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Cycling-Inclusive Policy Development: A Handbook

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Cycling-Inclusive Policy Development: A Handbook

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Foreword

Riding a bicycle is common practice in The Netherlands. A bicycle is a very handy means of transport, especially in cities, but also outside urban areas. The Netherlands is a densely populated country so Dutch people make good use of bicycles. Cycling is cheap, environmentally friendly and does not cause parking problems. This way, we keep our cities livable and our problems manageable.

There is increasing international interest in the Dutch transport policy, because of the key role assigned to the bicycle and the management of car traffic in the cities. A transport policy primarily focused on cars will make cycling and walking too dangerous. Especially in developing countries this will lead to isolation and it will block the majority of the population's way to jobs, amenities and social activities. Additionally, traffic will become completely jammed up and this will have a dramatic effect on the environment.

The importance of good amenities for walking and cycling is being recognized more and more. Cycling and walking, together with high-quality public transport, form a sustainable traffic and transport system, which will influence poverty control, cost management, quality of life in cities, health and the environment.

As a Dutch Minister I am proud that our country is a role model for developing sustainable urban traffic and transport with an integral system of traffic amenities encompassing all modes of transport.

The high share of bicycles should not necessarily have to remain typically Dutch. Anywhere in the world, half of all urban commutes are relatively short, within cycling distance, regardless of the size of the urban area. That is the reason why a plan that includes cycles could also play an important and useful part in metropolitan cities. However, knowledge about relevant policy developments and about planning and designing a 'cycling-friendly' infrastructure is virtually non-existent in developing countries.

I-CE's Bicycle Partnership Program provides knowledge transfer about this subject. I-CE compiled this training manual with a group of experts who have made knowledge from the Dutch experiences applicable to development processes in Asia, Africa and Latin America. I trust this book will contribute to an integral vision on urban transport, where the limited focus on cars will be replaced by a cycling inclusive approach. Especially poor people will benefit from this.

Bert Koenders

Minister for Development Cooperation

The Netherlands

Introduction to readers

This handbook provides detailed information on how to develop cycling-friendly policies and facilities. It can help you, as a planner, engineer, community leader or advocate to enrich your own ideas about the future traffic and transport system where you live and work.

The key ideas behind this document are based on the creation of an integral plan, by offering you a revealing look at the crucial relationship between town planning and traffic and transport policy. Along the way, authors offer specific tools, methods, and related information. Above all, this handbook is written to inspire and empower you to achieve these objectives.

This handbook focuses on policy development rather than detailed design issues. It will teach you how to develop cycling-inclusive policies and develop a cycle plan for your city or town. It is designed to provide additional support for the training courses and workshops provided by its authors and the organisations involved and to accompany other manuals that focus on bicycle infrastructure planning and design, particularly the CROW manual (2007) on cycling-friendly urban design.

So this is *not* a design manual!! This handbook focuses on *how* to create the policies and the environment necessary to achieve the most in this field. Design manuals answer *what can be developed.* From the authors' perspective, such manuals should be embedded in local practices and legal frameworks. This is why the Bicycle Partnership Program from Interface for Cycling Expertise (I-CE) is working with local actors to draft regional manuals in Asia, Latin America and Africa. This document should enable policy makers to communicate better with planners, designers and citizens about how to set priorities when making difficult choices, and guide planners and engineers on how to think about policies and planning, when designing cycling-inclusive environments.

We intend you to use this handbook as a convenient and authoritative reference on specific topics, which you probably will not read from cover to cover. Because of this and the contributions from several authors, there is some occasional repetition of arguments and information. The participation of different authors also provides readers with sometimes slightly different views on cycling-inclusive urban transport. We consider this as an advantage as it enables the reader to develop his or her own views on the subject.

The first two chapters provide the background and challenges of urban transport in contemporary cities (primarily those in the developing world). Chapter 3 focuses on the relationship between land use and transport. Chapter 4 describes how to get started on the policy-making process and involving key stakeholders in transport policies and projects. Chapters 5 through 10 provide details on the requirements and design issues inherent in a cycling-inclusive project. Chapter 11 provides an overview of different options for integrating bicycles and public transport. Chapter 12 analyses different issues related to regulation of bicycles and their use, and Chapters 13 and 14 provide guidelines on how to include the population in terms of social marketing, citizen participation and education. Finally, Chapter 15 describes different methods of collecting information for a cycling-inclusive project. Thus, readers can "dip into" the chapters of their choice depending on their needs. The document also includes a detailed glossary with terms that are used throughout.

This handbook was initially based on a previous "Training Course on Non-motorized Transport" document, developed by GTZ and supported by other GTZ SUTP materials. Today, this project offers an expanding set of resources on sustainable urban transport, including: a Sourcebook on Sustainable Urban Transport for Policymakers in Developing Cities, a set of training documents (on Bus Rapid Transit Planning, Mass Transit, Bus Regulation and Planning, Public Awareness and Behaviour Change and Non-motorized Transport), and other resources which are constantly being updated and published in www.sutp.org.

This publication has also been made possible by financial support from the Bicycle Partnership Program BPP (from I-CE) and from the SUMA program (a partnership with the Clean Air Initiatives for Asian Cities). The BPP is supported by the Dutch Minister for Development Cooperation, the SUMA program is supported by the Asian Development Bank through a grant from Sida.

