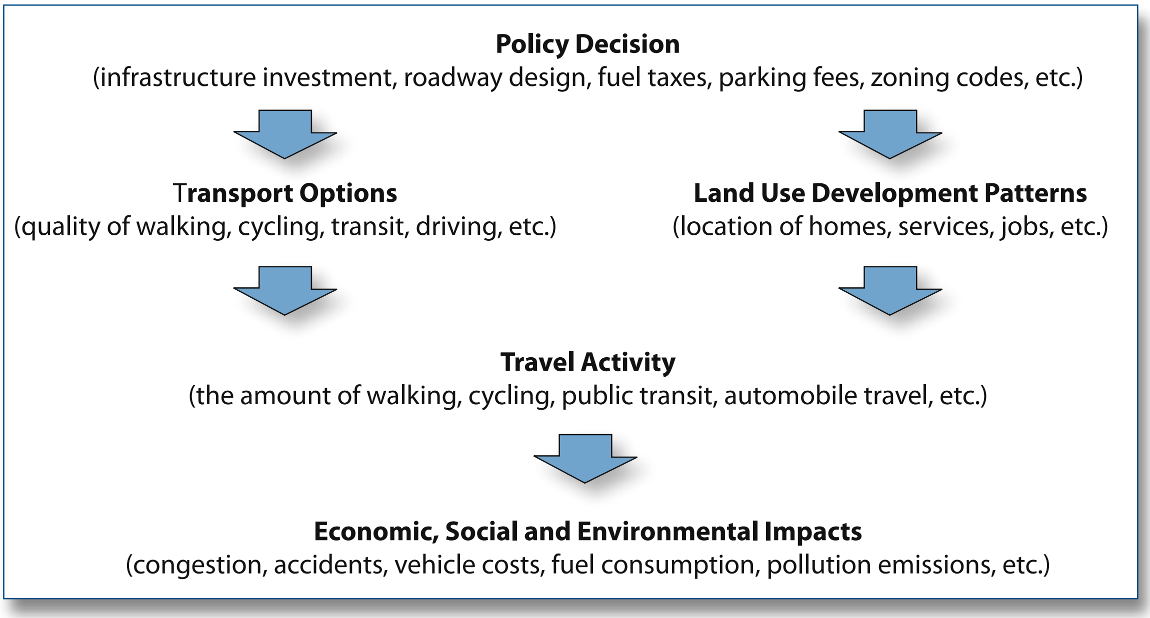


Figure 1

There may be several steps between a policy decision, its impacts on transport options and land use development, effects on travel activity, and its ultimate economic, social and environmental impacts.

Source: Litman, 2011

Automobile-dependency refers to transport and land use patterns that favour automobile travel and provide relatively inferior transportation alternatives (in this case, "automobile" includes cars, vans, light trucks and motorcycles).

The alternative to Automobile Dependency is not a total lack of private vehicles (called Car-Free Planning), rather, it is a *multi-modal* transport system), meaning that consumers have various travel options to choose from, with good integration that provides a high degree of accessibility for non-drivers.

Table 1 compares these various types of transport systems. Automobile dependency is a matter of degree: few communities are totally automobile dependent (that is, driving is the *only* form of transport). Even areas considered automobile dependent often have a significant amount of walking, cycling and transit travel among certain groups, such as by children, seniors and people with low incomes.

An automobile dependent transportation system makes automobile use "compulsory" due to inadequate alternatives. As a result, a *personal* automobile is required to use the system. Non-drivers must be chauffeured, and it becomes difficult to withdraw driving privileges for people who are unfit since there are few viable alternatives. Automobile dependency reduces the range of solutions that can be used to address problems such as traffic congestion, road and parking facility costs, crashes and pollution. For example, in an automobile dependency transport system the only solution to

Table 1: Attributes of automobile dependency

Indicator	Description	Low	Medium	High
Name	**What they are generally called by planners**	**Low car dependency**	**Multi-modal**	**Automobile Dependent**
Vehicle Ownership	*Per capita* motor vehicle ownership (usually measured per 1 000 population)	Less than 200 per 1 000 pop.	200–400	400 +
Vehicle Travel	*Per capita* annual motor vehicle mileage	Less than 6 000 km	6 000–12 000 km	12 000 km plus
Vehicle Trips	Automobile trips as a portion of total personal trips	Less than 50 %	50–80 %	80 %+
Quality of Transport Alternatives	Convenience, speed, comfort, affordability and prestige of walking, cycling and public transit relative to driving	Alternative modes are of competitive quality	Alternative modes are somewhat inferior	Alternative modes are very inferior
Relative Mobility Of Non-Drivers	Mobility of personal travel by non-drivers compared with drivers	Non-drivers are not severely disadvantaged	Non-drivers are moderately disadvantaged	Non-drivers are severely disadvantaged
Land use patterns	Land use density (residents and jobs per acre) and mix (proximity of different land use types)	Very compact and mixed	Moderately compact and mixed	Dispersed and homogenous
Transport system	Type of transport facilities and services available	Mainly non-motorised and public transit	Very mixed: non-motorised, public transit and automobile	Mainly automobile (roads and parking facilities)
Roadway design	Design features of public roads	Highly pedestrian oriented	Mixed	Designed to maximise auto traffic speeds and volumes
Shopping Options	Where retail and other public services are located	Along public streets	Mainly along public streets near transit areas	In private malls, located along major highways
Market Distortions Favouring Automobile Use	Relative advantage provided to automobile transport over other modes in planning, funding, tax policy, etc.	Minimal bias favouring automobile travel	Moderate bias favouring automobile travel	Significant bias favouring automobile travel
Automobile commute mode split	How people travel to work and school	Less than 35 %	35–65 %	More than 65 %
Errand travel	How people normally travel to stores, professional appointments, recreation activities, etc.	Mostly walking, cycling and public transit	Walking, cycling, public transit and automobile	Mostly automobile
Performance Indicators	How transport system performance is evaluated	Quality of walking, cycling and public transit	Multi-modal	Automobile-oriented

This table summarises various indicators of automobile dependency.

Source: Litman, 2011

traffic or parking congestion is to expand roads and parking facilities; it is unrealistic to address such problems by encouraging travellers to shift mode, since the alternatives are so inconvenient.

Automobile dependency tends to impose various costs and risks on individuals and society. These costs are examined in Chapter 5.

To a large degree, automobile dependency results from public policy and planning decisions that favour automobile travel and sprawl to the detriment of other modes and more accessible land use development. This tends to create the self-reinforcing cycle illustrated in Figure 2. While some of these changes are rational and efficient – it makes sense to accommodate a certain amount of automobile travel with adequate roads and parking facilities, many of these policies are implemented without constraints, creating a self-fulfilling prophecy. For example, although an efficient transport system requires adequate paved roads and parking facilities, it also requires mobility management (MM) strategies that encourage their efficient use, such as adequate fuel taxes and parking fees, bike and bus lanes that favour efficient modes, and land use planning that encourages development of walkable, mixed-use neighbourhoods.

Cycle of automobile dependency and sprawl

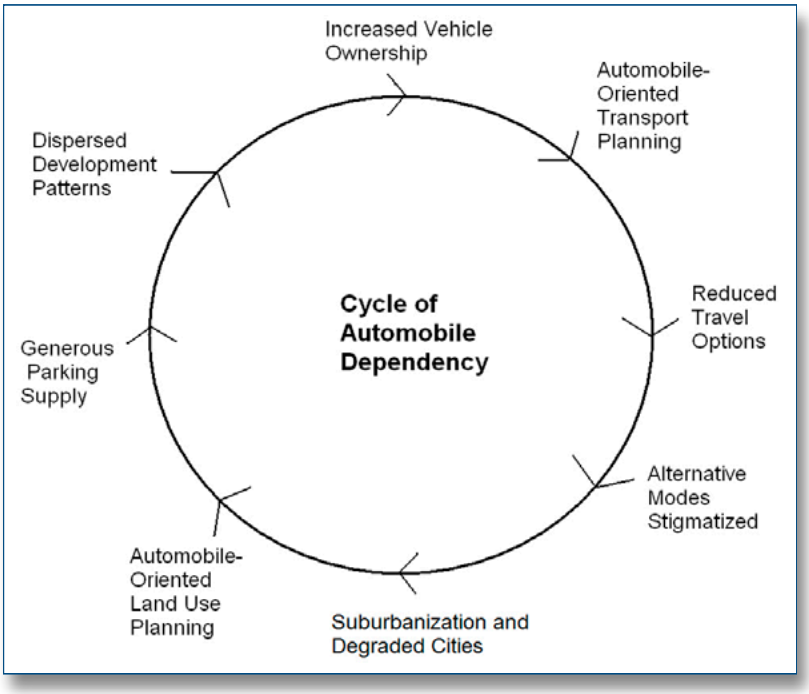


Figure 2

This figure illustrates the self-reinforcing cycle of increased automobile dependency and sprawl. Establishing objectives to reduce vehicle travel and increase use of alternative modes can help correct existing market distortions that lead to inadequate transport options, economically excessive automobile travel, and sprawled land use patterns.

Source: Litman, 2011

Note that many of the factors that contribute to automobile dependency are indirect and complex. For example, most cities have minimum parking requirements in zoning codes. These contribute to automobile dependency by increasing driving convenience, reducing the costs of owning and operating an automobile, and increasing building land requirements which encourages more dispersed developing at the urban fringe where land is cheaper. Each of these contributes to automobile dependency, particularly if implemented in conjunction with the other factors in Figure 1. This is not to suggest that cities do not provide parking facilities, however, there are many possible ways to regulate and manage parking supply, some of which are far more resource efficient and help maintain a diverse transport system[1]. For example, municipal policies can encourage sharing of

[1] See GIZ's Module 2c "Parking Management: A Contribution for Liveable Cities" at: http://www.sutp.org/index.php?option=com_docman&task=cat_view&gid=46&Itemid=54&lang=

parking facilities, and support walking, cycling and public transit, so fewer spaces are needed in a community.

This has important implications for developing countries. Most developing countries are experiencing increasing personal vehicle use and declining mode shares of non-motorised transport (NMT) and public transport (PT). This reflects economic development and increasing affluence, which allows consumers to afford more motor vehicles and fuel.

However, the degree of automobile dependency, and resulting levels of vehicle ownership and use, depend on public policies. Policy decisions made now will determine whether a particular country, city and neighbourhood will maximise transport system efficiency and preserve diversity, or whether they will become automobile dependent. Many wealthy countries have multi-modal policies and planning practices that prevent automobile dependency, particularly in large urban areas. This can provide significant economic, social and environmental benefits.

Developing country cities have an opportunity to apply experience gained around the world to avoid problems associated with automobile dependency, and leapfrog to more sustainable transport policies.

This document attempts to present some examples of good practice from various cities in an illustrative manner, such that developing cities can incorporate the success factors in their transport policies and avoid the unsuccessful ones. The ultimate objective is to indicate a path towards the creation of a sustainable future for urban transport.

2. Road and parking space

The limits of urban vehicle traffic

Cities are areas where people and activities concentrate. An efficient city requires compact development to maximise accessibility. Transport policies significantly affect development density. Transport facilities (sidewalks, paths, roads, parking lots, rail lines and stations, ports and airports) use a major portion of urban land, ranging from 20–40 % in residential neighbourhoods and 40–60 % in commercial centres (downtowns, shopping malls and industrial parks) (Arnold and Gibbons, 1996) in the United States.

Automobile travel requires more space than other modes. As travel speeds vehicles require more *shy distance* (clearance from other objects), including wider lanes and more distance between vehicles. Vehicles also require parking at destinations. A typical parking space is 2.5 metres wide and 6.0 long, totalling about 15 m^2, and off-street parking requires additional space for access lanes and landscaping. There are typically two to six parking spaces per vehicle (one at home, one at work, plus various other destinations). Pedestrians and public transit users generally require no parking, and more than a dozen bicycles can park in the space required for one car. Table 2 compares the road and parking space required for various commute modes.

Table 2: Space required by travel mode*

Mode	Standing	Moving	Travel Area	Parking Area	Total Area
	Sq. Metres	Sq. Metres	Sq. Metre–Min.	Sq. Metre–Min.	Sq. Metre–Min.
Pedestrian – 5 km/h	1	3	120	–	120
Bicycle – 15 km/h	2	9	360	960	1 320
Bus – 25 km/h	2	2	80	–	80
Automobile – 30 km/h	10	30	1 200	4 800	6 000
Automobile – 100 km/h	20	300	12 000	9 600	21 600

This table compares road and parking space requirements for a 20-minute commute by various modes, measured in square-metre-minutes (m^2 times number of minutes).

* *Transport Land Requirements Spreadsheet* (http://www.vtpi.org/Transport_Land.xls), based on Eric Bruun and Vukan Vuchic (1995), "The Time-Area Concept: Development, Meaning and Applications", *Transportation Research Record 1499*, TRB (http://www.trb.org), pp. 95–104.

Figure 3 illustrates these differences. Automobile commuting requires much more space than walking, bicycling and public transit travel.

