



# Co-benefits of Cycling-inclusive Planning and Promotion

World Bank | GRSF, contract 7152334

Interface for cycling expertise





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Co-Benefits for Safe and Affordable Transport Strategy in Urban Areas  
The Example of Cycling-Inclusive Planning and Promotion

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Interface for Cycling Expertise

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# Summary



<b>Project</b>	Co Benefits for Safe, Clean and Affordable Transport Strategy in Urban Areas, The Example of Cycling Inclusive Planning and Promotion
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# 1 Introduction



## 1.1 Background

The World Bank Group launched on May 21, 2008 a new transport business strategy for 2008-2012 that will help partner countries establish the governance, strategies, policies and services to deliver transport for development in a way that is economically, financially, environmentally and socially sustainable.

Named *Safe, Clean, and Affordable... Transport for Development*, the business strategy strengthens the alignment of the transport sector approach with the Millennium Development Goals adopted by the United Nations in 2000. At the same time, it widens the directions and deepens the routes that will be taken to meet the evolving development agenda. It gives more attention to emerging trends, such as trade globalization, urbanization of populations; rising concerns about climate change, the increase in traffic congestion and crashes; and the recognition of access as a key to both economic opportunity and good governance.

The World Bank Global Road Safety Facility is preparing a strategy paper to encourage urban transport policies that promote the new transport business strategy. This requires clear concepts for the planning of urban transport facilities in combination with communication strategies to promote safe and clean transport behaviour options. Further, for such strategy indicators have to reflect the goals for safety, affordability and sustainability in order to assess the impact of policies and measures properly. The challenge is to highlight co-benefits of policies for Safe, Clean and Affordable transport in urban areas.

In particular, cycling promotion and cycling-inclusive urban and transport planning can contribute to combined traffic safety, affordability for all and vehicle emissions reduction in urban transport management and operations. As such cycling provides a good case for demonstrating the validity of the concept of a safe, clean and affordable transport system. To make sure that all benefits and co-benefits of cycling are properly weighed in decision making processes in urban transport planning we also discuss current indicators to see whether and how these (co-)benefits are properly included already.

## 1.2 Purpose

The study reviews and discusses how the promotion of cycling as an affordable and clean means of transport, is related to the promotion of road safety. Modern road safety policies seek to reduce the risks that serious accidents might occur to individual road users or between road users. They are also based on the quality requirements for road infrastructure that take the specific characteristics of cyclists into account. Integration of these policies requires that road design (and its' setting, i.e. adjoining land uses) is brought in line with the function of a road and (intended and actual) road-user behaviour. Categorisation of the road system and traffic circulation measures give direction as to the type of facilities suitable for the different types of road use: modes of transport, short/long distance trips, social activities.

To assess the impact of policies and measures, one needs indicators for road safety, affordable accessibility, and related impacts on the environment and to

climate change. The commonly used indicators for road safety will be reviewed in chapter 6. Not only the risk for the road user himself, but also the risk for other road users has to be taken into account. It also makes a difference whether the reference denominator is kilometres or trips. Appropriate indicators for affordable accessibility are hard to find. Impact assessments of transport policies tend to rely on indicators for travel time and travel speed by vehicles and do not take qualitative aspects of transport involving social factors such as affordability, equity and social inclusion into account. Currently, impact assessment on the environment and climate is mainly linked to emissions per vehicle and not to personal mobility needs.

However, a conceptual approach of defining mobility and accessibility, and an appropriate definition of indicators cannot be isolated from each other. The paper will present a critical review of current practices and give recommendations to bring transport policies more in line with the new World Bank transport business strategy as outlined above.

### **1.3 Objectives**

The objectives of the study are:

- 1 To develop a conceptual framework for the integrated planning of Safe, Clean and Affordable Urban Transport.
- 2 To review and develop indicators for impact assessment of urban transport policies that are developed around the themes of Safe, Clean and Affordable Transport Strategy.
- 3 To carry out an impact assessment of a local urban transport policy in India that intends to integrate road safety, affordable accessibility and climate issues in a sustainability context.

### **1.4 Scope of work**

This study has, first of all, a global strategic scope. It will review current approaches in urban transport and present cycling as an indispensable part of the urban transport system. Co-benefits of cycling-inclusive transport policies will be explained and current indicators for impact assessment will be reviewed to evaluate whether they are taking these co-benefits properly into account. And it will propose alternative concepts and indicators that value the contribution of cycling to the integrated goals for road safety, affordable accessibility and sustainability.

The (separate) case study in India demonstrates some of these concepts and illustrates the difference in impact that a local urban transport policy can make. The case study concerns the Delhi BRT corridor so as to show the added value of a cycling-inclusive approach in the design of urban transport projects. It is an illustration, using available data, applying traffic modelling, connected to a specific local context.

### **1.5 Structure of this report**

In chapter 2 we give a general description of urban developments, the role of transport and its impact on development. Chapter 3 argues why cycling is an

indispensable and integral part of transport planning, challenging transport planners to plan for 'an optimal mix'. Chapter 4 focuses on the contribution of cycling to an improvement of accessibility and road safety. Chapter 5 gives an overview of the benefits and co-benefits that can be attributed to (the promotion of) cycling. In chapter 6 we discuss how indicators for the performance of the transport system should be formulated to correctly reflect the contribution of cycling to its performance.



## 2 Current approaches in urban transport

### 2.1 Fast urban growth

In most parts of the world, urban/metropolitan areas grow in an unprecedented pace. At first this growth was induced by the shift of people from rural areas, and other countries, into urban and metropolitan areas. The modernisation of agriculture led to larger yields, but simultaneously decimated the workforce in rural areas. At the same time numbers of urban activities have been growing fast, stimulating migration of large numbers of people from the rural areas into the cities. Because of that, the majority of the World population is now living in cities. As a result, the autonomous growth of the urban population is now larger than the rural-urban migration.

Traditionally cities had a concentric, densely populated urban form, in order to minimise the perimeter that had to be defended. All kinds of industry, even the more polluting ones, could be found within the city walls. With time cities have broken out of their straitjacket. Neighbouring villages were taken in. Harbours, heavy industry, and polluting activities could be moved away from residential areas. New ideas on urban planning led not only to constructing of residential districts stretching out away from the city centre like fingers (in radial directions), but also to building 'garden villages', and 'new towns', at some distance in the countryside. Large cities gradually transformed into metropolitan areas, conglomerates of several cities, urban districts, former villages, new towns, industrial estates etc. The development of transport has played a large role in this urban development.

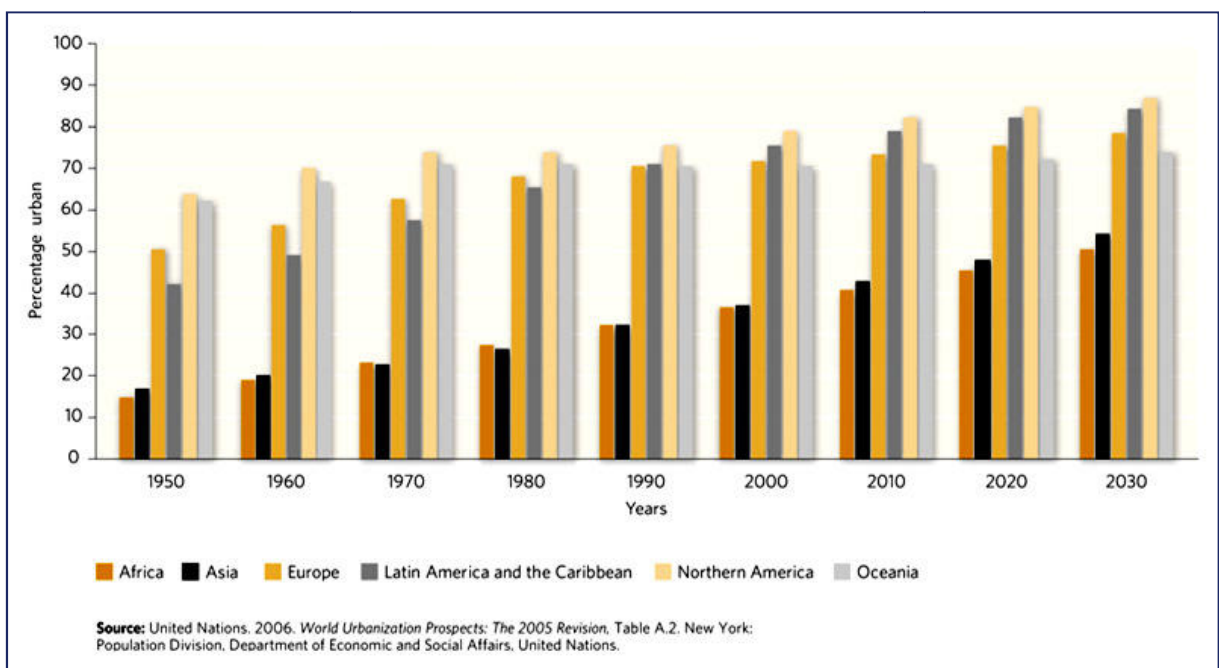


Figure 1 Percentage of Population at Mid-year Residing in Urban Areas, by Region, 1950-2030 (UNFPA, State of World Population 2007: Unleashing the Potential of Urban Growth)

## 2.2 Transport Development in various parts of the world

The growth of urban/metropolitan areas, takes up villages and large rural areas around the original cities. At the same time businesses, schools, institutions, parks, etc. grow in scale, each of them serving more people. As a result the inhabitants (have to) travel over longer distances. It is also the other way around: only the possibilities to travel over longer distances allow cities to grow the way they did.

The growth of urban/metropolitan areas, quickly takes up villages and the larger rural areas around the cities. At the same time businesses, schools, institutions, parks, etc. grow in size and scale, each one of them serving more people. As a result the inhabitants (have to) travel longer distances. But it also works the other way around: only the possibilities to travel over longer distances allow cities to grow the way they did.

At first the bicycle, taxi bus, bus, and maybe some rail transport helps to bridge longer distances, while the private car is only available for the happy few. Later a rapid growth of car ownership and use follows. In developed countries (North America, Europe) we have seen urban and transport planning being based almost entirely on adapting the cities to the (dominance of) the car. In the last decades, however, as a reaction to this car dominance, such policies have been questioned more and more. In a growing number of countries this is resulting in a reevaluation of public space, public transport and non-motorised modes of transport. Ironically developing countries seem to go through the same phase in which transport planning is identical to planning for cars, not taking into account the lessons learnt in the developed world, and neglecting the interests of the vast majority of their population that has no access to a car anyway.