We hope you enjoy reading this handbook and that it will inspire you in your daily work. If you have any comment, criticism or suggestions for improvements to this handbook, please let us know.

The editors

Acknowledgments

The authors and editors would like to express our gratitude to the many individuals and organisations worldwide that contributed their work and knowledge to this handbook, which was initially based on the NMT training document by Walter Hook, issued and published by GTZ. Special thanks go to our expert reviewers: Dr Geetam Tiwari, IIT-TRIPP (Delhi, India); Jeroen Buis, I-CE (The Netherlands), and Dr Walter Hook, ITDP (New York, US). Their comments on earlier drafts led to many substantial improvements. Critical comments from Manfred Breithaupt to the draft final were most useful as well. Several institutions, city governments, researchers and photographers also gave permission to use their material (graphics, figures, photos, definitions) and we greatly appreciate their generosity (specific credits are used with the items themselves). We also thank Rodrigo Quijada (Santiago, Chile) for his comments and suggestions during final corrections. We are also thankful to Sida and ADB for their kind contribution to this project.

1. Introduction: learning from others' successes and failures

Hans de Jong and Anke Rouwette

We can learn as much from our failures as from our successes. In the case of urban and transport planning in European cities, many mistakes have been made, above all the tendency to facilitate unbridled use of the car, which has brought many unforeseen difficulties, particularly in terms of road safety and the harm it has done to quality of life. In many ways, this handbook is about positive responses to negative developments.

1.1 Urban transport planning: learning from the failure of the car-based city

Learning from the mistakes made by European and North American cities gives planners everywhere the chance to avoid problems that often block further changes today, allowing them to leapfrog beyond the so-called developed cities to address recent problems (heterogeneous mix of traffic, availability of motorized two wheelers and low marginal cost of using a two wheeler, plus contemporary issues such as climate change) more effectively.

Improving the share of daily commutes made by cycling and walking has been an uphill battle in many cities. Before World War Two, private cars played a limited role in city transport systems. In Amsterdam, cycling's share of total trips (car, moped and public transport) was 70%, versus 20% in Basel (Switzerland), with cities in Germany, Denmark and England somewhere in between. From 1950 on, as incomes soared so did car ownership.

Throughout the 1960s, cities responded consciously or unconsciously by facilitating motorized traffic, above all, cars. In some cities, highways invaded old city centres, with politicians, engineers and citizens treating this almost as a 'natural' development. Moreover, people assumed that as walking and cycling were replaced by cars and mopeds, road safety would improve. Instead, although the number of cyclists decreased, the number of fatal accidents amongst cyclists and pedestrians soared.

Figure 1
Cities in Europe are transforming transport and urban policies, offering useful lessons to all.
Photo by Carlosfelipe Pardo

The first pressure groups appeared, demanding that local and national politicians react. Fifty years later, in 2008, the American Institute for Highway Safety expressed the same erroneous hope for India: switching from cycling to driving was expected to improve road safety.

By the 1970s, cycling's share of daily commutes bottomed out, at 3% (Manchester, England) and 27% (Amsterdam). Quality of life went into a tailspin. Old city centres became less attractive to pedestrians who saw "their" sidewalks and parks taken over by moving and parked cars. City centre or central business district economies came under pressure from car-friendly shopping malls on the outskirts. Small shops could not compete, but malls were not in easy reach of most cyclists and pedestrians.

So city traffic and transport became increasingly car-centred. We began to create cities for cars, rather than people. In Europe, however, this decade saw people and pressure groups begin to oppose these developments. Awareness grew that road fatalities, environmental impacts and poor liveability of cities were too high a price for this so-called "progress".

Box 1: Sustainability: a key concept in this handbook

Sustainable society This term, coined by the Brundtland Commission, led by former Norwegian Prime Minister Gro Harlem Brundtland, defined sustainable development as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (see http://www.un.org/documents/ga/res/42/ares42-187.htm for the original report). In this sense, a sustainable society seeks to apply this principle to its current environmental capacity, social and economic needs, working to reinforce cycles of energy, materials and other elements, rather than models producing high levels of "waste" that then become dangerous pollutants of air, soil and water. This is often defined in terms of combining population, capital, and technology to provide adequate living standards for all; the usage rates of renewable resources does not exceed their regeneration rates; the usage rate of non-renewable resources does not exceed the rate at which substitutes are developed; and pollutants generated remain within the environment's ability to assimilate.

Sustainable Transport Modes In line with the previous definition, the main sustainable transport modes are generally considered to be walking, cycling and public transport, although some researchers, such as Richard Gilbert (Toronto, http://www.richardgilbert.ca) argue that animal traction will regain importance in many countries as part of sustainable transport strategies.

Sustainable transport A sustainable transportation system is one that

(a) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations;

(b) is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy;

(c) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise (Toronto Centre for Sustainability).

Sustainable In reference to resource use, *Sustainable* describes a method of harvesting or using a resource so that resource is not depleted or permanently damaged; *Sustainable business* refers to a business that provides goods and services, and/or has incorporated into its daily operations practices that result in cleaner air and water, less waste and pollution, conservation of energy and natural resources, less traffic, improved quality of life for residents and workers, and a stronger and more viable local economy; *Sustainable community/city*: a community or city that meets its present needs without sacrificing the ability of future generations to meet their own needs. More specifically, a sustainable community is one that improves and enhances its natural, social and economic resources in ways that allow current and future members of the community to lead healthy, productive and satisfying lives. (From the Sustainable City Plan, Santa Monica, California, US http://www.smgov.net/epd/scp/glossary.htm).