Space required by travel mode

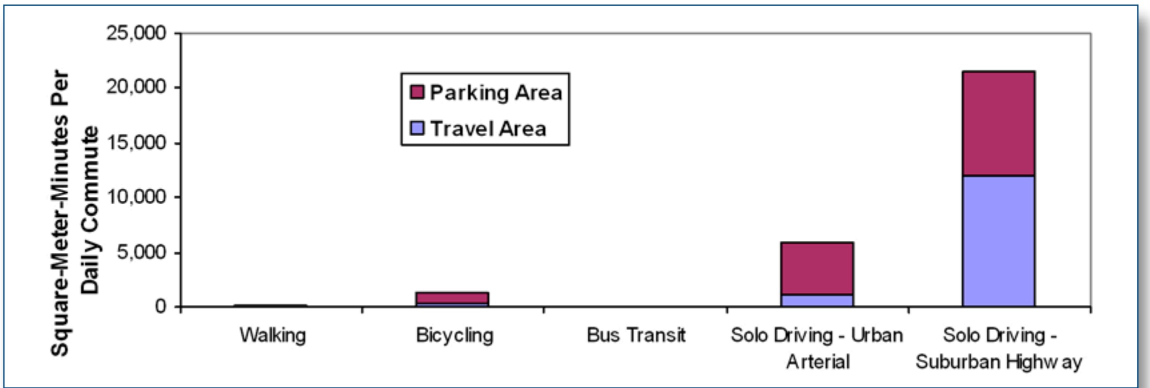


Figure 3
Automobile travel requires far more space for travel and parking than other modes.

Although it is possible to build elevated highways and underground parking facilities that minimise land consumption, they are costly, and often exacerbate traffic problems by increasing local vehicle traffic. For example, a two-lane highway to a downtown typically adds about 10 000 additional vehicles a day to surface streets, increasing local traffic problems. In practice, even wealthy cities with aggressive highway building programs cannot accommodate unlimited automobile travel demand. Inevitably, something must constrain traffic growth.

An urban arterial traffic lane can typically accommodate about 1 000 peak-period vehicles. If the average urban automobile commuter drives 10 kilometres each way on a 3-metre wide lane, each requires 60 m^2 of additional road space (3 m width x 10 000 m length x 2 daily commutes ÷ 1 000), plus two to four parking spaces (one at home, one at work, and a share at other destinations) that average 10 m^2 for curb parking or 20 m^2 for off-street parking. Each additional urban motorist therefore requires 80 to 140 m^2 of land for additional road and parking space to avoid increasing traffic and parking congestion.

Compare this with other urban land uses. A typical urban resident uses about 100 m^2 of land for a small-lot (400 m^2) single-family home with four residents, and less for multi-family housing (townhouses, condominiums and apartments). A typical employee needs about 10 m^2 of office space or about 30 m^2 for retail. This indicates that an automobile requires more land than a typical urban resident uses for housing, jobs and commercial activities. Automobiles more than double the amount of land required *per capita*.

This means that a square kilometre of urban land can accommodate up to 10 000 automobiles if completely paved for roads and parking facilities, assuming 100 m^2 per vehicle, but this would leave no land for other purposes. If a neighborhood wants to devote just 20 % of land to roads and parking facilities in order to leave significant space for homes, businesses, schools, parks and gardens, it can only accommodate about 2 000 vehicles per square kilometre.

If traffic volumes increase beyond roads' capacity, congestion will increase to the point at which it discourages additional traffic growth, making congestion self-limiting. However, this is inefficient. It wastes travellers' time and financial costs, creates uncertainty and stress, and increases fuel consumption and pollution emissions. It is also unfair because buses and HOV occupants are also delayed although they contribute far less to congestion per passenger.

Automobile traffic causes other problem, including accident risk, noise and air pollution. This degrades walking and cycling conditions, which directly harms people who use these modes, and it encourages travellers to shift from walking, cycling and public transit to automobile travel, creating a self-reinforcing cycle of increased driving and reduced alternatives.

Automobile transport is also burdensome to users, typically costing hundreds of dollars annually in purchase, finance, maintenance and repairs, registration and insurance fees, fuel and oil. Most of these are fixed costs, not directly affected by the amount the vehicle is driven. This price structure tends to encourage driving, because motorists want to get a reasonable return on their fixed expenses. This contributes to traffic problems.

Of course, walking, cycling and public transport travel are generally slower than driving. They provide less *mobility* (users cannot travel as far in a given time period) and so they require more land use *accessibility* (they require that people live closer to where they work, shop and recreate). This suggests that the key to solving urban transportation problems is to improve *accessibility* in ways that do not increase motor vehicle travel.

3. Motorisation: current trends

As countries become more economically successful and affluent, vehicle ownership and use tend to increase, as illustrated in Figure 4.

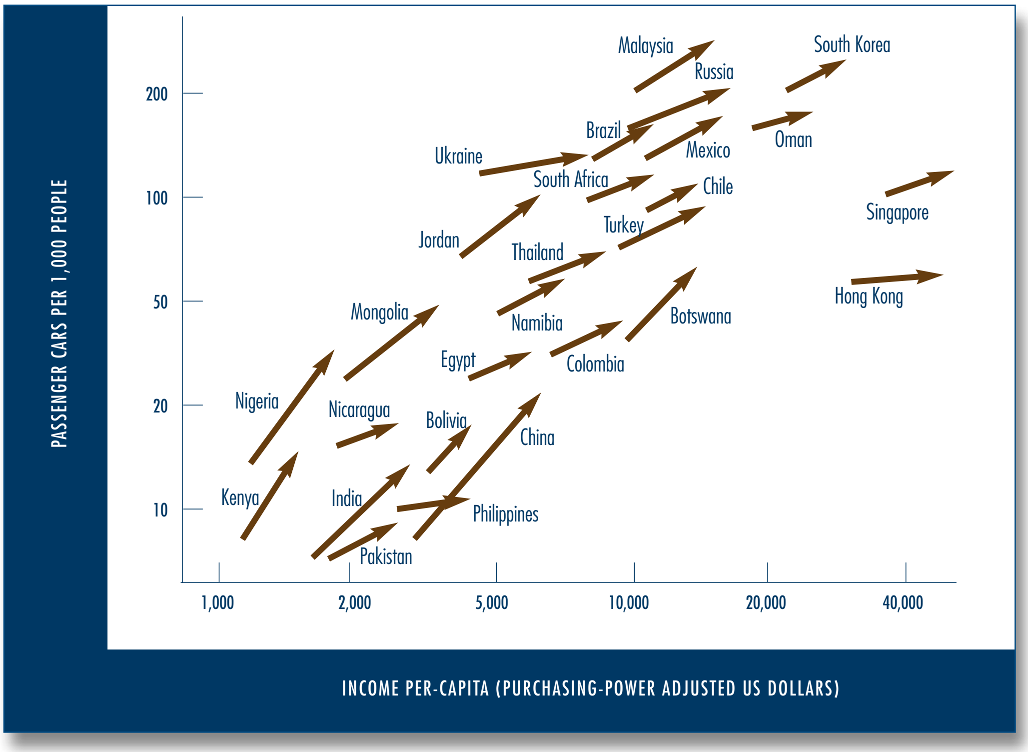


Figure 4

Relation between Income per-capita and passenger cars.

Source: Kurtzbach, 2010

However, vehicle ownership and use eventually saturates, as illustrated in Figure 5. This shows that, among industrialised countries *per capita* vehicle travel has stabilised. The level at which it stabilises varies significantly between countries and cities of similar income depending on transport and land use policies, including factors such as fuel prices and vehicle fees, parking supply and pricing, transport investments, and development practices. This indicates that it is possible for developing countries to avoid automobile dependency and maintain an efficient and diverse transport system.

International vehicle travel trends

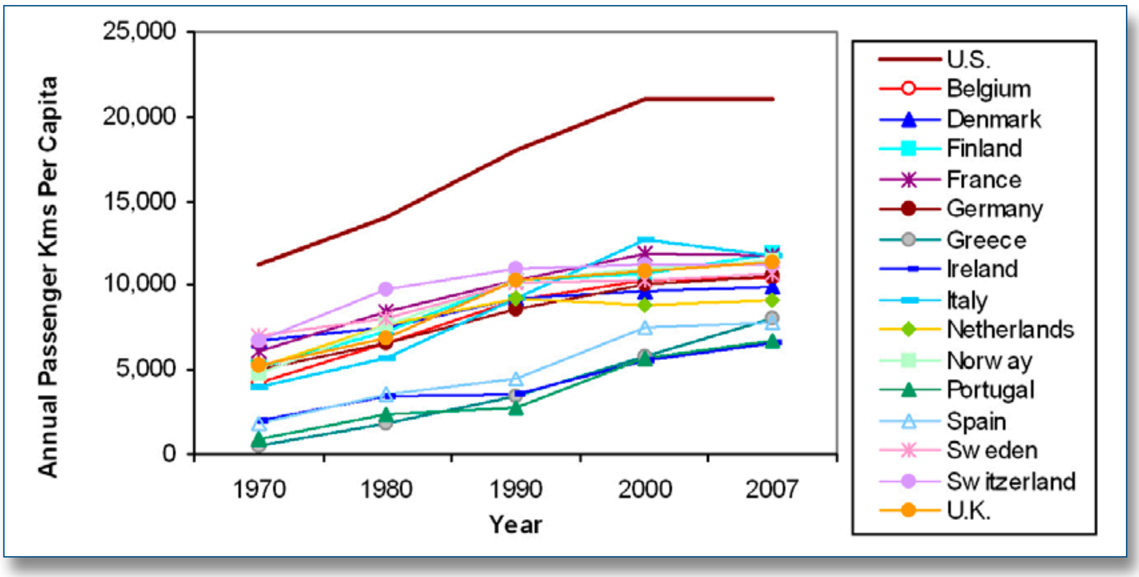


Figure 5

Per capita vehicle travel grew rapidly between 1970 and 1990, but has since leveled off and is much lower in European countries than in the US.

Source: EC 2007; FHWA, Various Years[2]

[2] US passenger-km based on FHWA vehicle-miles x 1.67 (miles to kilometres) x 1.58 (vehicle-km to passenger-km) x 0.8 (total vehicles to passenger vehicles).

Automobiles are also status symbols, which motivate people to want a car even if it is not a necessity. Many countries have policies that encourage residents to purchase vehicles and shift from alternative modes to automobile travel, based on the assumption that this supports economic development and modern lifestyles. Any negative impacts, such as traffic congestion, increased accidents and pollution, and reduced mobility for non-drivers, is considered to be a short-term cost of increased affluence which can be reduced with infrastructure development and technological improvements.

However, many of these assumptions are incorrect, leading to inefficient and inequitable policies. Although a certain amount of automobile travel is efficient and productive, beyond an optimal level, increased driving is harmful overall and reduces economic development, as discussed later in this paper. An optimal transport system is diverse and efficient; it offers travellers a variety of accessibility options, and incentives that favour higher value trips and more efficient modes, so users will select the most efficient option for each trip. This means that cities:

- Maintain good walking and cycling conditions, high quality public transit and taxi services, plus good telecommunications and delivery services that substitute for physical travel.
- Road space is allocated to favour walking, cycling, public transport, freight and service vehicles over personal automobile traffic.
- Motorists pay directly for using roads and parking facilities through tolls, fees and fuel taxes.
- Land use policies favour more compact, accessible community development, and limit automobile-oriented sprawl.

Where this occurs, even affluent residents will walk, bike and use public transport for a significant portion of travel. In fact, affluent people often prefer these modes because they find that walking and cycling are enjoyable and healthy, and they can relax or work during public transport trips. Affluent travellers are particularly sensitive to service quality; just as they choose cars that have extra comfort and convenience features, such as leather seats and electronic navigation systems, they will only choose alternative modes if they are convenient, comfortable and safe to use.

This means that as a country develops and residents become more affluent and demanding consumers, overall transport system efficiency depends on improving walking, cycling and public transport so it will attract discretionary users (people who have the option of travelling by automobile), with features such as wide sidewalk and safe crosswalks, well-designed bike paths and lanes, fast and frequent bus and train services, with clean and uncrowded vehicles, and attractive stations. These service quality improvements require significant investments, which often requires new planning and engineering capacity, and new funding sources. This may seem expensive, but is almost always cheaper than the full costs of automobile dependency, considering the total costs of vehicles, roadways, parking facilities and various indirect costs (accidents, oil imports, pollution, sprawl) that result if most trips are made by automobile.