Walking is still the most frequently used mode of transport in the great majority of the urban/metropolitan areas around the world. In some towns in Africa, 60% of the commuters walk to work in the Central Business District, or industrial estates, from their homes on the periphery of the urban area.

## 2.3 Transport Captivity

The growth of the urban population does not happen without grave problems. To find a suitable place in society, according to one's potential and aspirations takes time and struggle, not only for the people migrating from rural areas, or other countries, but also for their children and grandchildren. Many starters, and the less fortunate among the population, find no other choice than to go and find a poor place to live in the periphery, far away from job opportunities, and services.

We must be aware that the transport situation in the urban areas of developing countries is quite different from the current situation in Europe and Northern America. Transport captivity is probably the most poignant distinction. Large groups of the population have very little choice: using public transport would take a too high share of their income, let alone that a car would be affordable. Thus they have to rely on walking and cycling. If transport planning doesn't cater for that, this means that they will hardly play a role as consumers on the markets of employment, housing and transport. Many will be struggling all their life to find work and a decent place to live. Less fortunate people have no

alternative but to move to a slum at the periphery. Moreover, there is a constant influx of new settlers, coming from rural areas and other countries, just hoping for the best. Even large numbers of people with a 'regular' job and a 'regular' home are 'captive' in their activities and transport.

Transport captivity is not the only, but certainly an important factor in the enormous lack of participation in society, and consequently the latent need of transport. Many children do not go to school, or leave early, because of the same reason, while many adults cannot find a decent job.

## 2.4 Transport patterns in urban/metropolitan areas

Travel in urban, and metropolitan areas forms various patterns, which are changing during the day. Every morning and every evening a large stream of commuters may go from residential areas to the Central Business District and vice versa. Public transport on dedicated routes may be a viable option, when these streams can be channelled on transport axes.

The majority of trips, however, forms dispersed patterns, going to a multitude of destinations, like shops and local services, schools, friends or family, business on other places, leisure facilities etc. What's more, passengers may have to travel considerable distances before and after using some form of public/collective transport. Most of these trips are relatively short, which makes them suitable for non-motorised travel modes. This asks for a different approach. Transport policy should take the full pattern of trips into account, and not only look to the demand on main axes during peak hours.

An excessive emphasis on transport axes not only demands high public investments to build major projects, like urban traffic arteries and dedicated public transport lines. It also puts extra pressure on businesses, schools, shops and services to move to a more central place of settlement, increasing the distances that are to be travelled, and resulting in even larger streams during peak hours.

The growth of car traffic may be seen as an inevitable consequence of urbanisation, but it is also a major force in spreading urban areas further and further into the surrounding countryside. No single phenomenon in the last century has influenced the shape of our cities as much as motorised transport has. Car traffic may facilitate travels over longer distances. At the same time, it deteriorates the living conditions in many urban areas, pushing inhabitants to residential places far 'out of town', relying heavily on the availability of a car, or even more than one per household. Streams of motorised traffic turn streets and avenues into traffic arteries, dividing urban areas into small 'islands' by destroying social/economic interaction across the street.

We observe all over the world the same phenomenon:



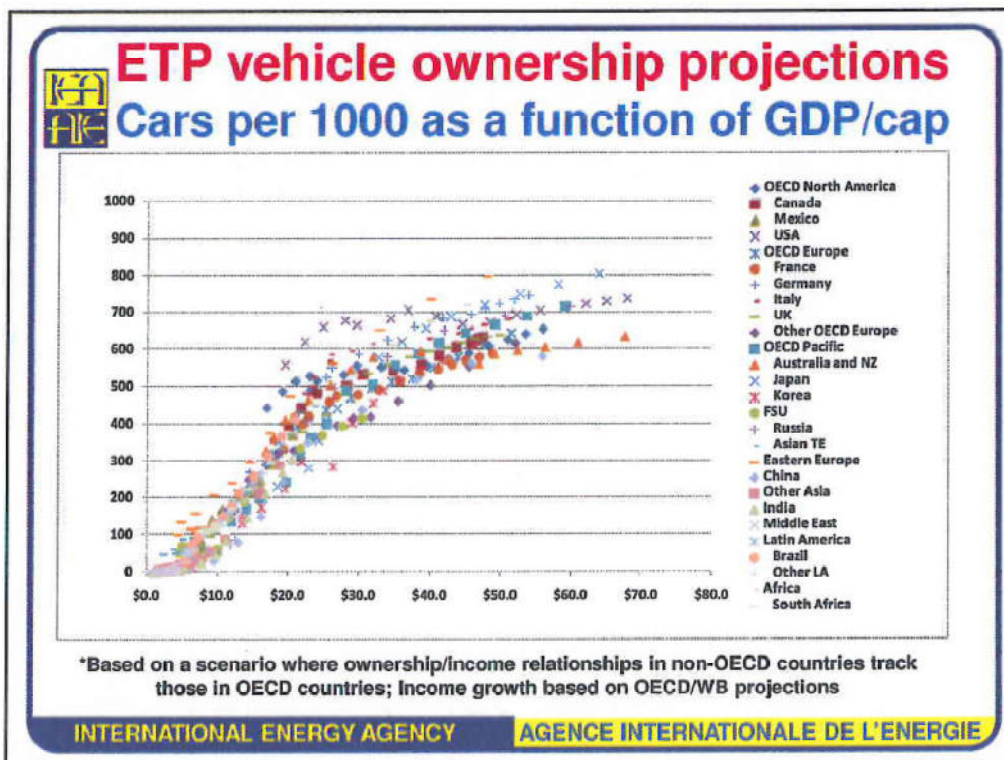
The experience is that it takes decades to bend this trend. There was, for instance, in countries of Western Europe and North America a steep growth of car use in the 1950's and 1960's going hand in hand with a steep growth in road casualties. Later, while car ownership and car use were still growing, the number



of road casualties reached a peak, and started decreasing again, not only in comparison to the distance travelled by car, but also in absolute figures. This improvement of road safety was to a large extent the outcome of growing restriction and regulation of the free movement of cars creating at the same time room for safe walking and cycling.

In other parts of the world, where only a minority of the population can dispose of its own car, one sees the same phenomenon Europe and the US faced in the 1950's and 1960's: a rapid increase of motorisation going hand in hand with a steep increase of road casualties. One could argue that developing countries should go through the same curve (read: process) as the developed countries have gone through. But the obvious challenge is to apply the lessons learnt in Europe and to develop the transport system without an initial growth of road casualties: 'leap frogging' the 'bad' stage of development.

Most transport planning is, however, biased towards motorised traffic, hardly recognising the needs of the non-motorised road users, and, what is more, ignoring the huge potential in solving urban transport problems.



Figur 2 There is an obvious relation between car ownership and income, as can be understood from this slide presented by Lew Felton (IEA) at the BAQ workshop in Bangkok in 2008. The relation between income and bicycle use is less clear: A number of the richest countries have a substantial (and sometimes increasing) level of bicycle use. The variety of transport policies (and its consistency over years) and cultural aspects seem to provide a much better explanation for the differences in bicycle use than income. At the same time it is clear that without dedicated effort to protect cycling, mass motorisation will go together with a dramatic decline of cycling.



## 2.5 The Potential of Cycling

A significant shift in urban and transport policies took place in the Netherlands. It was widely accepted, on all levels of government, that walking, cycling, and public transport are the predominant modes of travel within urban areas, now and in the future. Of course, car traffic and freight transport are facilitated as well within urban areas, but only to a certain extent. Priority is given, more and more, to non motorised road users. Bicycle facilities and public transport lines are used as 'backbone' for new urban plans. Parking fees for visiting cars are raised to protect neighbourhoods from excessive parking. The emphasis in urban transport plans shifted from accommodating car traffic and car parking, to facilitating cycling, walking, and other activities on the street.

### Costs of cycling-inclusive infrastructure in the Netherlands

As a part of its cycling-inclusive transport policies the Dutch national, provincial and municipal governments are investing in cycling-friendly infrastructure and services. These investments aren't always clearly labelled as 'cycling investments'. Many urban road investments have a cycling component which simply is included in the overall project costs. In the early 1990's a study was done to make a valuation of the total yearly expenditure on cycling infrastructure in the Netherlands. The findings were that the investments of provincial and municipal added up to NLG 200 million (about € 120 million, price level 1992).<sup>1</sup> National government subsidies supplemented this amount with about NGL 60 million per year. Including the expenditure on other services for cyclists and on promotion activities this added up to some NLG 300 million (about € 135 million) expenditure per year for cycling. Since then no new calculations have been made, but the impression is that today most municipalities and provinces have raised their ambitions on cycling promotion, and subsequently their expenditure. (And of course inflation needs to be taken into account as well.)

In 2000 Interface for Cycling Expertise produced the report *The Economic Significance of Cycling*, which included some cost/benefit calculations of investments in cycling. In all cases the cost/benefit ratio was profitable. Understandably the ratio appeared to be more profitable in situations where cycling investments were a rather new phenomenon. The marginal profits of further improvements of an existing reasonable good situation is usually lower the profits of a first improvement of a very bad situation.

The effect of this policy has been impressive. It stopped and reversed the decline of cycling, and nowadays 27% of all trips in the Netherlands is made by bicycle. In urban areas this percentage can be as high as over 50% of urban trips. 40 % of rail passengers use the bicycle to go to the station, and this percentage is still rising. Urban centres are only limited accessible by private cars and are redesigned to offer an agreeable atmosphere for people walking and cycling. Residential areas are turned into large 'Habitat areas' with a speed limit of 30 km/h or less. These policies have a very positive impact on road safety trends. Road casualty numbers peaked in the Netherlands in the early 1970's and are now back to about 25% of the 1970's figures. In the same period both the number of cycling trips and car trips increased.