1.1.1 Paradigm shift in traffic and transport policies

The response was a conscious search for innovative policies that could meet these new challenges. Perhaps the most striking example was the Dutch "woonerf" or "home zone": a residential street designed to keep cars moving at a walking pace, thus giving priority to these places as habitat, rather than as corridors.

The Dutch, the Danes and other pioneers learned that the best approach was to pay attention to all modes when developing transport policies and planning access in their cities.

By 1975, the Dutch had begun to create Traffic Circulation Plans for cities, which pay equal attention to all transport modes, particularly where improving road safety is crucial. Redesigning urban space policy in this sense is a regularly recurring subject, particularly since these plans strive to integrate all transport modes. Cities began to attract people again, while figures for road accidents fell 75% and cycling's share of trips rose steadily, to average 27%[1] of all trips. In several cities this share is even higher: 38%[2], for example in the city of Zwolle. Within the city ring road of the city of Groningen the bicycle share is 50%.

Already now an important lesson can be drawn from the European experience:

> *For those cities in developing countries that still enjoy a reasonably high share of cycling and walking trips, but poised on the brink of massive private car use, we recommend policies to preserve existing facilities and invest in additional measures for cyclists and pedestrians. Indeed, this is what distinguishes the Netherlands and Denmark from other European and North American countries: they managed to introduce these measures before all cycling had disappeared. Policies should aim to enhance cycling and walking and to minimize the harm to urban and natural environments from excessive reliance on the private car. If cycling is neglected, as happened in other European cities, it can take a long time to correct this mistake.*

1 Mobility study AVV, The Netherlands, 2005.

2 CBS, The Netherlands, 2003.

1.2 The Netherlands: more than 30 years of cycling-friendly measures

In 1976, when the Netherlands' national government started to stimulate and finance cycle infrastructure in cities (through cycle paths, lanes and parking facilities), cycling was still a popular transport mode. The government therefore sought to ensure that provinces (regions) were able to build separate cycle paths along regional roads with through-going traffic. Moreover, it made funding available for experimental projects.

In cities, planners moved toward a more holistic and integrated approach to traffic and transport, treating cycling as an important ingredient in the mix. Since the 1970s, the generally accepted policy has been to develop traffic circulation plans that give priority to all road users and strive to improve road safety.

In the 1990s, the national government applied a Bicycle Master Plan within the National Mobility Plan, targeting local authorities as key players and putting a lot of effort into facilitating pro-cycling policies. As a result, nowadays virtually all city governments have a genuine cycling-inclusive urban transport plans.

Nationally, a Project Team implemented the Bicycle Master Plan, in cooperation with a national bicycle taskforce involving representatives from the government, the bicycle industry and user groups, such as the Fietsersbond (the Dutch cyclists' union). Seminars were organised along with post-graduate and diploma programs. The Project Team's main role has been to develop, exchange and ensure knowledge circulates.

In the framework of the Bicycle Master Plan, regional governments created project groups to exchange knowledge at the technical, community and user-group levels. Politicians met regularly to discuss the cost-benefits of their proposed cycle and other transport projects. These debates built consensus around which projects should be financed.

During this period, the Netherlands invested €400 million to improve cycling conditions. With experience came greater integration and cycling projects began to fit seamlessly into municipalities' overall traffic and transport policies. Increasingly they involved more than infrastructure, including cycling promotion within company and organisations' travel plans (cycling to work campaigns) and public transport combined with cycling.

This effort achieved its goal: cycling policy and projects became an integral part of mainstream

Figure 2
The Netherlands is an excellent example of successful cycling-inclusive planning.
Photo by Carlosfelipe Pardo

Box 2: Measures to improve the quality of life – and local economies

In the 1970s, more and more European cities woke up to the fact that soaring use of private cars threatened the liveability of their cities.

Today, many have achieved attractive city centres, providing reasonable access to public transport users, cyclists, motorists, pedestrians and other vehicles. Restrictions on motorized traffic flows and parking policies are the norm, not the exception. Conditions favour public transport and cycling. And city centres have been redesigned to focus on pedestrian areas and, increasingly, to include the differently abled (people in wheel chairs or with different mobility needs, children, the elderly, women, and so on).

This policy has proven successful in terms of social and economic development too. From shopkeepers to transport companies, politicians, engineers, civil society organisations and other stakeholders: all want these policies to continue, encouraging cities to speed up efforts to improve the urban environment.

urban transport planning. Studies generated vital data. Cyclists became part of analysing needs, proposing solutions and testing measures and designs, strengthening both their quality and the likelihood of their success.

Dutch experience teaches us that facilitating cycling-inclusive policy development and implementation is vital to success. Involving politicians, from the Minister of Transport through local municipal politicians, is essential. Participation from other politicians, engineers, citizens, current and potential bicycle users is equally important. The Netherlands' example has inspired other European (and developing) countries to learn from the Bicycle Master Plan.

1.3 All kinds of people must cooperate to build a shared vision

Building a shared vision is crucial to turning today's grimy, noisy, smelly cities into healthier and happier cities for people. The Cities for Mobility international network[3] strives to identify all the ways of achieving sustainable mobility. This is defined as mobility that is accessible to all citizens, environmentally friendly and economically viable. A clear, explicit vision like this offers essential guidance for future projects.