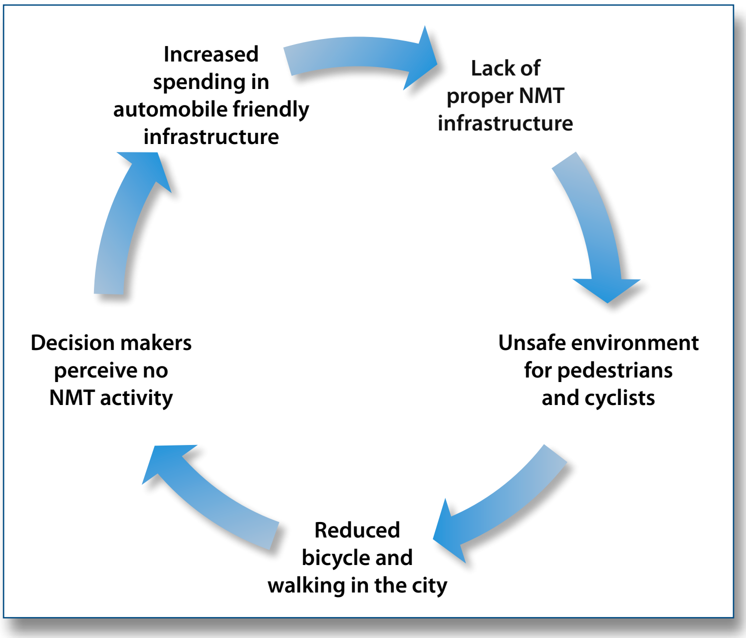
Declining NMT and PT modal shares

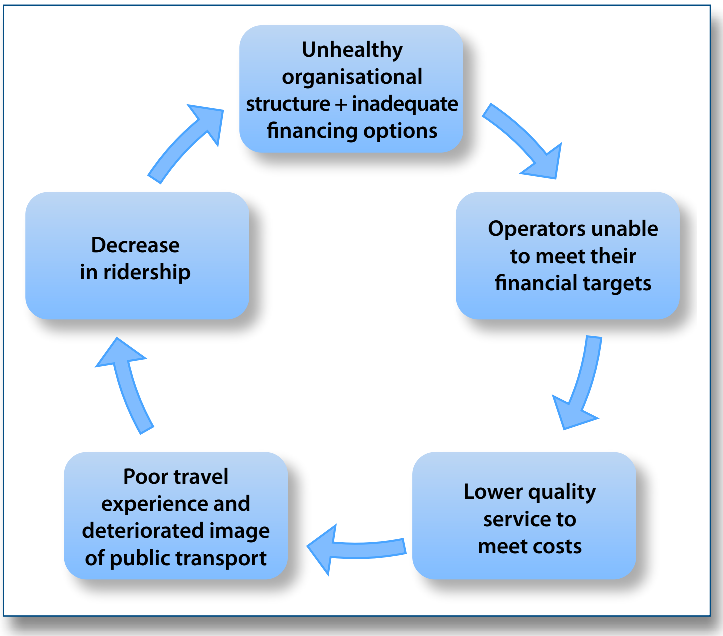
High and rapid motorisation tends to reduce the share of other transport modes unless supportive measures are put in place.

The lack of available infrastructure and priority for NMT deters the people from walking and cycling, which reduce the modal share for these modes (Figure 6). On the other hand, the reduction in walking and cycling is perceived by decision makers as people being disinterested in these modes and they fail to make decisions favouring these modes. The non-motorists who are able to afford a personal motor vehicle shift to the motorised modes and hence join the increasing vehicle owners and add to the ever increasing congestion in a city.

> *"It is evident in many developing cities that a continuous and coherent footpath is absent."*

The situation in public transport is very similar. In many cities, public transport is run by private operators under a permit from the government (Figure 7). The fares are usually decided by the government. The governments try to keep the fares often low through subsidies, with the notion that the public transport is accessible for the poorer echelons of the city. The operators have to meet their costs from the fare box revenues; when the fares are kept low and no incentives are provided there will be a gap between the costs and income for the operators. To meet their costs the operators reduce the quality of the service they provide. The reduction in quality translates into lower frequencies of operation, initial crowding on the buses and poor quality vehicles. This process reduces the overall image of public transport reducing ridership and further pushing the revenues down. At this point, the quality of the whole system is deteriorated and ridership is eventually at stake.





Figures 6 (top) and 7 (bottom)

Vicious cycles: decreasing NMT (top) and public transport use (bottom).

Source: Santhosh Kodukula, based on GIZ, 2009

4. Vehicle travel and economic development

Economic development impacts

People sometimes assume that because vehicle travel tends to increase with economic development, any effort to reduce vehicle travel is economically harmful. Certainly energy use, vehicle travel and GDP tend to increase together, but this reflects several factors:

1. Motor vehicle travel can increase economic productivity, particularly when used for high value transport such as service delivery, business travel and emergency trips.
2. Increased wealth allows some wealthy households to choose more accessible locations, allowing them to reduce their vehicle travel.
3. Vehicle travel imposes external costs (congestion, accident damages, import exchange burdens, pollution emissions) that can reduce economic productivity.
4. Increased vehicle travel tends to create more automobile-dependent transport systems and dispersed land use patterns which increases the amount of travel needed to maintain a given level of accessibility. This tends to reduce economic productivity.

Only Factor 1 *causes* wealth to increase with vehicle travel, while factors 2–4 *result from* increased wealth. Factors 1 and 2 cause *positive* relationships between vehicle travel and GDP, while Factors 3 and 4 cause negative relationships. Because these effects vary, the overall relationships between vehicle travel and economic productivity depend on specific conditions, including a region's level of development, economic factors such as the costs of importing fuel, and the policies that are applied.

It is unsurprising that vehicle travel and GDP correlate, since vehicle expenditures account for 10–20 % of personal consumption in wealthy countries, and a significant portion of government and business consumption, so all else being equal, doubling vehicle travel increases GDP by about 10 %. However, this does not necessarily reflect increased social welfare: it could simply reflect an increase in costs. For example, policies that stimulate sprawl will increase both vehicle travel and GDP, since residents must drive more annual miles, spend more on vehicles and fuel, although consumers and society could be worse off overall. In such situations, vehicle travel reductions can support economic development.

Figure 8
Per capita vehicle mileage is significantly higher in the US than in other industrialised countries. Residents of wealthy countries such as Switzerland, Norway and Sweden drive about half as much as in the US due to policies and planning practices that increase transport system efficiency.
Source: OECD, 2009

Per capita annual vehicle travel by country

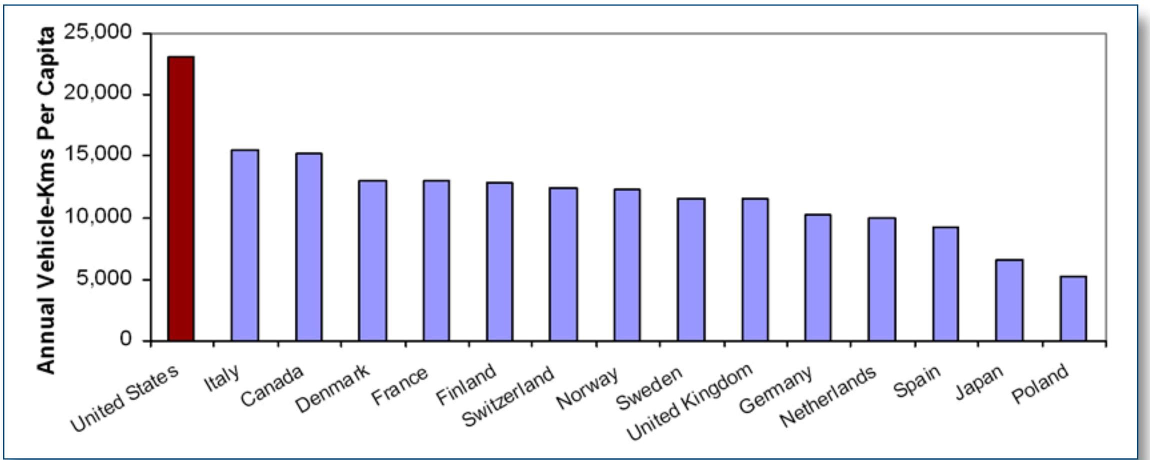


Figure 8 shows the variation in *per capita* vehicle travel among peer countries. Of particular interest is Norway, which produces petroleum but maintains high fuel prices and has other mobility management policies to discourage vehicle travel and support alternative modes. These policies minimised domestic fuel consumption, leaving more oil to export. As a result, Norway has one of the world's highest incomes, a competitive and expanding economy, a positive trade balance, and the world's largest legacy fund.

Described differently, the amount of energy and vehicle travel required per unit of GDP varies widely. Virtually all developed countries are increasing GDP per unit of energy and mobility, and some extract far more productivity (material wealth and income) per unit of energy and mobility than others, as illustrated in Figure 9, due, in part to policies that encourage efficiency. All else being equal, policies that encourage more efficient transport increase economic productivity and competitiveness, and this will become increasingly important in future as oil prices rise. This is sometimes called *decoupling*.

GDP per passenger-kilometre for various countries

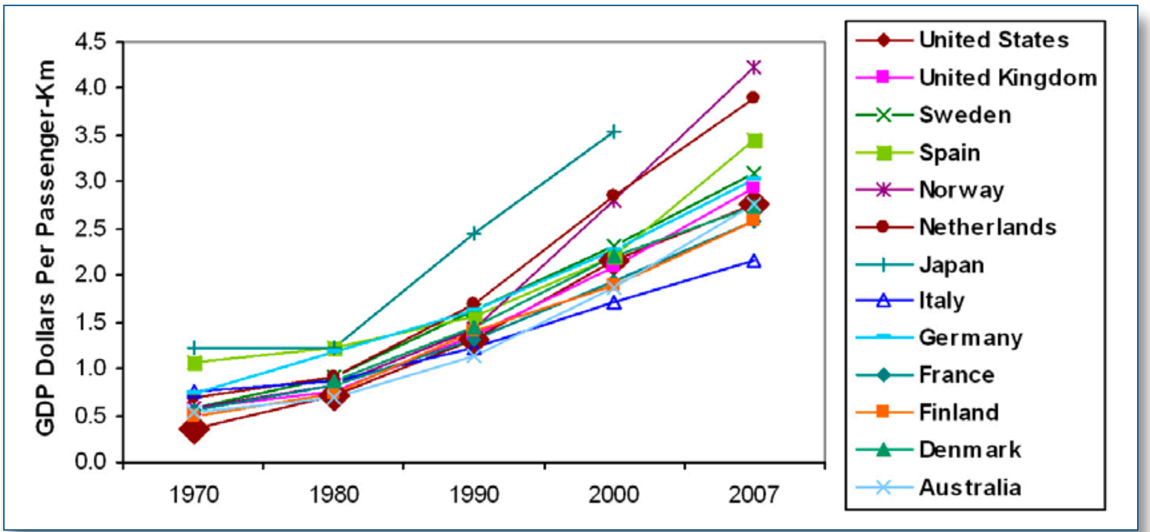


Figure 9

Most countries are increasing GDP per passenger-mile, some much more than the US.

Source: OECD, 2009

A rigid relationship between mobility and economic productivity implies that economies are inflexible: there is only one efficient way to produce goods, and that economic development requires ever more energy and movement. A flexible relationship between mobility and economic productivity implies that economies are responsive and creative: if energy and mobility are cheap, businesses and consumer use a lot, but if prices increase or other policies encourage conservation, the economy becomes more efficient.

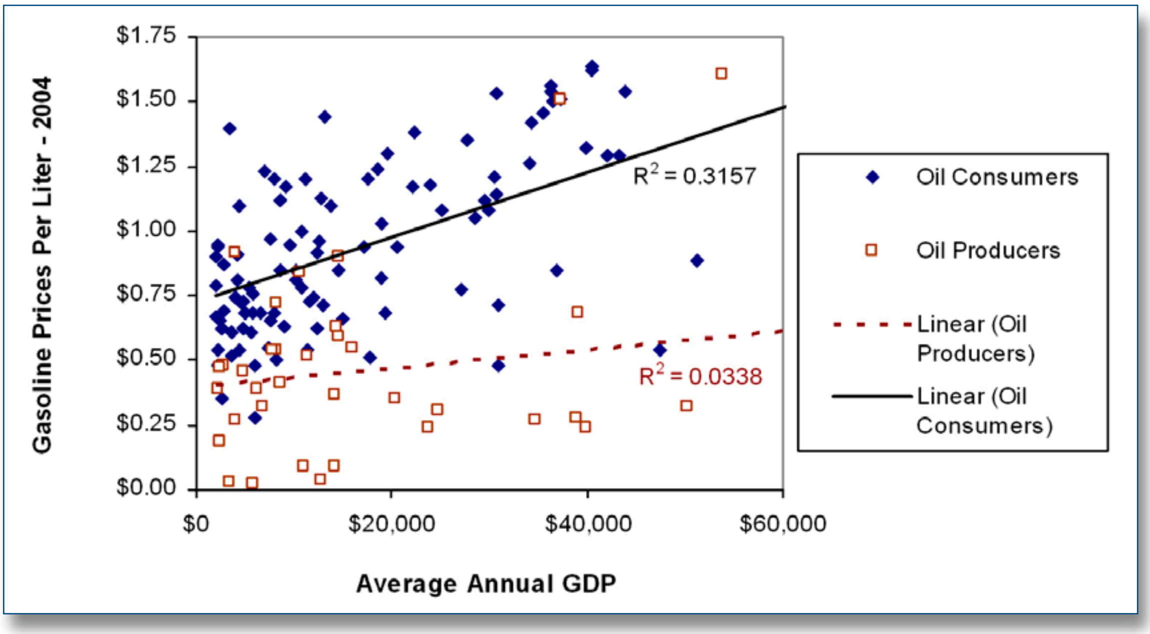
Figure 10 shows that *per capita* GDP increases with fuel prices, particularly among oil importing countries ("Oil Consumers"). This suggests that, contrary to popular belief, high fuel prices (and therefore, high vehicle operating costs) increase economic productivity and development by increasing transport system efficiency and reducing the wealth lost to importing fuel.