	Cycling km p p p day	Killed cyclists per 100 mln km
GREAT BRITAIN	0.1	6.0
ITALY	0.2	11.0
AUSTRIA	0.4	6.8
NORWAY	0.4	3.0
SWITZERL	0.5	3.7
FINLAND	0.7	5.0
GERMANY	0.8	3.6
SWEDEN	0.9	1.8
DENMARK	1.7	2.3
NETHERLAND	3.0	1.6

Figuur 3 This table shows that the risk of cycling are more or less inversely proportional to the levels of bicycle use: the more cyclists/cycling, the less risk per km cycled. (Walcing)

These cycling promoting policies have also helped cities to meet the (ever more strict) legal standards for air quality. In some respects the Netherlands have been lucky: unlike most other developed countries the Netherland still had a substantive share of cycling at that time. It 'only' had to preserve the existing cycling, whereas many other European countries adopting these policies, had to start from almost scratch. But nowadays in Europe and in North America there is a growing and almost general recognition of the relevance of cycling for urban transport. Cycling appears to be a mode of transport combining a wide variety of co-benefits. On an individual level it provides affordable and very flexible mobility giving access to almost every single address in the urban fabric (even in congested circumstances). Concomitantly cycling provides an easy form of physical exercise, thus contributing to a healthy life style. For society increased cycling is contributing to road safety, air quality and liveable cities, combating congestion, liveable cities and fighting climate change. One would expect that these advantages of cycling would be irresistible for any sensible politician or decision maker. So the main question is: why is cycling still so low on the political agenda? And consequently: what is needed to integrate cycling in policies for transport, road safety and climate protection?

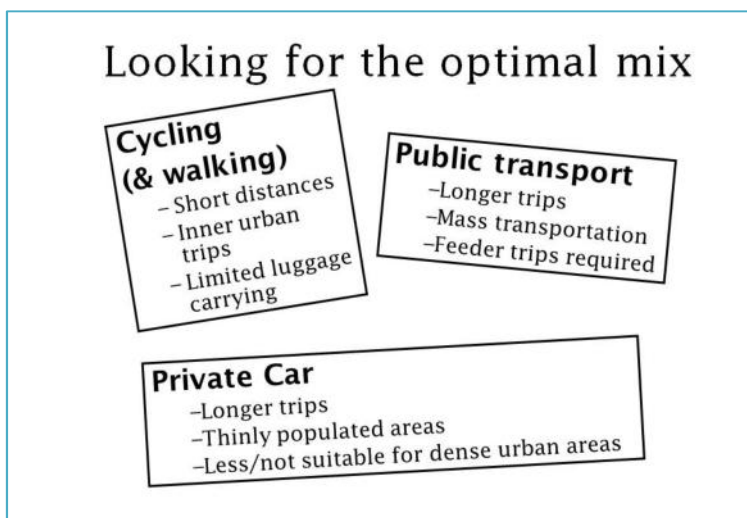
## 3 Cycling as an indispensable part of the modal mix<sup>1</sup>

### 3.1 Integral transport planning

The planning for cycling will always happen within the context of an existing transport system. If authorities really want to utilise the potential of cycling for societal aims as improved accessibility, better air quality, more liveable cities and improved public health, then cycling should not be accommodated as an isolated 'add on' to the existing transport system, but as an integral part of the transport system. This requires a thorough reflection on the role of cycling and the other modes in the transport system, and even beyond that: on what we consider to be the performance requirements for a sustainable transport system. We propose the following strategic goal for transport planning:

*To meet the transport needs of individuals and society, thus maximising the contribution of transport to social and economic well being while minimising its adverse effects.*

It should be clear that this is a complicated task. Transport planners should utilise the positive characteristics of all available modes of transport, while avoiding or neutralizing 'problematic' use. The implication is that one should look for an optimal mix, giving each mode priority in those situations and for those trips for which it is appropriate.



Figur 4 Good urban transport planning should make the most of the strengths – and minimize the weaknesses – of the different transport modes, rather than planning solely for one mode at a time, in isolation from others.

### 3.2 The three markets model

To understand how and to what extent cycling can be appropriate to meet the transport needs of individuals and society, we first look at the transport system

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<sup>1</sup> This chapter is an adapted version of parts from 'Strategic Planning For Cycling' in 'Locomotives Full Steam Ahead', I-CE, 2007

in terms of its basic functions. Transport can be looked upon at three 'markets' for travel, transport and traffic:

### 1. *Travel market*

People travel in order to participate in social and economic activities. The spatial distribution of these socio-economic activities and their timeframes to a large extent determine travel needs. This can be considered as a market as people have to decide whether the activity (or a similar alternative) is worth the travelling. In terms of facilitating social and economical needs society should strive for the highest level of participation against the lowest level of travelling. Many socio-economic and cultural factors, such as economical up-scaling and globalisation affect travel needs and go far beyond the reach of any physical planning. Land use planning and urban structure, however, are important factors which can be used to at least prevent unnecessary growth of the need to travel.

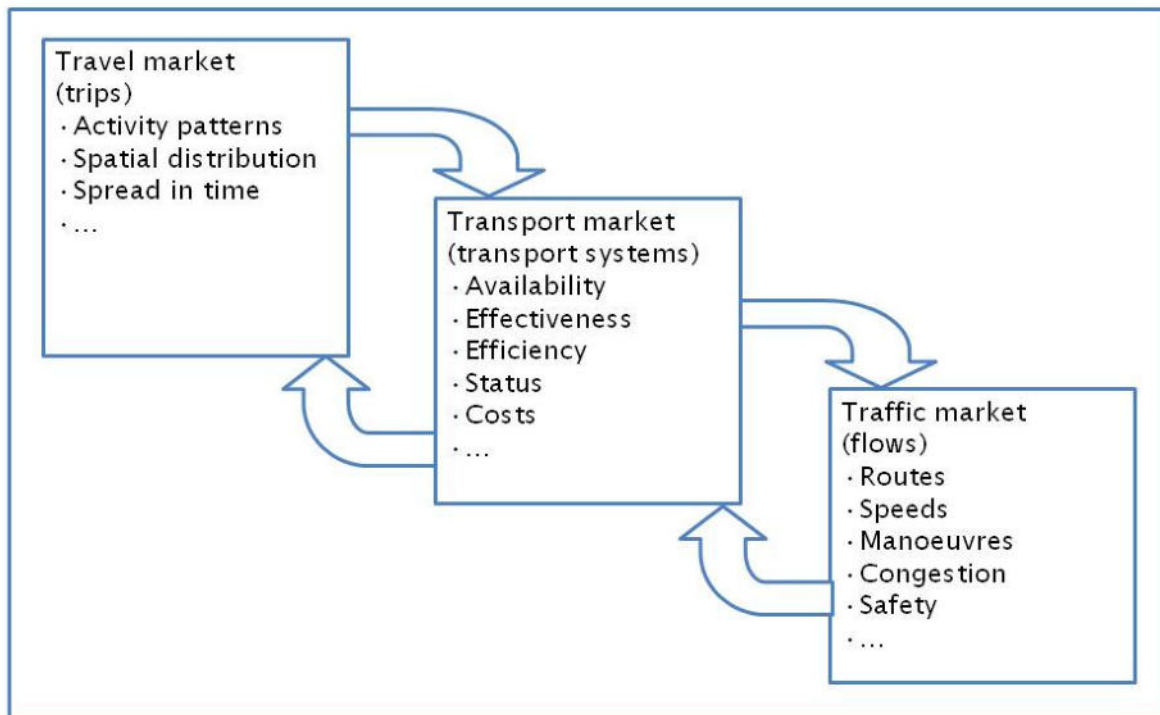
### 2. *Transport market*

At the transport market people choose from the transport systems available to meet their need to travel, while operators may offer transport services there were there is this need for travel. Depending on the distance to be covered and the spatial context, several modes of transport can be used. Again individuals will weigh 'costs' and 'benefits' of each choice. Transport strategies should aim at promoting those (combinations of) mode choices which offer the best cost-benefit ratio for society as a whole. It should be noted that this asks for a wider interpretation of 'costs and benefits', taking all effects (wanted and unwanted) into account.

### 3. *Traffic market*

Once an individual has chosen a certain transport mode, the trip should be as smooth and safe as possible. On this market individuals are choosing their route and their road behaviour (speed, manoeuvres, etcetera). These behavioural choices are made within the framework of the available infrastructure, regulations and the interaction with other road users. This requires safe infrastructure in an attractive and secure environment, a network connecting origin and destination, and so on, the core-business of traffic engineers and urban designers.

These markets are highly interrelated. One's possibilities and choices at a certain level may well have consequences for one's choices on another market. Bad road conditions on the travel market may influence choices made on the transport market, as the (non) availability of certain transport modes may influence the travel market choices. The figure 3 offers insight on how these three levels are related.



Figuur 5 How transport-related markets are interrelated

This diagram is useful because it highlights potential points for action by policy makers seeking to intervene in the traffic and transport system. In all three markets interventions can encourage or discourage cycling. Clearly, the *traffic market* is the domain of traditional traffic engineering. Physical planning of road infrastructure is a typical point of action administered by governments. The *transport market*, on the other hand, offers opportunities for civil society organisations and other stakeholders to take the initiative. The *travel market* is strongly influenced by all kind of economic, social and cultural developments. The most obvious point of action is land use and urban development policies.

Where does cycling fit into these markets? This question is asking for an assessment of the possible choices on all three markets. The answers depend on the kind of activities an individual wants to engage in, and as a consequence what kind of travel is required. Is a bicycle suitable to make the required trips, is it available and if so at what cost? And how comfortable and safe the ride will be? These questions need also be answered regarding other travel possibilities available. Then one can conclude how competitive cycling is compared to these other transport modes. The implication of this approach is that transport planners need to know about travel patterns, availability and quality of transport systems, and the various ways to accommodate these transport systems. An analysis of the strengths and weaknesses of the various modes, therefore, may be enlightening.

But on beforehand we can formulate a basic condition for maximizing the potential for cycling. Land use planning should be based as much as possible on

the *principle of proximity* to keep daily destinations within cycling distance. These destinations should be concentrated at nodes in the urban fabric and along bicycle routes. And, as the other side of the same coin, bicycle routes should be planned to connect these nodes and run along existing destinations. Cycling should be treated as a realistic (if not the best) option for urban trips. And safe and comfortable bicycle infrastructure should allow cyclists to reach their destinations safely, securely and reasonably quickly.

### 3.3 Analysis of strengths and weaknesses of various transport modes

A strength/weakness analysis of transport modes could begin by subdividing these modes into private versus public and individual versus collective modes. This could result in the matrix (figure 4).