[3] http://www.cities-for-mobility.org

Box 3: Copenhagen

The capital of Denmark, Copenhagen has pioneered the concept of *cities for people*. Attractive and lively, despite a harsh climate, tourists flock to enjoy the city. Twenty percent of all commutes are by bicycle. During the Velocity 2007 conference, Copenhagen's mayor announced that boosting bicycle use even further was key to continuing to ensure that Copenhagen is genuinely a *city for people*.

Having a strong sense of where you want to go helps to avoid problems, set clear goals, define the type of organisation you need, find funding and apply the right planning measures.

But having a vision is not strictly necessary to carry out a successful (bicycle) plan. A city can simply start with a small project. Then it is important to evaluate your project, learn from it and scale it up. Step by step, you can create the city you want to live in.

International networks, conferences and such can stimulate planners, advocates and other process leaders to analyse results from early cycling measures in considerable detail, to publish their results and to discuss them at congresses. To teach is to learn more about your own situation. You wake up to what's

Figure 3
Cities such as Bogotá (Colombia) have successfully adapted concepts of sustainable transport and cycling-inclusive policies from the Netherlands and Europe and improved people's lifestyles while also improving transport quality.
Photo by Shreya Gadepalli

happening in your own city. This all will help to set course for the transformation of cities into places where people are put first and where quality of life will not be sacrificed to the ever increasing demand for space for motorized private transport.

1.4 Learning and building better cities is an ongoing process

Making cities more attractive is an ongoing process and cities all over the world can learn a lot from each other. There are so many lessons from the past and from our contemporaries.

This handbook is based primarily, but not only, on European and specifically Dutch experience with developing cycling policies, enriched by best practices in cities all over the world. It offers information on a wide range of aspects to be considered when developing a cycling policy. But every situation is different and will require its own approach.

We hope this information will help you respond with the latest information on best (and worst!) practices at your fingertips.

Figure 4

Bicycle lane at Notre Dame, in the heart of Paris, France. The municipality has promoted cycling since citizens took to their bikes amidst a prolonged public transport strike in 1990s and after a study showed the severe health effects from air pollution caused by motorized transport.

Photo by I-CE, Roelof Wittink

2. From car-based to people-centred cities

Tom Godefrooij, Hans de Jong, and Anke Rouwette

For related subjects

See ***Chapter 4*** on managing and implementing plans and policies.

See ***Chapter 13***, on social marketing and citizens' participation.

See ***Chapter 14***, on education, awareness-building and advocacy.

See ***Glossary*** on civil society organisations.

Cities today face more and more problems: congestion, pollution, social inequity and other challenges. Many are related to traffic and transport. This chapter shows how enhancing the role of cycling and other forms of human-powered transport can contribute to solving many of these problems. In fact, cycling should not be treated as a goal, but rather, as this chapter shows, as a useful and necessary tool to solve the cities' many troubles. Cycling-friendly planning not only benefits cyclists, but also creates more humane, sustainable and democratic cities, which particularly benefit the poor or marginalized.

Section 2.1 summarizes the traffic-related problems that cities face. Section 2.2 looks at how cities could improve, by solving these problems. Section 2.3 examines the role of transport, and especially that of cycling, in achieving the desired city. Section 2.4 elaborates a bit further on the specific benefits of and barriers to cycling. Finally, Section 2.5 discusses the context of the problems and solutions described in this chapter.

Figure 5

The city we want to live in. This street design in an old shopping district in a small Dutch town welcomes the elderly and disabled. It is a nice example of a recent reconstruction to make urban space attractive for all road users, including motorized traffic: cars and trucks have limited access to deliver goods.

Photo by Hans de Jong

Figure 6

This square in the Dutch 'cycle town' of Houten gives people the opportunity to recreate, to make music in the bandstand or to have a drink on the terrace.

Photo by I-CE, Hans de Jong

2.1 Cities suffer from traffic diseases

In the 20th century, as motorization progressed, cities poured most of their investment into roads, to accommodate motorized traffic. Today, car traffic is on the rise worldwide, particularly in developing countries. Combined with massive infrastructure and sprawled development, this has hurt people's health and increased road hazards. Traffic no longer flows freely and time losses due to congestion increase every year. Investment in human-powered and public transport has lagged far behind or become inexistent. Today we have to solve the resulting problems, as is explored in more detail below.

2.1.1 Congestion

Where proper measures have not been taken, inner city traffic speeds drop year by year. In some cities, they have even dropped below walking speeds during peak hours. A number of city centres in the developed world have faced similar problems in recent decades, but have now managed to increase speeds due to good traffic demand management. London, with its congestion charging system, is an example of this kind of success.

Since the car is the most inefficient mode of transport in terms of the use of space (see Figure 7), increased use has led to severe congestion, particularly in city centres.

In Bangkok city centre, for instance, average car speeds during the morning rush-hour have fallen to 10.1 km/h (2005) and, without intervention, are projected to fall to 6.4 km/h by 2010, according to studies from the Office of Transport and Traffic Policy and Planning (OTP, Thailand), rising to 9.3 km/h in 2010, with the implementation of a new 137-km rapid transit (rail) system.

Percentage of trips within walkable/cyclable distances:

Delhi (1994): 57% of trips below 5 km.
Bogotá (1998): 52% of trips below 7 km.