GDP versus fuel prices, countries

Figure 10

Economic productivity tends to increase with higher fuel prices, indicating that substantial increases in vehicle fees can be achieved without reducing overall economic productivity.

Source: Metschies 2005[2]



[2] Fuel price (http://www.international-fuelprices.com), GDP (http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita), petroleum production (http://en.wikipedia.org/wiki/Petroleum); excluding countries with average annual GDP under USD 2 000.

Two factors help explain why GDP tends to decline at high levels of vehicle travel:

1. Marginal productivity benefits decline as a declining portion of travel is for productive uses, such as freight and service delivery, and business travel.
2. The additional vehicle travel imposes increasing economic costs (vehicle expenses, road and parking facility costs, traffic service costs, accident and pollution damages, etc.).

5. Automobile dependency costs

There are various costs and risks associated with automobile dependency. These costs are imposed on individuals and society. Automobile dependency costs usually include:

- Increased traffic and parking congestion;
- Increased road and parking facility costs;
- Increased consumer costs and reduced affordability (high costs for lower-income households);
- Increased traffic accidents;
- Increased traffic barriers and risks to pedestrians and cyclists;
- Reduced mobility for non-drivers, and therefore increased social inequality;
- Increased need for drivers to chauffeur non-drivers;
- Increased fuel consumption, and associated economic costs for importing petroleum;
- Increased air pollution and greenhouse gas emissions;
- More sprawled land use development, which reduces overall accessibility, particularly for non-drivers;
- Reduced physical fitness and health.

The key costs linked to automobile dependency, such as congestion, accidents, energy and environmental costs, are examined in the following.

5.1 Increased traffic congestion

One of the most common transport problems is traffic congestion. In urban areas, the demand for road space is usually high. When the number of cars entering a road is greater than the road's capacity (the optimum level) to accommodate them, traffic congestion arises. This impacts traffic flow and travel speed adversely. Delays occur and travel times increase. Cities with high levels of car use experience high levels of traffic congestion. As there are important costs linked to traffic congestion, this represents a challenge for cities aiming at developing an efficient and sustainable transport system.

Newbery (1990) estimated congestion costs by road type in the UK. He found that the marginal costs for urban roads were 29.23 pence per mile (central, off-peak) and 36.97 p/mile (central, peak time). Moreover, the TTI (2011) calculated traffic congestion costs for major urban areas in the USA, which amounted to more than USD 100 billion in 2011. The TTI also publishes a congestion cost index[2].

5.2 Increased traffic accidents

Besides the pollution problem, increasing automobiles also poses a social threat such as reduction in road safety. This scene is evident in many developing cities. Innocent lives are lost due to the increase in vehicular growth. The most common culprit is the speed of the vehicles. In many cities due to the wide and straight roads, the motorists have the liberty to speed, thus increasing the average travel speed. Studies show that speeds more than 30 kilometres per hour (km/h) increase the risk of fatality in an accident. In many cities the roads seldom have at grade pedestrian crossings. A common engineering solution for pedestrian to cross the road is the provision of pedestrian overpasses/bridges. This kind of infrastructure is seldom used as it is cumbersome for the pedestrian to ascend and descend a long flight of stairs. The pedestrian overpasses/bridges also do not cater the bicyclists. In some cities underpasses are provided for crossing a road. The underpasses are also seldom used as they become unsafe and deserted during certain times in the day. Moreover, in terms of cost both overpasses and underpasses cost the municipal government a large sum. In order

[2] See Texas Transportation Institute's (TTI) "Annual Urban Mobility Report" at: http://mobility.tamu.edu/ums

to avoid the use of this cumbersome infrastructure the pedestrians risk their lives and cross the road at grade. In other words, not only vehicle speed and driver behaviour but also inadequate NMT infrastructure play a role in transport safety.

Figure 11 shows that the majority of the people involved in traffic fatalities in the developing cities, *e.g.* Delhi (India) are males. In Indian culture, males are the main (and often sole) bread earner of the family. The loss of the key earning member of the family is a huge cost for the entire family.

Traffic fatalities in Delhi by gender

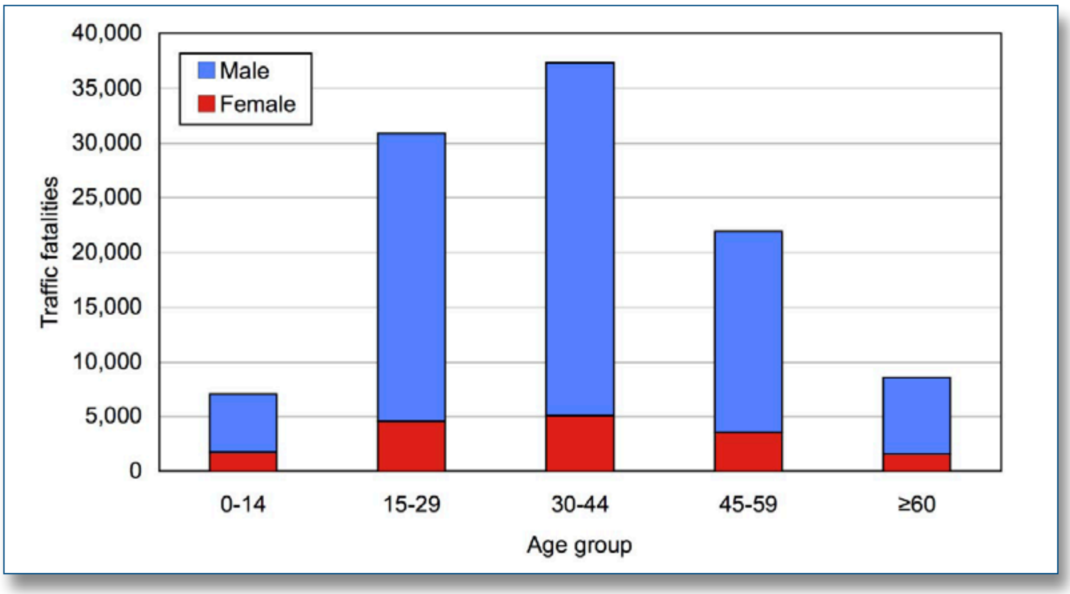


Figure 11

Source: Mohan, D., Tsimhoni, O., Sivak, M., and Flannagan, M.J., 2009

Box 1 indicates that most of the people involved in traffic accidents in India are either pedestrians or two wheeler riders. The situation is same even in Brazil (see Figure 12).

box 1

Road accidents in India

In India, every 6 minutes someone dies in a motor vehicle crash, every 1½ minutes someone is injured and every 1¼ minutes a traffic accident occurs. In the state of Kerala, when compared to the national average the accident ratio is on the higher side. Each day in this tiny state, an average of 108 traffic accidents are taking place and more than 8 persons are killed and 133 are injured. Records show that for every 1 000 vehicles in Kerala, 15 vehicles are likely to get in to an accident and more than 1 person is likely to die and more than 18 persons are likely to get injured.

Research shows that most of those killed or injured in road accidents in India are pedestrians and two wheeler riders. Unfortunately, most of these victims are the only breadwinners of their families. It is estimated that 50 % of families losing a member in a road crash subsequently fell below the poverty line.

Source: World Road Safety Partnership (WRSP), 2007, http://www.worldroadsafety.org/php/showContent.php?linkid=39

Traffic fatalities by mode in Brazil

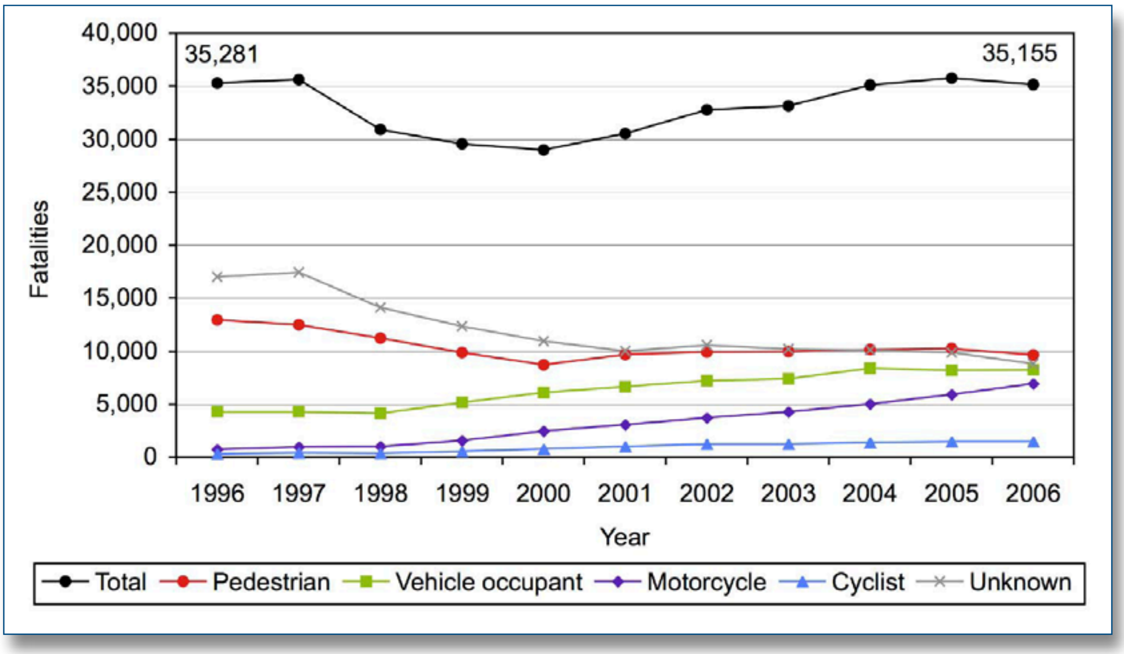


Figure 12
Source: Eduardo A. Vasconcellos and Michael Sivak, 2009

Apart from the social costs of road accidents, it is estimated that they also represent approximately 1–2 % of the country GDP (around 5 % in extreme cases) (GRSP, 2011). Thus the economic costs of such accidents can also be substantial.

Comparisons between otherwise similar countries, regions and people indicate that *per capita* traffic casualty rates increase with vehicle travel (Edlin and Karaca-Mandic, 2006; Litman and Fitzroy, 2010).

Vehicle mileage and traffic fatality rates in OECD countries

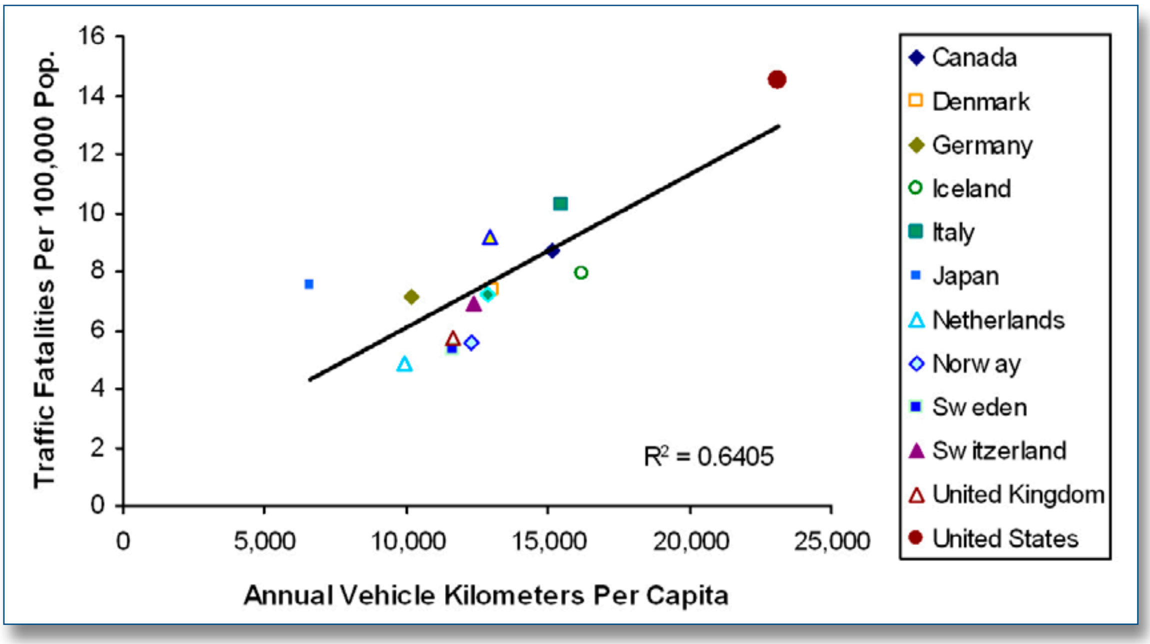


Figure 13
Among economically developed countries, per capita traffic fatalities increase with vehicle travel.
Source: OECD Data

Figure 13 shows a positive relationship between *per capita* vehicle travel and fatality rates among OECD (Organization for Economic Cooperation and Development) countries.