	Public	Private
Collective	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• More efficient use of a transport system (less unused hours)</li> <li>• Available if user doesn't have his own vehicle</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Attuned to average speed needs, not to individual needs</li> <li>• Only available in case of sufficient demand</li> </ul>	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Independent from collective (i.e. political) decision making</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Adding up of individual choices doesn't necessarily result in the best outcome for society</li> </ul>
Individual	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Accommodates travel from door to door (access to individual addresses)</li> <li>• Meets individual travel needs</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Wasteful use of transport capacity</li> </ul>	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Train</li> <li>• Bus</li> <li>• Tram</li> <li>• Metro</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Airplane</li> <li>• ...</li> </ul>
Collective	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Advantages of scale in case of large flows</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• No direct access to individual addresses</li> </ul>	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Charter transport</li> <li>• Company bus</li> <li>• Touring car</li> <li>• Charter plane</li> <li>• ...</li> <li>• Carpool</li> <li>• Shared car ownership</li> <li>• ...</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• ...</li> </ul>
Individual	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Accommodates travel from door to door (access to individual addresses)</li> <li>• Meets individual travel needs</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Wasteful use of transport capacity</li> </ul>	<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>• Taxi</li> <li>• Rickshaw</li> <li>• Bodaboda</li> <li>• Public bicycle</li> </ul> <p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>• Walking</li> <li>• Bicycle</li> <li>• Moped</li> <li>• Motorcycle</li> <li>• Car</li> <li>• ...</li> </ul>

Figur 6 Matrix for analysing strengths and weaknesses

For the sake of simplicity we confine ourselves to 'transport modes', but to be precise we should rather look at transport *systems*, a somewhat different concept from transport *modes*. A transport system is a *characteristic combination of transport mode(s) and its accompanying infrastructure*. In fact there are single modal and multi-modal transport systems. Most public transport trips appear to be multi-modal as they include the access and egress trips. One could think of a bicycle-train system, requiring not only the usual facilities and

infrastructure for both individual modes, but also smooth transfers between them.

This subdivision of transport systems into public versus private and individual versus collective is too rough to judge all advantages and disadvantages of all transport modes, and decide on what is needed for optimum conditions from society's point of view. (Note also that the matrix does not include transport systems for moving freight. This sector, however, represents a substantial and growing percentage of traffic flows.)

Speed, or better the time one needs to go from door to door, is of course very important to the individual road user. But it is impossible to make general comparisons on this point, because the time to go from door to door depends largely on local conditions. In a rural situation with good roads the private car will certainly be in a favourable position. Tests in dense urban situations, however, have proven in many places, that cyclists win in this respect over car drivers and public transport passengers. They are more flexible in choosing their route. They don't need as much time to find a parking place and handle parking procedures, nor do they have to walk to/from a station and wait for the next vehicle to come.

Criteria for judging the appropriateness of different transport systems for specific (type of) trips in specific contexts are:

- radius of action, distance to be covered
- transport capacity (influenced by the combination of vehicle and infrastructure)
- penetration ability (offering access to individual addresses; the weighting of this criterion is determined by the accessibility of the respective destination)
- flexibility
- affordability
- availability
- luggage transport possibility
- purpose of trip
- ease of use
- safety
- security
- spatial context, use of public space
- environmental impact
- impact on liveability of cities
- required levels of investments (compared to available budgets)
- running costs for the public and private sector
- geographic conditions (hilly ness)
- predominant weather conditions
- etc.

These criteria can be applied at the individual or household level (how does this transport mode serve the individual and household transport needs?) and at the level of society (what are the social, ecological and economic impacts of total use of this mode on the functioning of the transport system and society (people, planet, profit?). As such again a strength-weakness analysis can be done.

**Table: Strengths and weaknesses of the cycling**

<b>Strengths</b>	<b>Weaknesses</b>
<ul style="list-style-type: none"> <li>- Individual and independent choice of time of travelling (flexibility)</li> <li>- Radius of action 3 times larger compared to walking resulting in a 9 times larger area accessible in the same time</li> <li>- Door-to-door travel</li> <li>- Relatively impervious to congestion</li> <li>- Relatively fast in (dense) urban conditions</li> <li>- Easy to use, little training required</li> <li>- Low costs per km travelled<sup>2</sup></li> <li>- Limited space consumption</li> <li>- Positive impact on liveability of cities</li> <li>- Little impact on environment and climate change: clean mode</li> <li>- Reasonable luggage transport capacity (compared to walking)</li> <li>- .....</li> </ul>	<ul style="list-style-type: none"> <li>- Less suited for longer distances</li> <li>- Cyclists are vulnerable</li> <li>- Limited luggage transport capacity (compared to cars)</li> <li>- Exposure to unpleasant weather conditions</li> <li>- Low status and lack of respect by other road users</li> <li>- Initial investment for purchase can sometimes be an impediment</li> <li>- .....</li> </ul>

If we look at the ‘transport market’ and the competitive position of the different modes, in many developing countries cycling should primarily be compared to walking, public transport and motorized two-wheelers. Within the foreseeable future, the majority of the population will still not have access to cars anyway, simply because they can’t afford them. Cycling, however, could be very relevant for them to increase their travel options, and thus their social-economic possibilities. The creation of a bicycle-friendly urban environment may temper people’s aspirations to car ownership, and raise awareness that for many trips cycling can be an option, not only for pedestrians, but for car owners as well. Thus, bicycle-friendly cities can moderate the ongoing growth of car use in the future. In many developing countries the real challenge is indeed to prevent a massive shift from sustainable (and non motorised) modes of transport to unsustainable private cars and motorised two-wheelers, and to sustain the present high levels of active transport. (Rather than to expect a large shift from cars to cycling.) The optimal level of bicycle use to maximize its contribution to society’s social, economical and environmental performance implies a different (and more optimal) balance between cycling, walking and public transport (including minibuses and taxis): increased levels of bicycle use will be at the cost of the modal shares of (mainly) walking and public transport. The impact on the modal share of car use in many developing countries will be mainly on their *future* shares: the modal share of private car traffic will grow less than forecasted.

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<sup>2</sup> The price of a new bicycle in India is about 1/10 of the price of a motorised two-wheeler. Upon that a bicycle has very low running costs, which are confined to maintenance only, whereas motorcycles also have costs for fuel and higher maintenance costs.



Yet the position of motorized travel will strongly affect the quality of cycling and walking in the *'traffic market'*. The quality of cycle and walking trips in terms of safety, directness and comfort declines as the volume of cars using the same road space increases. Moreover, politicians and traffic engineers have developed a strong bias in favour of motorized traffic, which limits their ability to fairly assess the needs of non-motorized traffic.

“In surveys done in relatively affluent and fast modernising cities like Delhi, it has been found that even now 60 per cent of the people commute by buses, which occupy less than 7 per cent of the road space, while cars which crowd over 75 per cent of the roads, transport only 20 per cent of the people. In other words, in these cities, the car has not *replaced* the bus or the bicycle it has only *marginalized* them; *crowded them out*.”<sup>3</sup>

This appears to be true often even more in countries with relatively low car ownership levels. Ironically, in their wish to become ‘modern’ they stick to old-fashioned car-oriented road designs. But a strategy to genuinely promote cycling will also affect the service and space available to motorized transport modes, although assigning some road space to segregated bicycle facilities may improve flows of motorized traffic, contributing to a more efficient use of the available road space.

### 3.4 Aims of an urban bicycle strategy

Politicians and policy makers may have different strategic or tactical reasons for adopting a bicycle policy. These considerations and objectives should be reflected in strategy components. It helps to identify clearly which of the many possible benefits of pro-bicycle policies most interest the specific politicians and policy maker in a given city.

- Simply giving cycling (and non-motorized transport in general) its fair share of the road. The simple fact that a part of the population uses bicycles is justification enough to provide for their needs. The larger cycling’s share within the modal split, the more convincing this reason. (The same argument may be used for good and proper pedestrian facilities.)
- Improving road safety: cyclists may constitute a disproportionate share of road casualties. Another factor is the *perception* of safety: chaotic traffic situations at high speeds, where drivers are paying little attention to cyclists and pedestrians may discourage cycling because it is perceived as too dangerous. The first aim is to decrease the number of cyclists injured or killed in traffic, and not necessarily to increase the number of cyclists. However, the higher cycling’s mode share, the lower the risks per distance cycled. Moreover, many measures to improve the cyclists’ safety will improve that of other road users too.<sup>4</sup>

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<sup>3</sup> CSE - Centre for Science and Environment, India. Fortnightly News Bulletin [October 12, 2006] Editorial: Urban growth model needs reality check, by Sunita Narain

<sup>4</sup> Wittink, Roelof.: Planning for cycling supports road safety, p 172-188 in: Sustainable Transport, Planning for walking and cycling in urban environments, edited by Rodney Tolley, Cambridge, England, 2003

- Offering (affordable) transport options to certain parts of the population, thus enabling them to participate more fully in social life and access education and jobs. Access to transport is increasingly a precondition for social participation, particularly where land use patterns and economic up scaling stretch distances between homes and work places, schools and shops. For much of the population, cars or public transport are not viable options. The main target is to expand travel options. The option of cycling is added to those already available.
- Improving liveability by enhancing the quality of public space. The massive use of private cars has a huge impact on the quality of the public domain. In the last century no single phenomenon has impacted on our cities as much as motorisation has. The (excessive) presence of cars is often incompatible with other uses of public space, even where that space is used by other modes of transport or for other purposes. Just hanging around, meeting people, street selling, children's play are traditional activities that are being squeezed out of existing public spaces. Creating a road environment that is pleasant for walking and cycling may also contribute to restoring traditional qualities of public space. This can improve the conditions for social inclusion, providing disadvantaged groups with *dignified public space*. 'Reclaiming streets' could be the right slogan for this approach.<sup>5</sup> The increasing interest for cycling from mayors of metropolitan cities around the world (Bogotá, Mexico City, Rio de Janeiro, Cape Town, Delhi, Pune) is related to their aim to make their cities more liveable and attractive.
- Solving problems in the urban traffic and transport system. Making suitable provision for cycling can be an effective instrument for traffic management. Just having dedicated facilities for cyclists makes urban arterials more efficient, because separation of motorized and non-motorized modes produces more homogeneous flows.
- Responding to lack of space: Moreover, many cities simply don't have enough space for the current number of motorists, producing congestion, pollution and noise. Congestion may threaten access to important destinations and hurt economic development and liveability. If the intention is to solve this kind of traffic and transport problem, cycling can contribute as bike trips can replace car trips, in cases where cycling is a realistic option, particularly shorter and/or less strenuous journeys. A bicycle strategy of this nature will not only promote the use of (space-efficient) bicycles by everyone, but also discourage the use of (space-consuming) private cars in those situations where excessive car use is causing problems like congestion and reduced liveability. (Or to phrase it more positively: such policies will also promote selective car use.) Such a strategy will be more effective when based on an integrated vision of where the different modes fit well into the urban context and specifically where cycling and public transport can complement each other.
- Contributing to traffic management: bicycle policies can help to impose order on a chaotic traffic situation where modes mingle, hampering each other's passage. For countries where car use is just emerging as an issue, the prime

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<sup>5</sup> Peñalosa, Enrique: A Healthier and Happier City, p. 10-11 in: Environment Matters 2005, The World Bank Group.

interest may not be discouraging car use, but providing fairly for existing bicycle use and to prevent motorized traffic from pushing bicycles off roads. The implementation of designated bicycle facilities may help to preserve cycling as a full-fledged transport mode, and optimize motorized traffic flows. In Delhi, this appears to be an important consideration for building bicycle paths.