Note: In small cities or where many people have no access to cars or buses, more than 60% of trips may cover distances of under 3 km.

(Source: *The Economic Significance of Cycling*, VNG Uitgeverij, Buis, J. and Wittink, R.W., The Hague, 2000).

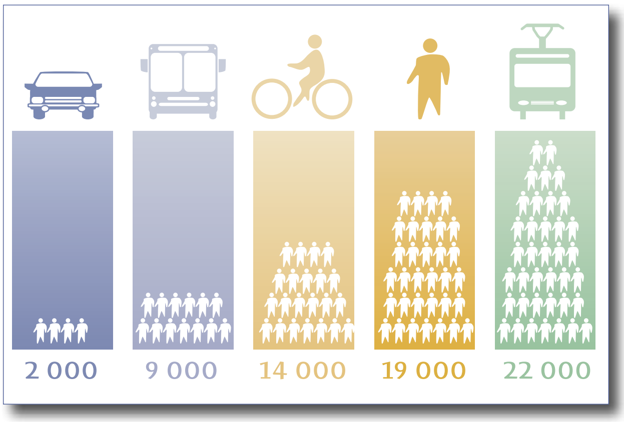


Figure 7
Persons per hour on a 3.5 m road width.

Adapted from: Botma and Papendrecht, TU Delft, 1991

Table 1: Speed Projections for Bangkok (Thailand)

Distance fom city cente	0–5 km	5–10 km	10–20 km	> 20 km
2005	10.1 km/h	11.3 km/h	18.9 km/h	19.4 km/h
2010	6.4 km/h	6.9 km/h	11.5 km/h	13.1 km/h
2010 + MRT	9.3 km/h	9.5 km/h	14.3 km/h	16.4 km/h

These are the average car speeds during the morning rush hour in the city centre. Figures for 2010 and 2010 + MRT are projections, with the latter reflecting implementation of a new, 137-km rapid transit (rail) system.

Congestion leads to long delays, unpredictable travel times and severe pollution. It is compounded by the fact that in most cities, even large ones, at least *half of all trips are less than 5 kilometres in length.* In a big city like London for instance, almost two-thirds are under five kilometres in length, an ideal distance to be covered on foot or bicycle, both modes that require minimal space for movement and zero or very little space for parking at destination. (Source: http://www.westlondoncarshare.com/harrow.asp)

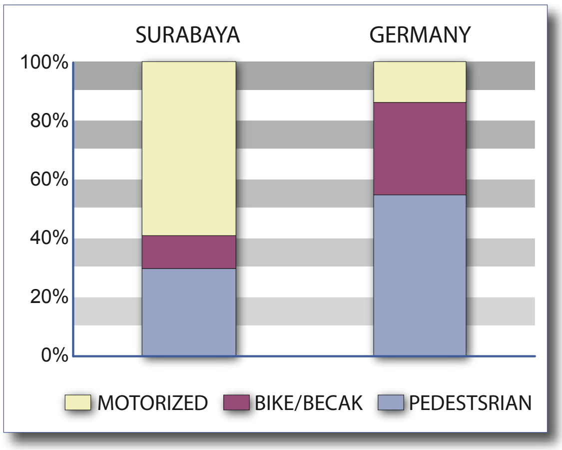
Figure 8
This traffic jam with users of different modes struggling to advance (Delhi, India) shows that in dense Asian cities, even a small percentage of car use can lead to severe congestion.

Photo by Carlosfelipe Pardo

Figure 9

Modal split for 1–3 km trips in Surabaya (Indonesia) and German (cities only), compared.

Source: ITDP & GTZ, 2000



This means the potential for reducing congestion by favouring walking and cycling is enormous. One European study found that drivers themselves admit they don't need a car for half of the short trips they make. That cities in developing countries have become increasingly dependent on cars, even for the shortest trips, as the Figure 9 shows, is worrying, but also points to significant room for improvement through the promotion of human-powered transport.[4)]

2.1.2 Cycling versus driving: air pollution, health, obesity

Every year, 3 million people worldwide die prematurely due to air pollution. Another 1.4 billion suffer from air pollution levels that exceed World Health Organisation (WHO) recommended limits. Although transportation is not the only factor, its contribution to air quality problems is substantial and ever increasing. People living within 50 metres of highways and busy roads are more likely to suffer from health problems than those living further away. In some countries, the number of deaths per year as a consequence of bad air quality is even higher than the number of people killed in traffic accidents.[5)]

Within the transport sector the private car is by far the largest contributor to these air quality problems.

Greenhouse gas (GHG) emissions are high on the agenda as global warming is a great concern all over the world. Half of all CO^2 emissions in cities come from transport and this sector's emissions continue to rise, particularly in developing countries.