5.3 Increased fuel consumption and associated economic costs for importing petroleum

Vehicles account for approximately 32.5 % of the total energy consumption worldwide (IEA, 2009). Higher levels of motorisation, as it is expected in developing cities, will imply greater energy needs. In order to meet the mobility needs of a population that is making a greater use of individual vehicles, the demand for fossil fuels in developing cities will sharply increase. This will impose large economic cost on countries that import petroleum, particularly as international oil prices rise, as predicted due to reduced production and growing demand.

Many developing countries currently underprice vehicle fuel through direct and indirect subsidies, and low taxes[3]. Eradicating subsidies to fossil fuels brings numerous benefits (*e.g.* reduced wasteful use, generation of additional revenues that can be used to improve more environmentally friendly modes of transport) and is a mandatory step to reduce car dependency and improve the efficiency of transport systems.[4]

Finally, excessive energy use also has negative implications for the environment.

5.4 Increased air pollution and greenhouse gas (GHG) emissions

Transport is responsible for around 23 % of the energy – related CO_2 emissions and approximately 14 % of GHG emissions (ITF, 2010). Urban traffic is responsible for around 40 % of CO_2 emissions and 70 % of other pollutants. According to OECD/ITF (2008), CO_2 from the transport sector are predicted to increase by 120 % on 2 000 levels by 2050. This poses a great challenge to mitigate climate change.

Today, many cities both in the developed and developing world face levels of air pollution that lay above the recommended levels. This is a serious and important (often underestimated) problem for urban citizens. Considering the predictions mentioned in previous sections, the repercussions on the environment will be daunting. The increase in vehicular ownership means that higher CO_2 emissions can be expected globally. This will thus further deteriorate the air quality in the cities and poses a health threat to anyone living in polluted cities.

Moreover, vehicular air pollution has other social implications. For example, non-motorists are forced to bear the social costs motorists create. This represents an example of a negative externality. In addition to that, the implications pollution and poor air quality have for urban citizens lead to more expensive bills for local governments, as the hospital and welfare costs increase.

[3] Gerhard Metschies (2009), *International Fuel Prices*, German Agency for Technical Cooperation (http://www.giz.de); at http://www.gtz.de/en/themen/29957.htm.
IEA (2010), *Analysis Of The Scope Of Energy Subsidies And Suggestions For The G-20 Initiative*, IEA, OPEC, OECD, World Bank Joint Report; at http://www.oecd.org/dataoecd/55/5/45575666.pdf.

[4] David Coady, *et al.* (2010), *Petroleum Product Subsidies: Costly, Inequitable, and Rising*, International Monetary Fund (http://www.imf.org); at http://www.imf.org/external/pubs/ft/spn/2010/spn1005.pdf.
GSI (2010), *Gaining Traction: The Importance Of Transparency In Accelerating The Reform Of Fossil-Fuel Subsidies*, Global Subsidies Initiative (http://www.globalsubsidies.org) of the International Institute for Sustainable Development (http://www.iisd.org); at http://www.globalsubsidies.org/files/assets/transparency_ffs.pdf.

Ambient air quality in Asian cities

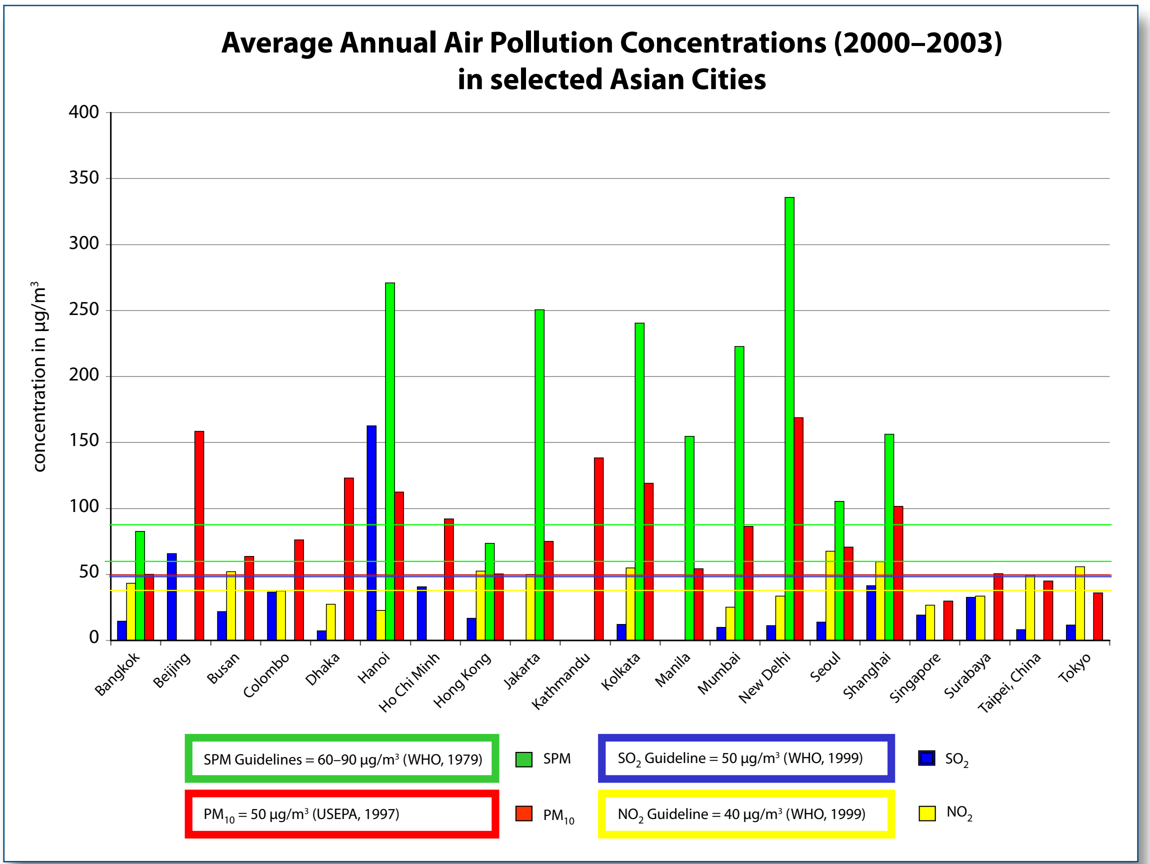


Figure 14
Source:
Clean Air Initiative for Asian Cities

Figure 14 clearly shows the deterioration of the air quality in Asian cities. The majority of the cities in the chart are cities with high vehicular usage.

5.5 Other costs[5]

Other common costs associated with automobile dependency include increased road and parking facility costs, increased consumer transport costs and reduced affordability (high costs for lower-income households), increased traffic barriers and risks to pedestrians and cyclists, reduced mobility for non-drivers (leading to increased social inequality), increased need for drivers to chauffeur non-drivers, reduced physical fitness and health and more sprawled land use development, which reduced overall accessibility (particularly for non-drivers).

[5] See section 10 for further reading on this topic.

6. Appropriate transport policies

According to economic theory, the optimal level of automobile ownership and use will occur if consumers have adequate transport options and prices that reflect marginal costs, including the total costs of providing roads, parking facilities and fuel, plus special fees to reflect the traffic congestion, accident risk and pollution emissions that vehicles impose on others.

As a result, an efficient transport system requires policies that:

- Maintain diverse transport options, including good walking and cycling conditions and high quality public transit services.
- Allocate road space to favour higher value trips and more space-efficient modes over lower-value trips and more space-intensive modes, for example, with adequate sidewalks, bike lanes and bus lanes having priority over general purpose lanes, or by applying congestion tolls to allocate scare urban road space.
- Efficient pricing of roads, parking facilities and insurance, using tolls, fees and fuel taxes, and distance-based insurance premiums and vehicle registration fees.

Economic efficiency and equity require that consumers of a good pay the full marginal costs that result, including indirect costs, such as accident risks and pollution that results from its production and use. Because motor vehicle use requires costly infrastructure and can impose various external costs, efficient pricing requires various types of fees:

- Correct policy and planning distortions that unintentionally favour automobile travel, such as fuel subsidies, planning that evaluates transport system performance based primarily on driving conditions, and generous minimum parking requirements.
- Apply smart growth development policies, to create more accessible, multi-modal communities, and discourage automobile-dependent sprawl.

7. Policies to create efficient and diverse transport systems

In order to increase the modal shares of NMT and PT, the principal criterion is to reduce the growth in automobile ownership and usage to levels that are economically, socially and environmentally affordable and feasible. This section highlights the key ingredients to successfully control the excessive and unnecessary automobile usage and hence reduce the excessive dependency on automobiles. Regional agreements such as Bangkok 2020 Declaration, which was agreed by Asian countries at the Fifth Regional EST Forum in Asia held in 2010 in Bangkok, could also benefit from such policies and measures by city and national governments.

All the cities that have successfully achieved lower automobile usage have implemented some common measures. The key ingredients are mentioned below.

Conventional transport planning tends to assume that its primary goal is to maximise *mobility* (physical travel), but the ultimate goal of most transport activity is *accessibility* (peoples' ability to reach desired services and activities). Many factors can affect accessibility, including the quality of travel options available, land use patterns (and therefore the distanced people must travel to reach services and activities) and mobility substitutes, such as telecommunications and delivery services. Accessibility-based planning expands the range of solutions that can be applied to transport problems, for example, allowing improvements to alternative modes, pricing reforms, and smart growth land use policies to be considered as possible solutions to problems such as traffic and parking congestion, or excessive accident risk and pollution emissions.

Accessibility-based planning provides a foundation for creating more efficient and diverse transport systems and reducing automobile dependency.

box 2

Innovative policy approaches and financing schemes

The bright side is that some cities have recognised the importance of the issues mentioned so far and are making strenuous efforts to ameliorate the situation. In India, a nationwide urban renewal mission, called the "Jawaharlal Nehru National Urban Renewal Mission" (JnNURM), has been launched to improve various urban sectors, including transport. The central government is offering financial and technical support to city governments in improving their urban transport. Innovative ideas such as Comprehensive Mobility Plans (CMPs) and financing measures are positive outcomes of the JnNURM. Many Indian cities are now investing money in promoting public transport and non-motorised transport. Cities are making efforts to develop integrated plans for transport, *i.e.* the CMPs. Similar efforts can also be seen in cities in Indonesia.

Multi-modal transport system performance indicators

Conventional transport system performance indicators, such as roadway level-of-service, average traffic speed, and *per capita* congestion delay, primarily consider vehicle travel conditions. This encourages selection of transport policies and projects that favour automobile travel, often in detriment of other modes. Multi-modal planning requires multi-modal performance indicators.

Comprehensive evaluation of impacts (benefits and costs)

Conventional transport planning dedicates funds to highways and parking facilities, which cannot be used to finance improvements to alternative modes or mobility management programs, even if they are most cost-effective overall.

The following are the principal areas that need special consideration while policy making. These areas encourage sustainable transport, reduce motorised modal shares and also comply with international declarations that the cities may have signed. For example, various Asian cities have signed the Bangkok 2020 Declaration, which aims to promote sustainable transport in cities and highlights the results in terms of goals (see Box 3 for the goals of Bangkok Declaration).

Least-cost planning funds the most cost-effective transport system improvements, considering and benefits and costs. In this way, alternative modes and demand management strategies can be implemented whenever they are most cost-effective solutions overall.

- ***Mixed Land-Use***: Many developing cities already have a healthy mixed land-use. Unfortunately this trend is disappearing in the newer developments where segregated land-use is taking priority. Mixed land-use, *i.e.* having shopping, residential, commercial and recreational spaces in one location will enable cities to avoid heavy traffic congestion. The liveability of the cities improves and they may also become attractive places for employees and employers.
- ***Density***: Density plays a crucial role in the accessibility and mobility patterns in any city. Studies have shown that denser cities have lower personal automobile usage than compared to their less dense counterparts (Newman and Kenworthy, 1999). Denser cities have a close knit urban fabric and hence bringing together various activities in a lesser radius. This will reduce the lengths of the trips and, in many cases, also affects the modal split. When the destinations are close, people would prefer to use alternative faster modes wherever available. Encouraging mixed land-use and density, directly complies with goals #1, 2 and indirectly supports the goals #13, 14, 15 and 17 of the Bangkok 2020 Declaration.
- ***Non-motorised Transport (NMT)***: It is very common in many developing cities that NMT has a lower status. This acts as a main deterrent from people using this mode. Coupled to this myth, the unavailability of proper infrastructure and facilities, which translates to the lack of priority for NMT, further deters using these modes. It has been proven in various developing cities and developed cities that providing proper infrastructure for NMT would encourage people in using this mode and hence increase modal shares.
- ***Public Transport (PT)***: People are prone to use public transport in cities where it is accessible, comfortable and attractive. The prioritisation of public transport is a factor for success in many European and wealthy Asian cities.
  Promoting non-motorised transport and public transport are evidently a huge factor of success in an effort to reduce motorised modal shares. This venture will also be responsible for satisfying the goals #4, 5, 6, 8 and 10 directly and also might indirectly satisfy the goals #13, 14, 15, 16, 17, 18 and 20 of the Bangkok 2020 Declaration.
- ***Transport Demand Management (TDM)***, which discourages unnecessary private vehicle use and encourages more environmentally friendly modes of transport. Important benefits can be achieved through the implementation of adequate regulatory and economic instruments: traffic organisation (*e.g.* PT prioritisation), low emission zones (LEZ), vehicle standards, vehicle quota, vehicle purchasing tax, fuel tax, road user pricing, parking fees, among others.
  The share on public transport and non-motorised transport can only be achieved if the demand for personal travel is controlled, which can be achieved by TDM. It also satisfies the Bangkok 2020 Declaration goals #6, 14 and 15 directly and the goals #16, 17, 18, 19 and 20 indirectly.