A mixture of the above considerations, with emphasis varying, often motivates politicians and policy makers. This may result in their readiness to formulate a more or less comprehensive bicycle strategy. Each consideration defines to a certain level the impact of the strategy on other transport modes. Some of these considerations may imply more or less drastic limitations on car use. Others may lead governments to prefer investing in cycling over, or in combination with, public transport. The more bicycle strategy is an integral part of overall transport planning, the more effective it will be.

An important aspect of any political decision about transport planning is that choices have to be made. It is not possible to make the system perfect for all modes, and it is certainly not possible to do everything at the same time. If politicians recognize that promoting cycling is profitable for society, and in fact could be a very cost-effective way of solving certain problems, this will imply a certain (re-)allocation of transport budgets. This is even more so in the poorer countries in the world. It is obvious that the benefits of a car-oriented transport policy will go mainly to the wealthy minority, whereas non-motorized transport policy will potentially benefit the large majority.



## 4 Cycling, accessibility and road safety

### 4.1 Introduction

The primary purpose of transport is getting (individuals and/or goods) somewhere (the result of transport on the 'travel market'). Therefore transport's contribution to accessibility is its main benefit. When discussing the overall performance of the transport system the main indicator for the benefits of transport would be the quality of the accessibility of destinations people want to travel to. And subsequently one should assess against which costs have to be put against these benefits. Traffic accidents and their effects should be labelled as 'costs'. So improving road safety is basically decreasing (a certain type of) costs of the transport system. Now the question is: can the promotion of cycling help to increase the benefits of the transport system (getting more people at their desired destination) and at the same time help to decrease the costs by contributing to an improved road safety. Similarly emissions should be seen as costs, and any measure to reduce emissions of transport is a decrease of those costs as well.

In summary: The performance of the transport system should be judged by:

- The benefits: maximizing the accessibility in order to facilitate participation in activities for all, fully including low-income groups  
A poor accessibility for certain groups diminishes their possibilities to find suitable work, education, restricts their social life, and impedes social cohesion for society as a whole.
- The costs: minimizing the resulting adverse effect of transport on society as a whole, especially road (un) safety, and the impact on the environment and climate change.

### 4.2 Accessibility

Accessibility is essentially a quality of locations, and this quality is highly dependent from how the location is situated in relation to the transport system and its functioning. In other words: changing the (quality of) the transport system may well change the accessibility of (a certain number of) locations.

The quality of the accessibility of a certain location is inversely proportional to the amount of time, money and effort that it takes from users to travel from their origin to the location (and back) for the purpose of their activities at that location.<sup>6</sup>

In developing countries the characteristics of travel and transport differ from those in, for example, the USA and Europe. This is an important consideration when using the theory of the travel markets. Obvious differences in travel patterns exist, for instance in the large share of walking trips as the main mode (in Africa it can be 60 percent in commuting between peripheral habitat and CBD). This is fortified because people have no choice for other transport modes;

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<sup>6</sup> Korte Afstanden Grootste Kansen, Werkgroep Bereikbaarheid, Strategische Agenda Milieu, Economie en Ruimte, 's-Hertogenbosch, 2003

there is a dominance of captivity in walking (and cycling). The high share of walking (and to a lesser extent cycling) is not problematic as such, but because of the fact that it is a result of a lack of choices rather than the consequence of an attractive walking and cycling environment in which people choose to do so. In their vision of accessibility Arora and Tiwari (2007) developed indicators that fit specific circumstances in developing countries. They use the 'origin oriented' definition of accessibility, being determined by the proximity of destinations and (or: in combination with) the facilities offered by the transport system to reach them. It should be noted here explicitly that 'proximity' should be understood as 'the distance to be travelled' which is often much more than the Euclidian distance 'as the crow flies'. In this perspective an urban arterial which constitutes a barrier for pedestrians and cyclists in the transversal direction is decreasing the proximity of destinations at the other side of this arterial/barrier. For public transport for instance the indicator is a combination of the walking distance to the bus stop and the time gap between two successive buses.

In search for an increase of prosperity poor people in developing countries cause a continuous influx of new customers in transport / travel market: immigrants into the urban economy and migrants within the city (evicted slum dwellers or voluntary migrants to better habitats in the urban periphery).

In terms of modal choice, the majority of the trips are being undertaken by sustainable modes: public transport, cycling or walking. For the future, this creates an opportunity: these modes should be defended, by transforming this choice from a captive one to a free choice for at least a substantial part of all trips when the alternative for private motorized vehicle use has arrived.

Planning for cycling should be aiming at bringing more destinations within cycling distance. This implies a network of bicycle connections providing short, direct routes with a minimum of delays between origin and destination areas. Additionally cycling should be developed and fostered as a feeder mode for public transport. This requires that public transport stops are well connected to the cycling route network and offer good facilities for a smooth transfer between bicycle and public transport, e.g. by offering well located and secure bicycle parking facilities.

### **4.3 Road safety**

Cyclists are vulnerable road users. And in many countries road conditions are endangering cyclists. Paradoxically the risk of cycling for an individual appears to be more or less inversely proportional to the number of cyclists. This is referred to as the 'safety by numbers' effect. In countries with higher levels of bicycle use the risk for the cycling individual is much lower compared to countries with lower levels of bicycle use. One can look at this phenomenon from two angles. On one hand more cyclists will have a positive effect on the awareness of car drivers that cyclists are on the road, and subsequently they drive more attentive. But another explanation is that cycling would not increase if circumstances weren't safe. In any case it is clear that, in any cycling related policy, road safety has to be an issue.

The question is not only how to plan for safe cycling, but also how to assess the impact of other transport developments (policies, road investments, mobility trends, et cetera) on cyclists' safety.

The overall goal of road safety policies is to minimise the overall number of serious accidents, and more specifically the number of killed and injured road users. Thus the question is how to organise the (urban) transport system as a whole to minimise the total number of casualties. One could argue that, for this purpose, most risky modes of transport should be discouraged. But here immediately there is a dilemma: what do we consider to be 'risky'? Do we mean those road users at risk, or do we mean those road users putting others at risk, causing the dangers on the road?

### Basic principles

In a physical sense the dangers of the road are caused by the potential energy that is the product of the speed and mass of road users and their vehicles in combination with the likelihood of collisions. So fast riding cars and trucks are much more dangerous, are causing much more risks than a pedestrian or a cyclist. And reasoning from this it is also clear that simply accommodating the continuous increase of car use will not contribute to the improvement of road safety. It is just adding potentially dangerous road users to the transport system. So from a road safety perspective the increase of motorised traffic should go together with deliberate measures to protect the vulnerable road users.

The risk for an individual is the product of the chance to be involved in an accident and the impact of the accident. From the basic observation that mass, speed and the likelihood of collisions are key elements for controlling the level of safety, we can directly formulate a few key principles to improve road safety:

- Lower speeds both result in fewer accidents and in lower impacts of the remaining accidents; therefore speed control as a general principle is imperative.
- High speeds are only acceptable when the likelihood of collisions is minimised; therefore large flows (if desirable or inevitable) should be homogenised (with regards to direction, speed and vulnerability).

The enhancement of the safety of cyclists (and pedestrians) boils down into two complementary principles to be applied in transport planning and road design:

- Segregated facilities (by means of paths, underpasses and overpasses) should be applied where speeds and/or volumes of motorized traffic cannot or should not be reduced.
- Where segregation is undesirable or unfeasible, speed reduction (by physical measures) is necessary whenever different traffic modes share the same infrastructure.

Additionally there is a third principle:

- Simplifying manoeuvres and creating more time to avoid collisions is helpful where traffic modes inevitably meet each other, making it easier to deal with conditions and reduce the severity of conflicts and collisions. This again implies effective speed reduction at these sites.

#### 4.4 A comprehensive approach

Sustaining and promoting the use of bicycles requires an improvement of the competitive position of cycling towards the competitive position of other modes. This can be done two ways: cycling can be made more attractive and other modes can be made less attractive. This goes back to 'planning for the optimal mix' as explained in paragraph 3.1. So promoting bicycle use is an integral part of overall transport planning with consequences for other modes as well.

Infrastructural provision for cycling should meet 5 main quality requirements<sup>7</sup>:

- 1 Coherence: cycling infrastructure should be coherent, i.e. it should provide a complete network of cyclable roads connecting all origins and destinations, offering consistent, recognizable and continuous quality.
- 2 Directness: the infrastructure should allow for direct cycling routes , minimizing detours and delay;
- 3 Safety: road conditions should be safe for cycling either by preventing conflicts with motorized traffic and/or by moderating these conflicts so as to ensure these conflicts don't cause serious injuries or worse.
- 4 Comfort: the physical and mental burden of cycling shouldn't cause too much stress. So no needless energy consuming stops, comfortable urb radiuses, enough width for comfortable manoeuvring, and avoidance of too complicated traffic situations;
- 5 Attractiveness: Cyclists prefer an attractive and agreeable environment, offering enough variety. The quality of attractiveness should include a sufficient level of social security, i.e. sufficient supervision and overview.

These requirements have implications at all levels of infrastructural design: the network, road sections and intersections and road surface.

In a proper promotion of cycling, infrastructural provisions go together with the availability of cycling related services. These include the provision of bicycle parking facilities, both in living areas and in destination areas, enough possibilities for bicycle repair and maintenance, restrooms and showers at offices, and the like. Also a good integration with the public transport system can substantially increase the usefulness of cycling. Such an integration implies the use of bicycles for feeder trips, and requires a smooth transfer from the bicycle ride to public transport by either offering safe bicycle parking facilities or the possibility to take one's bicycle onto the public transport vehicle.