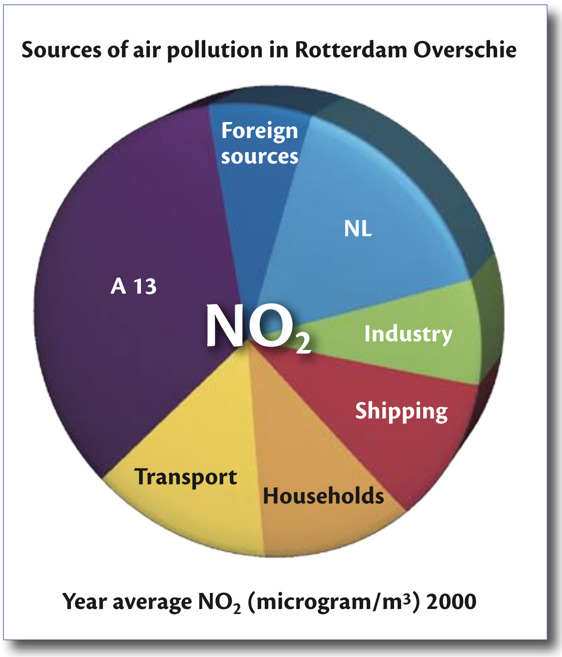
New technologies may partly relieve this situation, but if car use continues to rise at current rates it will constantly outpace improvements. The best way to reduce green house gas (GHG) emissions is to restrict the growing *use* of motorized vehicles. This can be done by developing more balanced traffic and transport policies, offering more and better alternatives (cycling, public transport, walking) to private car use. Improvements for other modes are essential to reduce private car use, especially in city centres and residential areas.

The question may arise about whether it is ethical to encourage people to cycle, thereby exposing themselves to unhealthy emissions. Although not entirely conclusive, studies examining exposure to air pollution of cyclists, drivers and public transport users indicate that drivers are exposed to more pollutants than cyclists.[6)] Even after taking the increased respi-

Figure 10

Main causes of the local air pollution in Rotterdam Overschie, a neighbourhood in the Dutch port-city of Rotterdam. Half of the air pollution is caused by traffic and transport. One-third of the total comes from traffic on national highway A13. People who live nearby suffer from traffic-related health problems. Recently, the maximum speed on such highways in built up areas has been cut from 120 to 80 km/h. Air and noise problems have fallen as a result.

Source: Ministry of Transport, Netherlands



4 Institutt voor Toegepaste Sociale wetenschappen ITS, Vervanging van autogebruik door fietsgebruik, Nijmegen, 1992.

5 Health costs due to Road Traffic Related Air-pollution, An impact-assessment project of Austria, France and Switzerland. Prepared for the WHO Ministerial Conference on Environment and Health, London, June 1999. Rita Seethaler, Federal Department of Environment, Transport, Energy and Communications, Bureau for Transport Studies, Bern, June 1999.

6 van Wijnen JH, Verhoeff AP, Jans HW, van Bruggen M, The exposure of cyclists, car drivers and pedestrians to traffic-related air pollutants, International Archives of Occupational and Environmental Health. 1995; 67(3): p. 188.

ration rate of cyclists[7] into consideration, car drivers appear to experience more exposure to airborne pollution than cyclists.[8]

It is safe to conclude that "public and non-motorized modes of transport should be promoted on the basis of low personal pollution exposure. Even so, the cyclists' pollution results suggest that to reduce their exposure, cycle paths should, wherever possible, be located away from main roads. Finally, public awareness should be raised concerning the potential pollution exposures by transport mode."[9]

There are other health risks that can be attributed to the massive use of private cars, largely due to the sedentary habits associated with driving. These health risks are substantial, and can be effectively reduced through use of more sustainable transport modes, as detailed elsewhere in this handbook.

One of the most significant health problems of our times, obesity, is increasingly in the spotlight as a major factor in serious and growing health problems. Indeed, public health authorities in many countries are increasingly treating obesity as a major public health problem or even an epidemic (see, for example, The Active Living Centre website, US, http://www.activelivingresources.org). Driving door-to-door reduces the exercise people, particularly children, would normally get with a better mix of transport modes that include walking and/or cycling. People who travel by car and work at a desk have a higher risk of obesity and other health problems, particularly heart disease.

Figure 11
In most cities motorized traffic, particularly cars, is responsible for a substantial share of total air pollution.
Photo by Carlosfelipe Pardo

Sleep deprivation due to noise from traffic is another problem on the rise. This, by definition, is affecting those not participating in traffic regardless their habitual way of travelling. Experts are only now beginning to understand its medical significance.

A major English policy review that examined the health and economic impacts of promoting more cycling and walking concluded that by reducing congestion, emissions, traffic accidents and health care costs, *for every penny invested in encouraging bicycle use, the city would earn*

[7] Van Wijnen *et al.,* Ibid., p. 193.
[8] Rank, J, Folke J, Jespersen PH., Differences in Cyclists and car drivers' exposure to air pollution from traffic in the city of Copenhagen, Science Total Environment. 12 November 2001: 279 (1–3): 131–6.
[9] Kingham *et al.,* Ibid. p. 274.