> ***"Personal vehicle usage can be tamed only with accessible, affordable and comfortable sustainable alternatives."***

box 3

Goals of the Bangkok 2020 Declaration

At the 5th Regional Environmentally Sustainable Transport (EST) Forum, held in Bangkok in August 2010, heads of several cities have jointly adopted the Bangkok 2020 Declaration. The idea of the declaration is, to promote EST in their cities by developing integrated and sustainable transport policy options, programmes, and projects against goals set in the declaration. The goals are:

Avoid: unnecessary trips

- Goal #1: Integrating Land-Use and Transport
- Goal #2: Mixed-Use Development
- Goal #3: Information and Communication Technologies (ICT)

Shift: adopt sustainable modes to replace existing unsustainable modes

- Goal #4: Promote and improve Public Transport
- Goal #5: Promote and encourage Non-motorised Transport
- Goal #6: Transport Demand Management (TDM)
- Goal #7: Use sustainable modes for inter-city passenger and goods transport

Improve: Renovate, redesign and retrofit existing technologies to be more sustainable

- Goal #8: Fuels and Vehicle Technologies
- Goal #9: Standards for vehicles, fuels and emissions
- Goal #10: Inspection and Maintenance
- Goal #11: Intelligent Transport Systems (ITS)
- Goal #12: Greening the Freight Transport

Cross-cutting Strategies

- Goal #13: Road Safety
- Goal #14: Public Health Improvement
- Goal #15: Better Air Quality and Lower Noise
- Goal #16: Climate Change and Energy Security
- Goal #17: Social Equity
- Goal #18: Innovative Financing Schemes
- Goal #19: Public Awareness and Information dispersal
- Goal #20: Institutional Development and Good Governance

Note: The above goals are defined according to the author's understanding of the "Bangkok 2020 Declaration" document. The complete document with the defined goals can be referred to at: http://www.uncrd.or.jp/env/5th-regional-est-forum/BangkokDeclaration.htm

The GIZ SUTP has also developed modules on the above mentioned topics. These modules may be referred for achieving specific goals mentioned above. All GIZ SUTP documents are available for download from the SUTP website (http://www.sutp.org), after a registration, at no charge.

8. Case studies

This section contains case studies from various cities, which illustrate their efforts to reduce automobile dependency. These cities implemented measures to restrict car use and prioritise alternative modes of transport. In this way, the share of car travel can be decreased and the share of NMT and PT can either be maintained or increased. These are examples of successful promotion of sustainable transport.

8.1 Curitiba, Brazil

In 1971, the first pedestrian network in Brazil was started in Curitiba, under the mayorship of Jaime Lerner. In 1974, Lerner's administration took the most significant step to create road hierarchy and land control system (Rabinovitch and Hoehn, 1995). The new road hierarchy paved the way for an innovative transport system: Bus Rapid Transit (BRT). In many aspects, the system is comparable to a rail system. Using a bus-based system on dedicated lanes proved to be more cost-effective and less cumbersome than a metro or light rail system. Exclusive bus lanes are located in the centre of the road and bordered by two local roads. The land along the bus corridors has been encouraged for high density mixed land-use. Adequate legislation made this possible. The express buses that run on the corridor are connected by conventional buses and special feeder buses, which bring people into the system. A study showed that 28 % of the bus users in Curitiba were car users. This translates to 25 % of fuel savings city wide. Based on 1991 traveller survey results, it was estimated that the introduction of the BRT had caused a reduction of about 27 million car trips per year, saving about 27 million litres of fuel annually. The passengers on the bus pay a single fare for their entire trip, which is roughly 40 US cents. As of 2011, about 1 100 buses make 12 500 trips every day, serving more than 1.3 million passengers, 50 times the number from 20 years ago.

Curitiba also participates in the world car-free day ('*Dia sem Carro*') held on the 22 September every year. On a car-free day in 2003, the transport system operated 135 additional vehicles, accounting for 800 vehicle-trips, to carry the additional passengers. According to Demery (2004), car use was reduced by 100 000 vehicles on that day.

> ***"28 % of the bus users in Curitiba were car users. This translates to 25 % of fuel savings city wide."***

Figure 15
BRT in Curitiba.
Photo: Manfred Breithaupt, 2006

Curitiba is considered to have the lowest ambient air pollution in Brazil. The city's efficient public transport system plays a key role to achieve that status.

8.2 Asia: Singapore and Hong Kong

Among Asian cities, Singapore and Hong Kong are often lauded for their high public transport ridership and low car ownership and usage. The main success factor in Hong Kong and Singapore is the integration of their transport and land-use planning. Both cities have high density developments along mass transit corridors. Furthermore, the cities have a very healthy mix of public transport options: the bus and train are integrated. In Hong Kong, both modes also have feeder services, which are provided by mini-buses. Water-based transport, which is connected to the bus system, is also very important in that city (Newman, 1996; Wang and Yeh, 1993).

Another success factor is the integration of pedestrians and bicycles with public transport. With a high density, compact urban form, the trip lengths in Hong Kong and Singapore are shorter. This enables a greater number of trips that do not require car use. Indeed, most of the trips in these cities are done by walking or PT.

Figure 16
Electronic Road Pricing (ERP) in Singapore, 2004.
Source: GIZ Photo Collection, 2010

In addition to developing public transport, Singapore and Hong Kong have realised that car use in urban areas can only be reduced by implementing effective car restraint measures. Both cities have used fiscal instruments for that purpose. In Singapore, the Electronic Road Pricing (ERP) scheme charges automobile users entering the charging area. The amount charged depends on the time of the day. The scheme seeks to avoid excessive car use. In addition to ERP, stringent laws on vehicle taxation and quota system to control the vehicle fleet also have an impact on car ownership and use. Private cars in Hong Kong pay an initial registration tax ranging from 35 % to 100 % of the cost of the vehicle. This tax has successfully contained ownership to about 50 cars per 1 000 people (Transport Department, 2005). In addition to the ownership tax, the fuel tax in Hong Kong

	Year			Average annual growth rate	
	1984	1994	2004	1984–1994	1994–2004
Rail car-km (million)	66	156	255	9.0%	5.0%
Rail-based passenger trips (million)	491	1,143	1,315	8.8%	1.4%
Franchised bus veh-km (million)[a]	279	313	513	1.7%	5.0%
Franchised bus passenger trips (million)	1,435	1,246	1,494	-1.4%	1.8%
Population (million)	5.4	6.1	6.9	1.2%	1.2%
Rail passenger trips per rail car-km	7.4	7.3	5.2	-0.2%	-3.5%
Franchised bus passenger trips per bus veh-km	5.1	4.0	2.9	-2.5%	-3.1%
Rail car-km per capita	12.2	25.5	37.0	7.7%	3.8%
Rail trips per capita	90.4	186.8	190.7	7.5%	0.2%
Franchised bus veh-km per capita	51.4	51.2	74.4	0.0%	3.8%
Franchised bus passenger trips per capita	264.2	203.6	216.6	-2.6%	0.6%
Combined rail & franchised bus passenger trips per capita	354.6	390.4	407.3	1.0%	0.4%

[a] The available bus vehicle-km figures between 1987 and 2004 are used for the trend analysis

Source: Census and Statistics Department, 2005; Transport Department, 2005.

Figure 17
Rail and bus trips per capita in Hong Kong (1984–2004).
Source: Lo, Tang and Wang, 2008

also deters car usage. As a consequence of this, PT use is increased. Figure 17 shows bus and train patronage in Hong Kong between 1994 and 2004 (Lo, Tang and Wang, 2008).

Table 3 shows recent data on car ownership in various Asian cities, including Singapore and Hong Kong. As it can be seen, both cities have low levels of car ownership per person and high GDP *per capita*.

Table 3: Car ownership in various Asian cities

	Population (millions)	Urban Density (persons per urbanized ha)	Car Ownership (per 1,000 persons)	Economy GDP/Capita (PPP$ 2008)
Singapore	4.6[b]	94 (1995); 107[a]; 96[b]	112 (2008)	50,456
Hong Kong	7.1[b]	320 (1995); 367[a]; 251[b]	55 (2008)	43,954
Tokyo	35.2[b]	88 (1995); 41[b]	335 (2008)	34,173
Taipei city	6.3[b]	230 (1995); 101[b]	253 (2008)	30,942
Seoul	19.9[b]	230 (1995); 282[a]; 101[b]	227 (2005)	27,620
Kuala Lumpur	5.8[b]	58 (1995); 26[b]	314 (estimate)	13,816
Bangkok	8.3[b]	139 (1995); 58[a]; 36[b]	330 (estimate)	8,216
Beijing	14.0[b]	123 (1995); 145[a]; 42[b]	103 (2008)	5,958
Guangzhou	13.2[b]	119 (1995); 365[a]; 66[b]	84 (2008)	5,958
Jakarta	22.0[b]	173 (1995); 127[a]; 85[b]	203 (2006)	3,975
Manila	20.8[b]	206 (1995); 141[b]	82 (2007)	3,507
Ahmedabad	5.4[b]	134[a]; 184[b]	55 (2007)	2,923
Ha Noi	2.4[b]	179 (urban core 2001); 82[b]	18 (2009 estimate)	2,788
Dhaka	10.1[b]	401[b]	27 (2009)	1,501
Sydney	3.7[b]	19 (1995); 20[b]	516 (1995)	36,417

GDP = gross domestic product, PPP = purchasing power parity.

Sources and notes: 1995 data are from Kenworthy & Laube (2001). Density figures marked [a] are "built-up area" densities for circa 2000 from Alain Bertaud's database via http://alain-bertaud.com/. Population and density figures marked [b] are from Demographia (2010). Ha Noi's 2001 urban core density is the gross density for the urban districts (1.506 million people in 84.3 km^2). Gross domestic product (GDP) per capita figures for the countries and/or territories that contain each city are from the Asian Development Bank (2009). Appendix 3 shows the data sources on car ownership estimates. Seoul population and density data are for Seoul plus its satellite cities, but the car ownership data are for Seoul City alone.

Source: Barter, 2011

Relation between parking requirements and car ownership in selected Asian cities

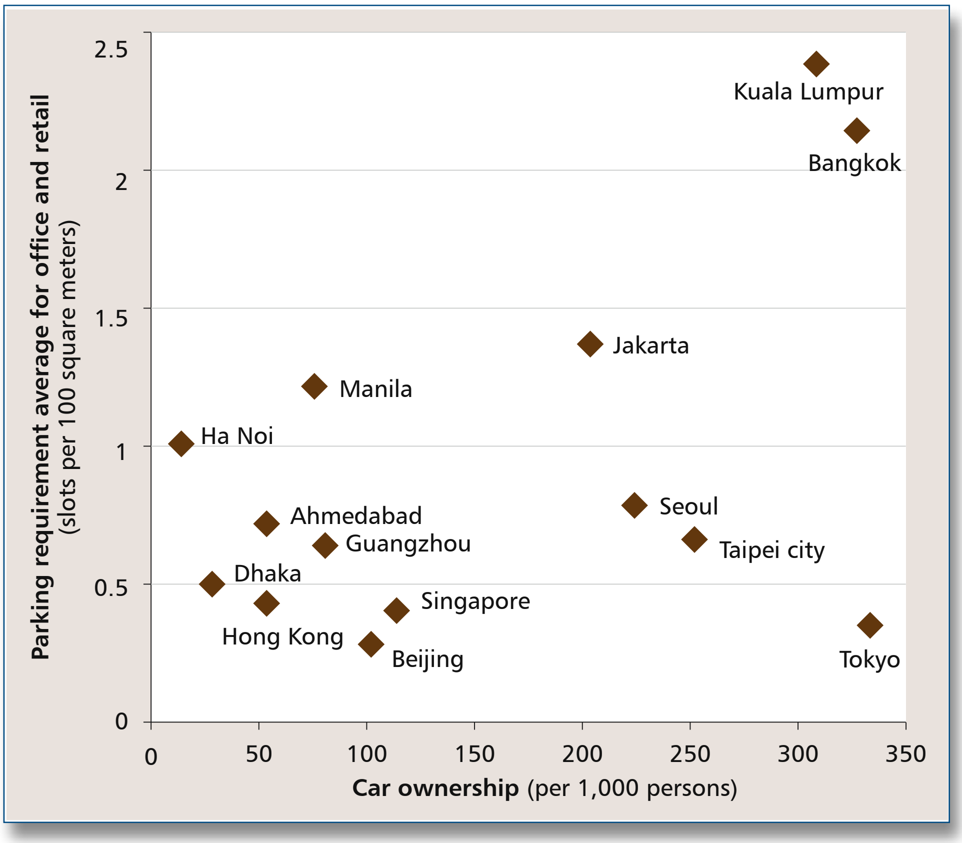


Figure 18
Source: Barter, 2011

Concerning parking, adequate parking management and pricing is an important factor to reduce vehicle use, as parking and car use are complementary goods. Hong Kong and Singapore have successfully introduced effective parking measures, such as low parking provision and high parking charges. Figure 18 shows the relationship between car ownership and parking requirements. In Singapore and Hong Kong, where policies that encourage high density and prioritise PT have been implemented, car ownership and parking requirements are kept low (Lo, Tang and Wang, 2008; Newman and Kenworthy, 1999).