Cycling promotion is more than only providing the proper infrastructure and services. The question about whether individuals consider cycling as a realistic option will be answered differently by different people. Often, the answer is not an objective matter, but rather depends on knowledge and perceptions. Therefore, a bicycle promotion strategy should not only deal with the physical road environment to make that road environment suitable for cycling, it should also pay attention to people's views of how feasible cycling is as a travel option. Perceptions are influenced by road safety, costs and savings, travel times,

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<sup>7</sup> CROW Record 10, Sign up for the bike, Design manual for cycle-friendly infrastructure, Ede, 1993



suitability of weather conditions, and so on. These perceptions also have strong cultural components, involving opinions about what constitutes decent behaviour, or the perception of the status of cycling. Perception, however, is not necessarily based on fact. Sometimes people simply don't know that cycling could be an option for them: cycling may in reality be less difficult, less dangerous, faster and more practical than many people suspect. Civil society organisations can play an important role in correcting perceptions. Social marketing instruments and involving (potential) cyclists in the planning process can also help a lot.

Summarising: To fully utilise the potential of cycling for improving accessibility and road safety, and for reducing pollutant emissions, a comprehensive approach is needed. Cycling planning is not an add on to the existing transport system, but should be planned as an integral part of it. Upon that appropriate services need to be available. Upon that communication with stakeholders and social marketing can help to change negative or indifferent attitudes to a more positive mentality.



# 5 Co-benefits of cycling

## 5.1 Introduction

The primary benefit of any mode of transport, including cycling, is to move an individual or good safe and efficiently to its' desired activity at the destination location. But there can be additional benefits not directly related to providing accessibility, i.e. co-benefits . Cycling has many co-benefits. Co-benefits can be grouped into benefits of improving the performance of the transport system at large and its' contribution to economic development, as well as in benefits that decrease the adverse effects of transport. In this chapter, we will discuss those co-benefits of cycling that are exclusive to cycling as a mode of transport.

## 5.2 Better performance of the transport system

### 5.2.1 Improved accessibility by cycling as a single mode

As explained in the previous paragraph, the provision of mobility, accessibility is the main general benefit of transport. Transport is a derived demand, which is supported by the transport system. Transport allows people to be engaged in activities, such as being at work, education, shopping, visiting hospital etc.

In this respect an important benefit of cycling is in the provision of an affordable (in terms of low cost) accessibility to those parts of the population that have no other options than walking or cycling. Compared to walking, cycling can enlarge an individual's radius of action within a given travel time budget with a factor 3 to 4 thus covering an area which is 9 to 16 times larger.

Also compared to public transport cycling (as a single mode) has a number of advantages: cycling is offering an individual mode of transport which is much more flexible than the public transport systems. Cycling can provide access to virtually any individual address as it has a high 'penetration ability', whereas most public transport systems are confined to certain routes. Also with regards to the time of travelling cycling is much more flexible as public transport has to operate within fixed time tables. The consequence is that cycling is much more efficient for shorter trips than public transport. This is even more so if we look at door-to-door connectivity. As public transport requires access and egress trips (or feeder trips), the travel time door-to-door is longer than the travel time of the public transport ride. The shorter the trip, the larger on average is the feeder trip component of the total travel time. As the majority of trips in urban areas are short trips, cycling could easily become the preferred mode if cycling conditions were more attractive.

The main advantage of cycling is that this mode of transport can be used by all social classes, and thus contributes to accessibility in a very equitable manner. Especially the urban poor, often living in the cities' peripheries, can get involved in the urban economy again if they can access the major locations by bicycle. Accommodating cycling through the provision of more cycling friendly road conditions doesn't harm or exclude anyone. The contrary, exclusive cycling facilities can also benefit other road users, by allowing for more efficient traffic flows, less conflict situation (mainly because of speed differences), as such contribute to traffic safety. Thus public spending on cycling facilities is (in principle) beneficiary for all parts of the population.

### 5.2.2 Contributing to a better performance of public transport

In the previous paragraph we assessed the benefits of cycling as a single mode also comparing it with public transport for those categories of trips where they are competing modes (mainly on short urban trips). In this paragraph we explain how, for longer trips, cycling can complement public transport. Making a strength/weakness analysis of both cycling and public transport, one can easily see that both modes are very complementary in their characteristics. Where cycling is superior in providing access to destinations on short distances, its weakness is its limited radius of action. Public transport on the other hand is very efficient when it comes to carrying large numbers of peoples over longer distances. Public transport travel times for those trips can become competitive as long as the feeder trip component of the total travel time door to door remains below a certain ratio. This 'feeder trip component' includes both the access and the egress trip, and is supposed to be 'acceptable' as long as the travelling individual will perceive it as a minor part of the total trip. For public transport in general 'walking' is the most 'used' feeder mode. Potentially 'cycling' can contribute to an improved ratio between feeder trip time and public transport trip time if cycling can be promoted as a feeder mode. As cycling can be 3 to 4 times faster than walking, the catchment area of public transport stops thus can become 9 to 16 times larger. If used intelligently one can build an integrated 'cycling and public transport' system, utilising the strengths of both cycling and public transport, and offering better options for their weaknesses. Such an integrated transport system would optimise both the public transport route network and the (more local) cycling route networks. The latter should be optimally connected to the important public transport stations (or 'stops'), and these stations should offer the proper services for a seamless transfer between the two modes (specifically secure bicycle parking facilities).

### 5.2.3 Countering congestion

The efficiency of the urban transport system is badly undermined by congestion problems in urban areas. As a consequence the average speed of car traffic in (certain parts of) cities is often below 15 km/h. From the experience in developed countries we know that just building new roads to make room for more cars doesn't solve this problem. The promotion of bicycle use can help here along two lines:

Firstly attractive cycling conditions will help to moderate (or at least delay) peoples aspirations to own and use cars, and thus have a moderating effect on the growth of the congestion problems. Secondly existing car users can be tempted to substitute a part of their trips by cycling trips. If cars would only be used for those trips for which a car is indispensable, most if not all congestion problems would be solved. From the previous paragraph we can also conclude that the combined use of bicycles and public transport offers even more possibilities to substitute car trips by more 'space efficient' modes. As congestion is the result of exceeding the capacity of the road system above a certain 'end point' or 'limit value', only a small modal shift from cars to more space efficient modes can sometimes already be enough to solve the problem.

But to utilise this potential co-benefit of bicycle use, it is obligatory to improve the competitive position of cycling (in combination with public transport) substantially.

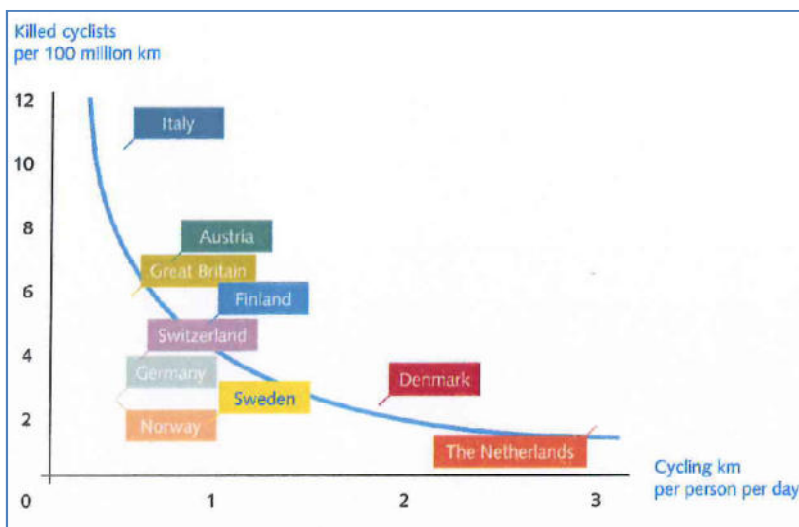
### 5.3 Minimising adverse effects of the transport system

#### 5.3.1 Improving road safety

Road accidents are to be seen as unintended adverse effects of the way society has organised the transport system, and should consequently be labelled as 'costs'. Improving road safety is therefore a 'saving'.

The consequences of cycling promotion for road safety have been discussed from different angles. Many have argued that cyclists are vulnerable road users, and subsequently concluded that promoting the use of bicycles would be detrimental for road safety. We cannot simply deny this argument: without changing the cycling conditions and with only a marginal increase of bicycle use the argument would be true. Therefore from a moral point of view the promotion of cycling should go hand in hand with improving cyclists' road safety. Yet the argument is only a part of the story. Cyclists are not causing the dangers on the road, but are rather the victims. The real cause of serious road accidents is in the number and the speed of motor vehicles, and thus an increase of car use would also be detrimental for road safety if no mitigating measures were taken.

So if we label 'improving road safety' as a co-benefit of cycling promotion, then what is the basis for this? And what are the conditions to receive these benefits? Again there are several lines of thinking. Firstly it is almost inconceivable that cycling promotion can be successful without improving cyclists' safety, as for many people lack of road safety is the main impediment for cycling more often. Thus 'cycling promotion' and 'improving road safety' can result in a self-reinforcing interaction of these two policies. Another reinforcing mechanism is the so-called 'safety by numbers' effect.



Figuur 7 More cyclists, lower risks, the relation between accidents and bicycle usage. (From 'Cycling in the Netherlands, Ministry of Transport, Public Works and Water management, 2009.)

Experiences in developed countries show that an increase of cycling is going together with a decrease of risks for the individual cyclist. Apart from the obvious combination of cycling promotion and improving road safety this is explained by the presumption that fellow road users will better adapt their road behaviour to the presence of cyclists when there are more of them on the road. The implication of this mechanism is that the gains of increased cycling with regards to road safety are only to be received when the increase is beyond a certain critical mass.

It may be interesting to compare road safety risks of cyclists and motorised two-wheelers. The table below presents the annual fatality rate (number of recorded death per billion kilometres travelled) for riders and passengers of bicycles and motorised two-wheelers per age category over the period 1999 to 2007 in the Netherlands (Source: Statistics Netherlands and the Netherlands Ministry of Transport, Public Works and Water Management). Of course these figures reflect the typical Dutch context in which cycling is rather safe compared to many other countries. Nevertheless differences in risk are striking.