Table 2: Results of personal monitoring on different modes of transport, September-October 1996

Pollutant	Mode	Monday 9/9	Tuesday 17/9	Wednesday 25/9	Thursday 3/10	Friday 11/10	Saturday 19/10
Benzene (µg/m^{-3})	Car	15.3	72.8	265.5	54.2	217.2	24.7
	Train	Lost	6.6	14.6	9.2	30.0	4.2
	Bus	5.9	18.6	29.8	10.1	53.9	8.8
	Bike-road	8.2	22.4	35.2	13.0	74.6	5.5
	Bike-path	6.3	8.7	14.8	8.7	50.7	4.8
Particulates (absorbance)	Car	5.3	6.1	11.1	4.8	14.7	3.5
	Train	Lost	6.8	6.9	3.5	7.7	3.6
	Bus	3.4	4.0	6.6	4.6	10.7	2.3
	Bike-road	3.8	5.3	7.0	3.8	15.1	2.9
	Bike-path	2.0	2.0	2.2	1.2	6.7	2.4

Source: Kingham *et al.,* 1998

from 2.2 to 3.6 pennies in benefits.[10] That is why some people advocate a more active role of the health sector in steering transport policies.[11]

Figure 12
Pollution hurts people's health, especially the young and the old, the most vulnerable.
Source: Swisscontact Jakarta

2.1.3 Traffic accidents

Aside from health problems and air pollution, growing motorization also drives up the number of traffic accidents. Worldwide every year 1.2 million people die in traffic accidents. Unless effective action is taken, this will rise to 1.8 million in 2020. The WHO forecasts that by 2020, traffic accidents will be the third leading cause of premature death worldwide, killing more people than respiratory diseases, diarrhoea and prenatal conditions. An annual investment of 0.25% of gross domestic product in traffic calming and facilities for cyclists and pedestrians could cut the number of fatalities by 80% over a 20-year period.

Cyclists and pedestrians suffer disproportionally from the hazards of the road. These are vulnerable road users. It is obvious that, in a collision with motorized vehicles, they are most at risk. Some groups, such as children, are even more at risk, because they lack the abilities and skills to cope with the complexity of the motorized transport system. If road design doesn't take the safety of these vulnerable road users explicitly into consideration, road safety problems will continue to exist.

2.1.4 Crowded streets and distribution of scarce urban space

In many cities, soaring car use has pushed pedestrians and cyclists off streets and sidewalks, as cars — in motion or parked — take over every available inch of public space, even public squares, parks and other areas normally reserved for people, even though in most places more trips are done on foot than in vehicles. This means that a minority of car drivers are using a disproportionate amount of scarce urban space, raising the issue of social equality.

Furthermore, many of the public spaces where people used to meet, play and interact socially have been sacrificed to create more room for traffic. This has a negative effect on the liveability and attractiveness of cities. Wide streets intensively used by fast-moving vehicles create barriers, dividing the city into sections with poor communication between each other, making human-powered trips difficult or even impossible and fragmenting public spaces. Freedom of movement for human-powered road users (especially children) is reduced.

2.1.5 Social inequity

The three population groups most affected by a car-centred transportation system are: low-income people, women and children. The first group suffers, because they generally cannot afford to own and use a car. Since high-quality

Figure 13
As this narrow walkway in the centre of Kuala Lampur reveals, car-centred planning produces many anomalies and inequalities, like this three-lane avenue with on-street parking.
Photo by Carlosfelipe Pardo

[10] Transport for London, "A business case and evaluation of the impacts of cycling in London", January 2004. http://www.tfl.gov.uk/cycles/company/reportlibrary.shtml

[11] House of Commons Health Committee report: "Obesity – Third report of session 2003–04", May 2004.

Figure 14
Roads as a barriers, difficult to cross: how to get to the shop at the other side of the road?
Photo by I-CE, Nick van Dalen

facilities for human-powered transport and public transport are often not available in car-oriented cities, this group finds it increasingly difficult to access the cities' goods and services. Lack of transportation makes it difficult to access employment and obtain food, education and other basics, drastically reducing their ability to participate in society. The particular needs and travel patterns of women, which typically involve trip chains to multiple destinations rather than a straightforward home-work commute, differ from those of men, but transportation planning often does not take this into account. Women also have more explicit personal safety concerns and physical needs.

Over-dependency on motorized transport modes also deprives children of their ability to move independently within their living area. Research indicates that this affects their physical, intellectual and emotional development in a negative way. Hillman Mayer and other researchers have found that "whilst 80 per cent of seven and eight year olds went to school on their own in the early 1970s, less than one in ten were doing so two decades later (Hillman, Adams and Whitelegg, 1991)."[12)]

By providing adequate transport facilities and safe road environments for the poor, women and children, transport planning can reduce social inequity by giving these vulnerable population groups more access to the city and therefore enhancing their ability to exercise their rights to work, to enjoy cultural and recreational programs, and to participate as full citizens.

[12] Cited by Mayer Hillman, Policy Studies Institute, London, UK, in *The Impact of Transport Policy on Children's Development*, Canterbury Safe Routes to Schools Project Seminar, 29 May 1999.

Figures 15 a, b
Unthinking support for car-centred urban models typically discriminate against low-income groups, women and young people, with public investment failing to reach those most in need.
Photos by Carlosfelipe Pardo

Figure 16
Large-scale infrastructure for automobile traffic, like this highway in Beijing, forces cyclists and pedestrians off the roads and promotes more use of unsustainable modes of transport. This is just one of many developing cities that have attempted to deal with congestion by building more roads. The nightmare worsens as more roads bring more cars (see Down's Law, p. 22) and more car use, making the city virtually unliveable, particularly during peak periods of activities.
Photo by Carlosfelipe Pardo

2.1.6 Sprawl favours malls and kills small businesses, hurting access, jobs

With motorization, cities expand, because people can travel over longer distances. One of the effects of car-based urban expansion, often referred to as sprawl, is that services and businesses tend to concentrate along key nodes, often accessible solely by car or, with difficulty, public transport. This tendency to concentrate services and businesses in outlying areas where land is less expensive means that large malls replace small, locally run businesses, further stimulating car use. Small shops can't compete and disappear, forcing customers to travel over longer distances to the larger shops. In this vicious circle, people travel over longer distances, stores grow larger, small shops disappear and people have to travel further again. This kind of development boosts dependency on private cars, traffic (more kilometres driven) and travel times. All these tendencies are harmful not only from a transport point of view, but also because the small shops forced out of business once provided vital services to the poor and because small businesses typically provide the majority of jobs. Their disappearance means that many, particularly low-income people, lose their jobs or must travel further and spend more to reach employment centres. In many cities this has resulted in the decline of whole city centres and the loss of important heritage as well.