Chapter 2 presented the road and parking space requirements, which are very high in an automobile dependent city. It can be argued that Hong Kong and Singapore had to take such measures due to their land constraints. However, current urban transport projects (which in most cases favour car use) in developing cities lead to high land consumption. Therefore, these cities should carefully consider this issue, if they aim to preserve land and dedicate it to more productive uses.

8.3 European cities

8.3.1 Zurich

European cities have proven to be able to maintain or even increase the modal share of public transport, despite high car ownership. Perhaps, Zurich (and Switzerland as a country) was the most successful European city to achieve that. Investment in public transport, particularly in trams, started in the 1970's in Zurich. This was contrary to the trend in many other European cities, which were scrapping their tram systems. The trams in Zurich had their own right-of-way and were also given priority over car traffic. The frequency of trams was increased (passengers would not wait for more than 6 minutes). Furthermore, the old trams were replaced by new ones. Thus the quality of the service trams provided, *e.g.* in terms of reliability, frequency and comfort, greatly improved. Figure 19 shows that, during the period 1970–1980, private car ownership growth in Zurich was lower than in other European cities. Between 1980 and 1990, car ownership slightly increased in Zurich (higher growth took place in the other European cities). Between 1990 and 1998, car ownership

Private car ownership growth in selected European cities

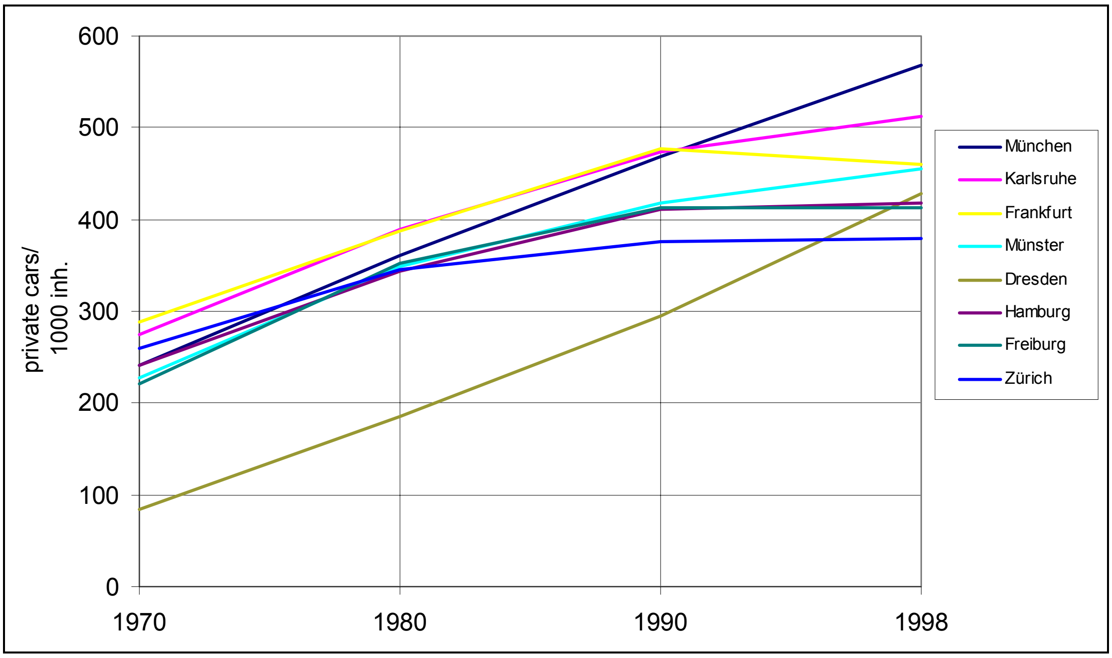


Figure 19
Source: Schley, 2001

in Zurich stabilised. Zurich had just 379 private cars for 1 000 inhabitants (the lowest level among the countries in Figure 19). This success can be attributed to Zurich's effective transport policy, including adequate and timely investment in public transport. This investment, which translates into public transport supply, can be seen in Figure 20. Overall public transport demand in Zurich also increased during the period 1970–1998, despite a slight decrease between 1990 and 1998 (Figure 21).

The increase in public transport supply and demand in Munich during that period is also remarkable.

Public transport supply in selected European cities during 1970–1998

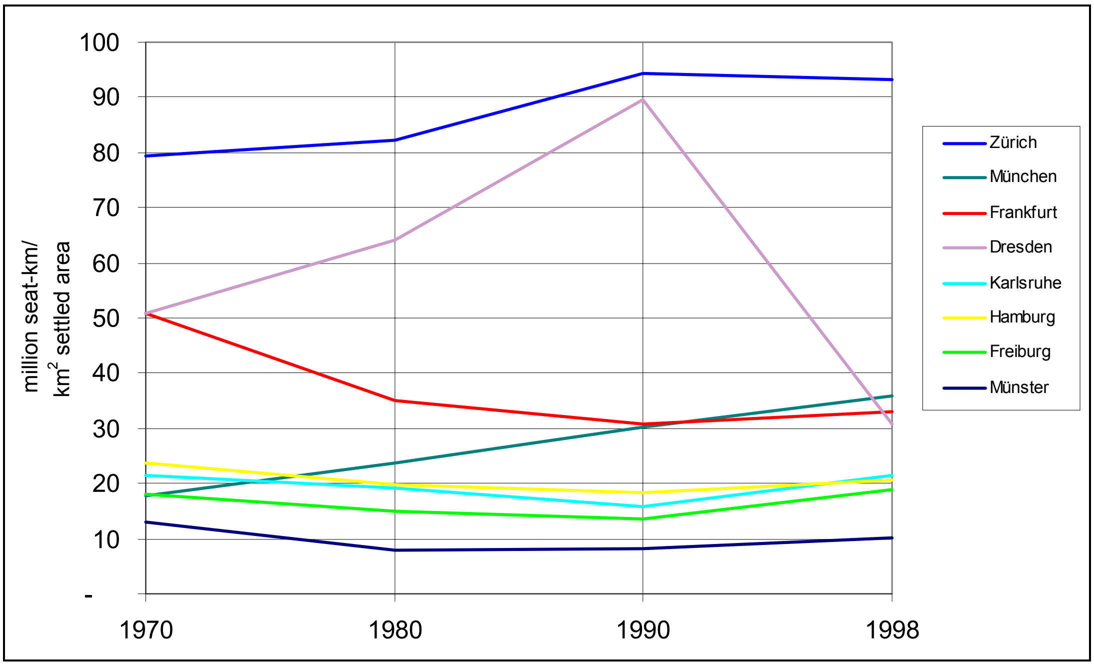


Figure 20
Source: Schley, 2001

Public transport trips in selected European cities during 1970–1998

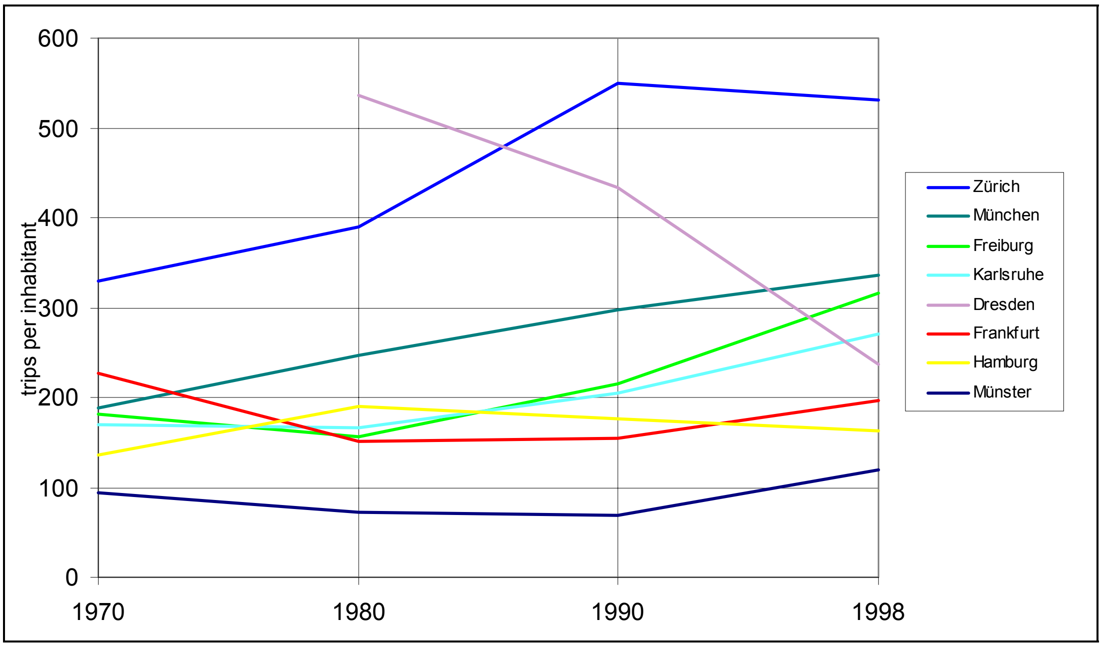


Figure 21
Source: Schley, 2001

Concerning modal split, Zurich had the greatest share of combined NMT and PT (for the years considered) among the European cities shown in Figure 22.

Modal shares in selected European cities

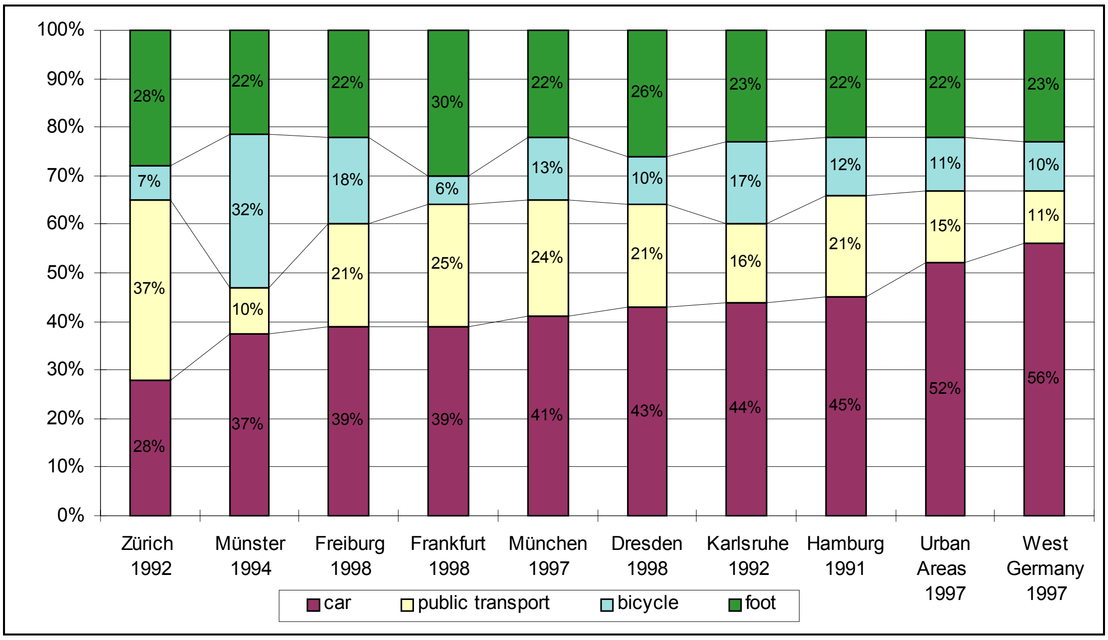


Figure 22

Source: Schley, 2001

"More than three-quarters of travel in the City of Zurich is done by an eco-friendly mode of transport (on foot, by bicycle or public transport)."

Figure 23

Tram in Zurich.

Photo: Lloyd Wright, 2005

In addition to the tramways, Zurich implemented the S-Railway (*S-Bahn*) in 1990. This new provision increased the range of public transport choices available to transport users. Coupled to that, the city of Zurich increased parking taxes and reduced the available parking spaces in 1994. This sent a clear message to transport users, reducing the appeal of cars and increasing the attractiveness of public transport. Between 1984 and 2005, public transport ridership in Zurich increased from 209 million to 294 million passengers (41 % increase). More than three-quarters of travel in the City of Zurich is done by an eco-friendly mode of transport (on foot, by bicycle or public transport).