Mode of transport (riders and passengers)	0-17 years	15-17 years	18-29 years	30-39 years	40-49 years	50-59 years	60+ years
Cyclists	9	--	7	5	6	10	45
Moped and light moped riders	--	87	64	50	37	60	302
Motorcycle and scooter riders	--	--	133	72	50	58	68

### 5.3.2 Making cities more attractive

The impact of the introduction of motorised transport on cities can hardly be overestimated. It has changed many cities around the world into urban structures rather to accommodate vehicular traffic than living people. Street life is banned to the edges or to isolated shopping malls. The freedom of movement of non motorised road users has seriously decreased. Children are amongst the groups that have suffered most of this at the cost of their scope to develop themselves as independent citizens.

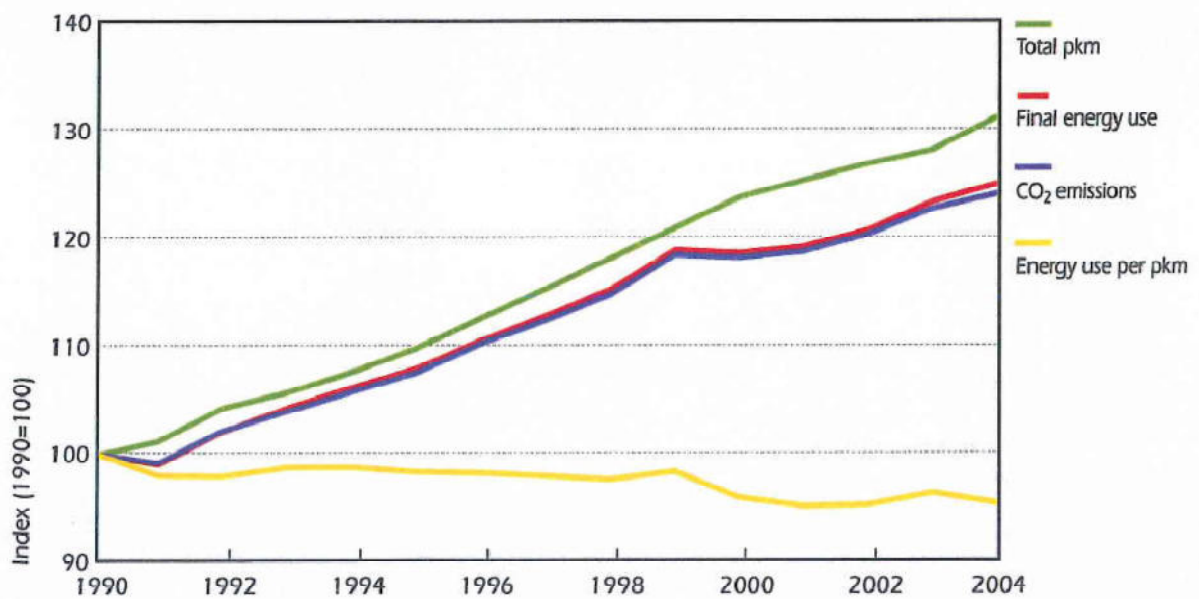
The promotion of cycling can help in a paradigm shift from vehicle oriented to people oriented transport planning. It can reintroduce the human scale in road design. And as a coherent network of cycling routes is one of the conditions for successful cycling promotion, it can help to overcome the severance effect of urban highways by a change in priorities. As a consequence of increased cycling the dominance of motorised traffic in the 'townscape' will be moderated.

### 5.3.3 Improving air quality and mitigation of climate change

Transport with its emissions is amongst the substantive contributors to both air quality problems (like SO<sub>2</sub>, NO<sub>x</sub>, PM) and the climate problem (CO<sub>2</sub>). Most problematic in this respect is that transport is a fast growing source of these

problematic emissions. Needless to say that it are the motorised modes of transport causing these emissions. And although much effort is being put in technical improvements of motor vehicles and cleaner fuels, the problem is that the gain of these improvements are immediately undone by the increase in the use of motorised vehicles.

Especially the CO<sub>2</sub>-emissions of transport are problematic, as these are almost completely proportional to the amount of motor vehicle kms made. Serious reductions of CO<sub>2</sub>-emissions by the transport sector requires therefore a decrease of the number of motorised vehicle kms.



Figuur 8 Overview of key trends in passenger transport (IEA, Energy Use in the New Millennium: Trends in IEA Countries, 2007)

Relevant in this respect are the observations of the Partnership on Sustainable Low Carbon Transport (SLOCAT)<sup>8</sup>, established to provide opportunities for coordination and cooperation among organizations working on sustainable, low carbon transport. In their documents, the partnership presents the following conclusions:

- Transport in developing countries is the one of the largest, and fastest growing, source of GHG emissions. Transport related CO<sub>2</sub> emissions are expected to increase 57% worldwide in the period 2005 – 2030, and it is estimated that transport (passenger and freight) in developing countries will contribute about 80 percent of this increase. However, most of the current GHG emissions in the transport sector and virtually all the expected growth in emissions of land transport will come from private cars, light duty vehicles and trucks.

<sup>8</sup> <http://www.slocatpartnership>

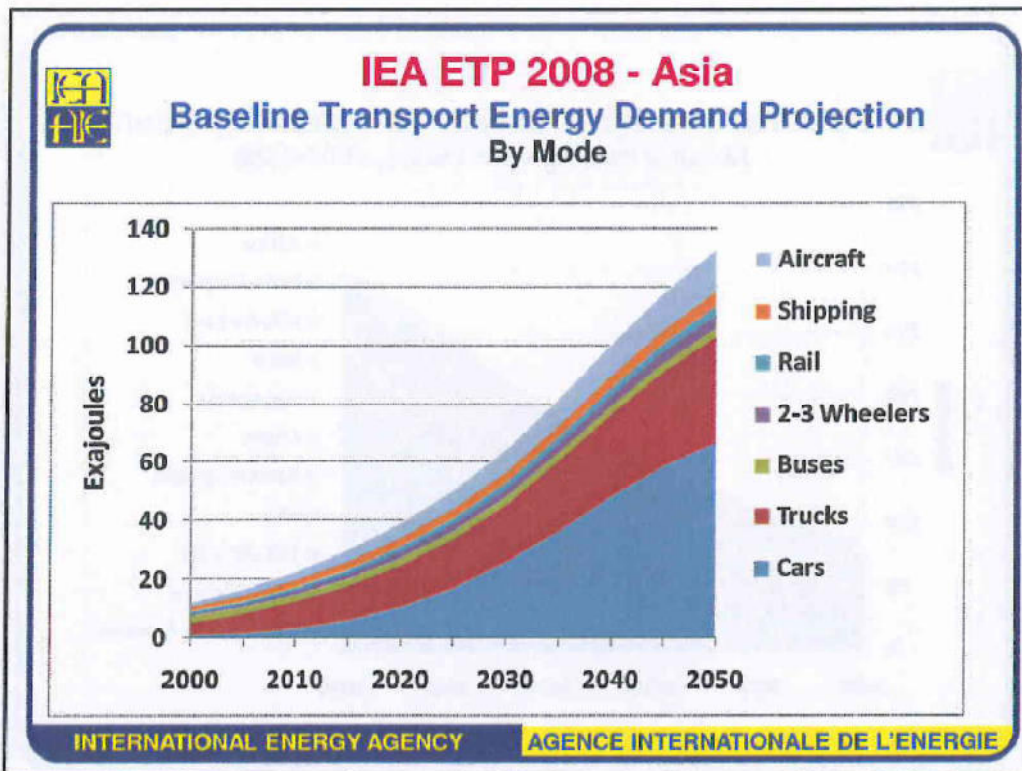


Figure 9 Illustrative slide from a presentation of Lew Felton (IEA) at the BAQ Workshop in Bangkok in 2008

- Growing GHG emissions from the transport sector in developing countries are inextricably linked to an overall lack of sustainability expressed by poor urban planning, increased motorization, increased air pollution and noise, growing congestion and decreasing road safety. A reduction of GHG emissions from transport can therefore only succeed through an integrated approach to sustainable transport systems and managed urban development.
- Technological improvements by themselves will not be enough for the transport sector to make a significant contribution to mitigation of GHG; a sector wide re-orientation to low carbon sustainable transport is required which combines policies and measures to (a) avoid/reduce the need for travel, (b) shifts to, or keeps transport at the most efficient mode, and (c) improves efficiency of motorized modes of transport.
- Developing countries should seize the opportunity to make their transport systems and infrastructure low carbon and more sustainable through a combination of: increased public awareness, low-carbon, sustainable transport policies, supportive policy instruments, institutional capacity development, appropriate pricing mechanisms and mobilization of financial resources.

Cycling is a zero emission mode of transport. Potentially cycling trips can substitute a large percentage of short urban trips by private motor vehicles. A considerable amount of motorised urban trips is within the range of cyclable distances. These short motorised urban trips are also the most polluting ones



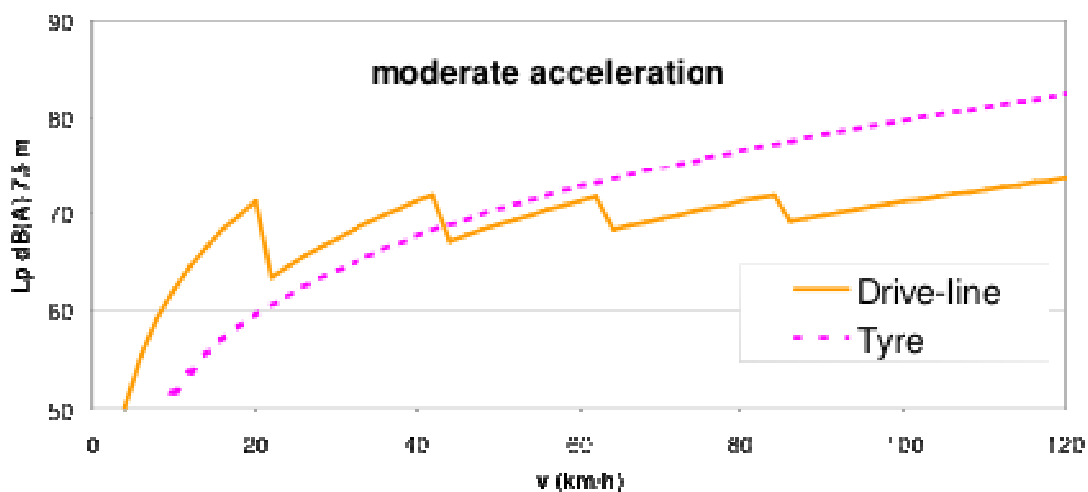
because of the stop-and-go character of these trips with relatively cold engines. This substitution of private car trips by cycling is very relevant for developed countries.

For developing countries the relevance of cycling is also that promotion of cycling can help to prevent a shift to private motorised modes. The gains of cycling promotion should be measured against the expected trends in transport in a business as usual scenario.

If this potential of cycling to contribute to a decrease of existing emissions and the prevention of (the growth of) future emissions is to be utilised, it is essential that cycling is perceived as an attractive, efficient, safe and convenient mode of transport. This co-benefit can only be harvested if the primary benefit (improved accessibility) is guaranteed. Individuals will not cycle primarily for the sake of the environment, but because its efficiency as a mode of transport for reaching their desired activity locations.

### 5.3.4 Noise reduction

Transport is also the cause of the noisy environment in large parts of our cities. The noise of traffic is a combination of the noise of the engines in the motor vehicles and the interaction between tyre and road surface. Both are correlating with driving speed, as the diagram shows. At higher speeds the sound of the tyres on the road surface is dominating the sound of the engine.



Figur 10 Example of the relation between drive-line noise and the tyre/road surface noise of a moderate accelerating gasoline car on an asphalt pavement (Kortbeek et al., 2000)

These noises are often an impediment for social interaction in the public domain, and the cause of stress, disturbed night's rest and subsequently a number of health problems. Again it is clear that motorised transport is the main cause of this noise. Noise related problems can, to a certain extent, be countered by 'silent' road surfaces, sound barriers and also by technical improvements on motor vehicles like a shift to electric engines. All these solutions have their restrictions and limitations and cannot be applied everywhere. Therefore it remains worthwhile to prevent the problem by

promotion of the use of non motorised modes of transport like cycling in sensitive urban areas (residential areas, school environment, hospital environment, city centres). To utilise the potential of cycling for noise reduction cycling promotion only is not enough. Noise reduction through changes in the modal composition of the traffic flows requires also dedicated measures to discourage and restrict car use in the areas concerned.

### **5.3.5 Improved physical health**

One of the (many) downsides of motorised transport is its enhancing of a sedentary lifestyle, with detrimental effects for individual and public health. More physical exercise is recognised as beneficial for countering many so called 'diseases of civilisation'.<sup>9</sup> But for many individuals it appears a too large appeal on their discipline to build in exercise as a specific activity in their activity pattern. To promote the integration of daily exercise into daily mobility patterns is therefore a very promising strategy for improving health. The required (minimum) level of daily exercise (20 to 30 minutes moderate exercise) equals an average cycling commuter trip. Cycling commuters appear to have (on average) a substantial better physical health than commuters using other modes.

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<sup>9</sup> <http://www.sustrans.org.uk/what-we-do/active-travel/139/the-evidence/physical-activity-and-health>

## 6 Appropriate indicators to assess the impact of cycling inclusive policies

### 6.1 Introduction

Investments for cycling have to compete with other road investments. Therefore decision makers, be it politicians, donors or funding institutions like development banks, have to be convinced that these investments are worthwhile. The implication is that the indicators used to assess project plans, should allow to show the added value of investments in cycling. Indicators always reflect the dominant paradigms and values of those working with them. So there is a need to review the indicator used to assess the performance of the transport system at the various levels of performance to check whether the positive contributions of cycling to accessibility and road safety is properly valued.

### 6.2 Accessibility indicators

To assess the quality of accessibility usually the following mobility indicators are used:

- 1 Average speeds: LOS (Level Of Service) is defined using average speed of motorised vehicles, or volume-over-capacity levels. Private vehicles(cars, motor cycles) are not differentiated from buses. NMVs( bicycles and pedestrians) are completely ignored.
- 2 Average/max flow: Number of vehicles/hour, capacity of a facility is defined using vehicles/hour. Focus is on vehicles rather than moving people.
- 3 Average delay/vehicles, maximum delay/vehicle is used to define LOS for intersection. Focus is on vehicles and not movement of persons.
- 4 Average queue length and maximum queue length is used for intersection LOS. Focus is on motorised vehicles( public and private combined).
- 5 Average delay/person, maximum delay/person is used for pedestrian LOS at intersection.

It is clear that these indicators are based on the belief that transport is synonymous with motorised transport. Moreover, none of these indicators is reflecting the notion that accessibility is basically a quality of specific locations, and has to be differentiated according to the various modes of travelling. E.g. locations can be well accessible for public transport users but less accessible for private cars, or the other way around. Similarly locations can be more or less accessible for pedestrians and cyclists.

When assessing the impact of interventions in the transport on accessibility we have to look at the impact on the accessibility of all relevant locations at an aggregated level. For this we can use two perspectives:

#### 1. Destination oriented perspective

Accessibility can be defined as the amount of people that can reach a certain location within a certain time (catchments area of the destination). Our proposed indicator for this is: *Average number of different types of destinations (employment places, schools, shops, sports centres et cetera)*

*within reach for persons living in a specific area given the actual access<sup>10</sup> to transport modes, based on travel times of respectively 15 minutes, 30 minutes, 45 minutes and 60 minutes.*

## 2. Origin oriented perspective

Accessibility can be defined as the number of destinations (jobs, education, healthcare, public services) that are in reach within a certain time (radius of action of an individual). If we choose this perspective the proposed indicator is: *Size and number of inhabitants of catchment area of relevant (clusters of) destinations based on travel times of 15, 30, 45 and 60 minutes specified for the various modes of transport.*

The advantage of these indicators are that they allow much better to assess who are the 'winners' and the 'losers' of road investments in terms of improved or deteriorated accessibility. Improving access for motorised vehicles may be well at the cost of access for pedestrians and cyclists; urban highways may cut off existing cycling and walking connections, forcing them to make detours. These indicators take rather people as point of departure than vehicles (as often is done by transport planners who have developed a bias for motorised transport).

## 6.3 Road safety indicators

For the road safety performance of the transport system a variety of indicators is being used:

### 1 User Safety: fatality/injury risk per trip can be used. However, most common indicators are:

- fatality or injury/1 million passenger km travelled,
- fatality or injury/ 100,000 population
- fatality or injury /10,000 vehicles

Fatality/injury risk per trip can be disaggregated to

- risk during access trip,
- risk as occupant of the vehicle and
- risk imposed to other vehicles/users on the road

### 2 Vehicle Safety indicators: fatality or injury/10,000 vehicles traditionally estimated for motorised vehicles only. Disaggregated risk can be applied to this also.

### 3 Road Safety indicators: Current indicators are:

- fatality/injury/km,
- fatality or injury/passenger km
- fatality or injury/vehicle km

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<sup>10</sup> We note here that actual use of transport modes is – although not identical – a good indicator for actual access to transport modes. Actual use is not only the result of individual preferences, but also a consequence of individual disposable time and money.

The three categories mentioned resemble each other to a certain extent. The difference is the *perspective* at looking at the road safety problem. The *user safety indicator* shows the probability of accidents per trip to the user. As the chosen modes of transport might imply different risks for the user, an individual can be tempted to use a less risky mode. The *road safety indicator* is measuring the safety of the road system. This shows the probability of accidents per km of the road. Higher probability of accidents indicates that road system needs to be corrected. The *vehicle safety indicator* is used by the insurance companies. The probability of accidents /100,000 population is used as a public health indicator.

As to a large extent risks in traffic appear to be proportional with time spent in traffic, and as variations in time spent in traffic are much smaller than variations in distances travelled, the indicators measuring fatalities or injuries per distance travelled appear to have a bias that favour the performance of faster travel modes, i.e. the motorised modes. Thus slower modes (cycling and walking) seem to be disproportionately risky, even if we recognise their higher vulnerability. We also note that most indicators don't properly assess the risks imposed on other road users. The consequence of this is that improvements in the safety of cycling and walking seem to be less substantive if measured against the distance travelled. For a more fair assessment of improvements of road safety we therefore propose to base decision making more on people oriented indicators and less on vehicle sensitive indicators. We propose the following indicators:

1 Number of fatalities and serious injuries per 100,000 population

Additionally:

2 Number of fatalities and serious injuries for relevant NMT-groups per 100.000 motor vehicles

*Remark: The cause of an accident is a very unreliable element. Moreover it depends strongly on the locally current definition. In many cycle unfriendly countries it is normal to assume that the cyclist (or pedestrian) is guilty unless otherwise proven. Therefore we choose as an indicator the number of road victims per number of motor vehicles, as it is a measure of how dangerous motorised traffic is for other road users.*

3 Risk of being involved in an accident with MT.

Although we argue for another type of indicators to make decision making more people oriented and less vehicle oriented, it may well appear that we need the 'old' indicators to make the proper calculations on what we would want to know. So this is no plea to abandon certain types of data collection, which will remain useful. What we question is much more the implicit values that are attached to these data as basis for decision making.

## 6.4 Sustainability performance

Cycling is a zero emission mode and silent of transport. To which extent these qualities of cycling contribute to the solution of sustainability problems (air quality, climate change, liveability of cities) is dependent on the mobility choices of people. But when it comes to indicators we see an enormous emphasis on fuel and vehicle efficiency. This fits very well in the strategy to reduce existing emissions. These indicators however can hardly be used to measure and assess the effectiveness of prevention strategies. Cycling fits perfectly in a prevention strategy. Cycling mobility can be seen as a carbon sink, similar to a forest. If trees are cut or burnt it releases carbon captured in the forest. If cyclists would change to the use of public transport, motorcycles and Nanos it releases carbon emissions which can be attributed to the cycling practice as a carbon capture, similar to forests. And carbon captures need to be protected and preserved.

The UN forum on climate change (UNFCCC) issues a validation and verification manual for CDM projects, which provides the basis for transport calculation models and emission measurement of vehicles and fuels. But how to calculate in the case of cycling? One cannot measure emissions of bicycles that don't emit. Should we model a hypothetical situation in which the substituted emissions are measured of a multitude of public transport vehicles, motorcycles and cars to which the cyclists would flee if not provided with river bridges and separated cycling paths? This sounds ridiculous.

We cannot squeeze cyclists into a validation system for vehicles and fuels. What we need is a paradigm shift in the validation mechanisms, at least for transport projects. These need to become more people-oriented. The new paradigm should be that carbon emissions are defined by citizens making mobility choices; so climate strategies should not give credit for producing green engines and fuels but for enabling the citizens' choice for sustainable mobility: cycling integrated with efficient (also emission-efficient) public transit. Such climate paradigm coincides well with the widely accepted urban development thinking that we should build cities for people and not for cars.





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Interface for cycling expertise