Newman (1996) asserts that the strategy adopted by the City of Zurich was "to point out other better possibilities of use". This can be inferred to the various other changes that the city government introduced. New public realms for people were introduced. Parking places were converted into public places and outdoor cafes appeared on streets. People from Zurich have more places to sit, relax and enjoy their city.

8.3.2 Copenhagen

(Authored by Oegel Kersten)

The city of Copenhagen sets a leading example of a city that is pursuing the strategy of sustainable urban development, in a true sense. With the aim to become "one of the most livable cities in the world" and a global leader of green cities, the city has come up with a vision called "Eco Metropolis 2015" (EcoMetropolis, 2015), which seeks to show other capitals how a greener urban environment can enhance the quality of life in practical terms. The objective is to reduce carbon emissions by 20 % until 2015 and eventually make the city CO_2–neutral by 2025 (Copenhagen Climate & Environment Plan).

box 4

Copenhagen: turning parking places into public spaces

In addition to its transit system, Copenhagen had to use innovative social planning to address the issue of growing personal automobile.

> *"By the 1960s, American values had begun to catch on – separate isolated homes and everyone driving. The city was suffering so how could we reverse these patterns? We decided to make the public realm so attractive it would drag people back into the streets, whilst making it simultaneously difficult to go there by car." (Gehl, 1992)*

Copenhagen took a veiled approach to promote public spaces. Every year the city officials reduced the available parking spaces in Copenhagen by 3 % and converted the reclaimed space into public space. The city housing was renovated or newly built at human scale. More space was given to pedestrians and street life was encouraged. As Jan Gehl says "the city became like a good party". Within 10 years, there was a 30 % reduction in parking availability, which was unnoticed by the public, as space reclaimed was given a new use for the people. Social activity in Copenhagen tripled.

Jan Gehl points out that the conventional wisdom was:

- "Denmark has never had a strong urban culture"
- "Danes will never get out of their cars"
- "Danes do not promenade like Italians"

Conventional wisdom proved to be wrong.

Figure 24
Bicycle users in Copenhagen.
Photo: Carlosfelipe Pardo, 2009

One way in which Copenhagen is achieving this goal is by ensuring eco-friendly and sustainable means of urban transport, including NMT (particularly bicycles) and PT transport.

The City of Copenhagen anticipated car traffic growth and initiated pro-bicycle planning as early as in the 70/80s. Today, Copenhagen is one of the most bicycle-friendly cities in the world. It increased its daily bicycle share (for work or education trips) from 30 % in 1998 to 35 % in 2010. Other modal shares include walking (7 %), PT (32 %) and car (26 %). According to Cycle Account (2010), Copenhagen's three target goals for cycle planning ('Eco-Metropolis 2015') are:

- At least 50 % of the travellers will reach their place of work or education by bike;
- The number of killed and seriously-injured cyclists in Copenhagen will be reduced by more than 50 % compared to 2005;
- At least 80 % of cyclists will feel safe when cycling in Copenhagen.

"Copenhagen's bicycle and public transport planning has priority over cars."

There are many reasons why Copenhagen has such a high share of bicycle trips today. The city has a long cycling tradition, which is recognised and accepted as a part of the daily lifestyle and routine of many citizens. Cycling is well embedded into the traffic planning, and the necessary measures (*e.g.* provision of adequate cycling infrastructure) to cater the increasing number of cyclists have been put forward at the right time. Today, there exists an extensive cycle network of about 411 km in an area of about 90 km².

Furthermore, the city continues to improve its cycling conditions, by making use of innovative transport planning instruments and by constantly optimising demand-oriented measures (Cycle Account, 2010). These include *inter alia*:

- Constant appraisal of the current cycle situation by surveying and counting;
- Frequent optimisation and extension of the cycle network (including maintenance of existing (sub-)urban cycle tracks);

- Widening of cycle tracks as a reaction to existing and future bicycle traffic demands;
- Measures to minimise cyclist's average journey time (*e.g.* through prioritisation at intersections, "green routes", "bicycle commuter superhighways");
- Supplying infrastructure for bicycle parking: bicycle racks or parking facilities (*e.g.* commercial: 0.5 bicycle parking spaces per employee; residential: 2.5 bicycle parking spaces per 100 m^2);
- Integration between cycling and PT (enabling intermodal trips);
- Additional services and innovations (*e.g.* LED warning sensors on special intersections, footboards in front of traffic lights, air pump stations).

From a sustainable transport perspective, another important step is the introduction of a strategy that aims to restrain car use. Copenhagen's transport planning gives priority to bicycles and PT over cars. The various measures taken in this regard are:

- Regulated or no access for cars on certain streets (*e.g.* planning for Nørrebrogade street);
- Decrease in the parking space in the inner city district of Copenhagen, at a rate of 2–3 % per year, which includes the outsourcing of parking space to the peripheral areas (University of Limerick, 2010);
- Raising awareness initiatives to promote environmentally friendly mobility;
- Future plans to introduce road pricing in Copenhagen.

Given Copenhagen's consistent efforts to deliver equitable, transparent and innovative transport policies, the city can be considered as a model for sustainable development.

8.3.3 Muenster

(Authored by Georg Doehn)

> ***"Today, Muenster supplies a high-performance cycle-network with a total length of 457 kilometres."***

During the past years, Muenster became Germany's bicycle capital. With a modal share of 37.6 %, the bicycle is the prevailing transport mode in that city. Muenster's 280 000 inhabitants own nearly half a million bikes. This indicates the role cycling plays in the city and requires a specific focus on the demands of cyclists.

Figure 25
Bicycle station in Muenster.
Photo: Georg Doehn, 2010

Today, the city of Muenster provides high standards of infrastructure and safety for cycling. Ten years ago, Muenster's road safety was poor. 50 % of all traffic-injured were cyclists. Therefore local politicians decided to elaborate a new policy "Vision Zero", which could meet the particular needs of the vulnerable cyclists, equally considering the failures and limited capacity of humans. With the introduction of "Vision Zero", the elimination of road causalities was targeted. In order to set a high road safety standard in Muenster, mutual consideration and compliance with traffic laws became key components of Muenster's mobility policies.

To combat non-compliance with right-of-ways and red traffic lights, the main reasons for accidents, Muenster implemented new transport infrastructure and intensified traffic regulation and monitoring. In the scope of these measures, cycle-paths along main roads, extended cycle highways with a minimum width of 5 metres and cycle-bridges and tunnels at intersections were constructed. Furthermore, the area of the former city wall was changed to a cycle-promenade, traffic speed was limited to 30 km/h in residential areas and segregated parking spaces were provided to avoid parking at cycle-paths. To increase the flexibility and attractiveness of cycling, one-ways were opened for free cycling. As an essential measure to reduce accidents, the overall visibility of cycle-routing was also improved. Today, Muenster supplies a high-performance cycle-network with a total length of 457 kilometres. Bike maintenance and parking, as well as rental and purchase options, are available.

Non-compliance with traffic laws is regulated in a specific cycle code. In order to strengthen cyclist's safety, cycling with blood alcohol or without the required lighting is punished through fines.

Funded by local and national institutions, the feasibility of these measures has been ensured by a shift of political and administrative engagement towards safety and capacity of cycle-paths.

All these measures led to several improvements in Muenster's city environment. Due to partial modal shift towards cycling, the overall traffic volume of vehicles was reduced. Hence noise and emissions decreased, too. Enhanced road safety supports especially the most vulnerable road users. Nowadays, elderly people and children are able to cycle with a higher level of safety. Other benefits include time and cost savings (*e.g.* children who are able to cycle safely to school do not require daily car lifts by their parents) and healthier lifestyles.

During the past years, Muenster has been capable of increasing road safety and the quality of life it offers to its citizens.

8.3.4 Freiburg

Freiburg is the only German city that can proudly boast of a declining car usage in spite of an increase in car ownership. This is greatly due to the importance Freiburg has given to its NMT and public transport development. The investment Freiburg made in its trams has turned out to be indeed fruitful. In 1997, trams were used for more than 44.6 million journeys and buses were used for 29 million journeys. The regional card introduced by the transport operator was a huge success: the first year after the introduction of the card, the daily trips in Freiburg and the region rose by 26 400; while car trips fell by 29 000.

Newman (1996) points out that the growth in car trips in Freiburg over 15 years was only 1.3 %. Between 1976 and 1991, PT ridership increased by 53 % and bicycle trips by 96 %. Freiburg's growth in mobility was met mainly by increased bicycle and PT supply. Between 1976 and 2005, the percentage of trips by car reduced from 60 % to 29 %.

> ***"More than 90 % of the students living in Freiburg use either bikes or public transport for their daily mobility needs."***

"Freiburg's growth in mobility was met mainly by increased bicycle and PT supply."

In 2005, despite the increase in Freiburg's population, the number of cars entering the city fell from 236 000 to 232 000. The high density and compact living created by the city government enabled almost 70 % of the population to live within 500 metres of a tram stop. The average distance between two tram stops was found to be 452 metres; while the average distance between two bus stops was 646 metres. More than 90 % of the students living in Freiburg use either bikes or PT for their daily mobility needs.

These astonishing results make Freiburg a leading example of sustainable transport.

Figure 26
Tram at Quartier Vauban, Freiburg (Germany).
Photo: Manfred Breithaupt, 2011

9. Conclusion

Transport and land-use policies can determine a city's future transport system efficiency and diversity. Many current policies unintentionally favour automobile transport over other modes, and sprawl over more compact, multi-modal community development. Although individually these policies may seem justified, their cumulative impacts can be harmful if they increase costs and reduce transport options.

Developing country cities are particularly vulnerable to the costs and risks of automobile dependency. They lack resources to build extensive highway systems and subsidised parking facilities. Most households cannot afford an automobile, or would be financially burdened if they were forced to own and operate a car due to inadequate alternatives. The economic costs of expanding roads, subsidizing parking facilities, importing fuel, and dealing with accident and pollution damages are substantial, and may become even larger in the future if automobile dependency increases.

Described more positively, developing country cities have an opportunity now to begin creating more efficient and diverse transport systems which will better meet their future needs. This can benefit everybody overall, including motorists who can enjoy less traffic and parking congestion, reduced risk and pollution damages, and reduced need to chauffeur non-drivers.

A number of specific policy reforms are needed to create an efficient, multi-modal transport system. These include:

- Accessibility-based planning, which considers impacts on all modes and land-use accessibility factors, as well as mobility;
- Set up comprehensive Mobility Plans;
- Multi-modal transport system performance indicators;
- Comprehensive evaluation of impacts (benefits and costs);
- Least-cost planning and funding, so alternative modes and demand management strategies can be implemented whenever they are most cost-effective solutions overall.

These reforms help increase transport system diversity, help create more efficient pricing and road space allocation, support smart growth development, and in other ways create more accessible, multi-modal communities where residents can use the most efficient travel option for each trip.

This papers describes examples of these policy reforms, and various programs being implemented in cities around the world to increase transport system efficiency and diversity. These include innovative policies in both developed and developing countries.

To achieve a sustainable transport, every city needs to rethink on the following factors:

- Mixed Land-Use/Compact cities: Many cities in the developing world have a great advantage over the developed world at providing mixed land-use and compact form. Unfortunately (and possibly unknowingly), this nature of cities is being lost due to the excessive dependence on personal automobile. Sufficient policy measures and legislative checks have to be brought forward to contain the "sprawl" of the cities and promote mixed use, high density and compact urban areas.
- Purpose of the transport mode: The first preference is given to the target group. If the proposed system is serving a large number of people (like in mass/public transport) or if the system is in favour of a specific target group (private motorists; in developing countries, often a majority lower-income group).
- Expected modal split: As the concept of induced demand says "the more we build, the more they come", this is valid for all modes of transport. While, building infrastructure for automobiles is unsustainable, building infrastructure for NMT (such as walking and cycling) and PT is fruitful. This has been shown in the cases of Curitiba, Bogota, Singapore, Hong Kong, Zurich, Copenhagen, Muenster, Freiburg and other cities.
- Pay the real cost: As it was earlier discussed, motorists are required to pay the real costs of their travel. Currently, motorists do not pay or are heavily subsidised at the cost of non-motorist

taxpayers for their travel. This is usually in the form of automobile friendly fly-overs (on which cyclists and pedestrian are not allowed, in many countries), wide roads (where footpaths are less than the standard width forcing the pedestrian on the road), poor public transport (forcing the people who can afford to shift to a personal automobile). Schemes such as ERP and high parking fees exercised in the examples discussed would be feasible steps forward. In addition to that, parallel improvement of NMT development and PT priority and is also required. In conclusion, transport demand management (TDM) can play a key role here.

This analysis does not deny the significant benefits provided by automobiles, nor does it suggest that cities should become completely car-free. This analysis suggests that an optimal transport system offers travellers a combination of automobile, non-motorised, and public transport options, with incentives to encourage users to choose the best option for each trip. The result is an efficient and equitable transport system that maximises benefits to users and society overall.

10. Further reading

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