Sprawling cities also stimulate more traffic across longer distances, making public transport less efficient and cycling less feasible. Regardless of size, encouraging medium to high densities is important to keep distances reasonable and therefore facilitate a healthy balance of more sustainable transport modes, especially buses, trains, trolleys, cycling and walking, depending on the distances to be covered.

2.1.7 Build and they will come: more roads bring more traffic

In recent decades, cities have struggled to reallocate often scarce urban space to accommodate rising car ownership and travel rates. What they have discovered, however, is that more infrastructure attracts more traffic, creating a vicious circle. As Clifford Winston, former Senior Fellow at the Brookings Institution, put it:

> *"Pick any pothole-laden, congested two-lane road in an urban area. Suppose public funds are used to widen the road to four lanes and to repave it. Benefits will immediately flow from this investment in the form of lower travel time and less vehicle damage. But many travellers who previously avoided the road during*

> *peak travel periods will now find the road attractive and want to use it. The improvements will also induce long-lived land use and vehicle purchase decisions. Before long, the road may again fill to capacity and steadily deteriorate. … This is an illustration of Downs's law (1962): On urban commuter expressways, peak-hour traffic congestion rises to meet maximum capacity, because commuters shift from less preferred modes and times of day" (our emphasis).* [13)]

As some researchers have put it, motorized traffic behaves like a gas, expanding to fill the space available. The more space, the more traffic, so the most common solution ultimately makes the problem worse. This, of course, is not sustainable, particularly in a world already affected by soaring fossil fuel prices and seriously threatened by global warming. The imbalanced expansion due to widespread car use leads to urban sprawl and reduces the space available for sustainable transport modes like cycling, walking and public transport.

From the 1970s on, awareness has gradually risen that motorization must somehow be stopped or brought under control, and that building more infrastructure only aggravates the problem. Since then, many European cities have moved toward more sustainable approaches, paying closer attention to the environment and improving conditions for alternative transport modes. With the right balance of measures, they still guarantee the necessary accessibility for private cars.

However, many cities around the world continue to blindly imitate the kind of urban design policies developed in the United States in the 1950s and 1960s, blithely unaware that not even that country, with all its experience and resources, can keep up with the costs required by this kind of infrastructure.

Often national and city authorities speak of "discouraging" car use, but in fact they are not offering incentives for motorists to shift modes. Car drivers do not pay the external costs they cause, for example, in terms of adverse health effects, pollution clean-ups, lost opportunities, lost lives. These are paid by society as a whole, public health systems, and so on. To correct these imbalances, traffic systems should reward sustainable travel behaviour such as walking, cycling and public transport use.

2.1.8 Rethinking our addiction to speed

Recent work by Europe's 'Foresight for Transport' project (Harris *et al.,* 2004) finds that faster cars and roads may actually be slowing us down. Virilio's law, for example, reveals that "increases in speed are coupled with increases in gridlock" (Virilio, 1991, 65). Moreover, "when journey times are reduced through increased speed the time saved is rarely used for other meaningful activities. Instead it tends to be ploughed back into transport." [14)]

On average, people spend about one hour a day on travelling, making three to four trips. Although there are large individual variations, this average tends to hold over time. This is understandable as we also need time for other activities, which are the reason for our travelling. As travel speeds rise, we tend to use this same time to travel further, rather than saving time.

Higher speed transportation systems are also more damaging to the environment, not only by increasing congestion and average trip lengths, thereby worsening air and water pollution, but also because increased traffic damages infrastructure, requiring more raw materials for repairs. Altogether this situation "creates a democratic deficit, where future generations are subject to risks, hazards and problems not of their own making and over which they have no control." [15)]

Equity is another value that is threatened by societies' obsession with speed. Harris *et al.,* note that "the current transport system is underpinned by high-speed principles, and is therefore biased to best serve those who require high-speed transport over longer distances." Timetables and transit systems respond to men in the 18–65 age group working a five-day week, leaving "the elderly, sick and disabled, who live at a different pace" poorly served by current transport policy.

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[13] Winston, Clifford. Efficient Transportation Infrastructure Policy. *The Journal of Economic Perspectives (1986–1998);* Winter 1991; 5, 1, pp. 113–114.

[14] Harris *et al.,* (2004), p. 6.

[15] Harris, Peter, Jamie Lewis and Barbara Adam, 2004. *Time, Sustainable Transport and the Politics of Speed.* World Transport Policy & Practice, Volume 10, Number 2 (2004), p. 7.

Inequities are also apparent as women, juggling family, community and work-related responsibilities, are more inclined to "trip chaining", as opposed to the single purpose, direct trips required by employed men. Today, public transportation involves "direct, single-purpose trips with single destinations, which means that women who try to fulfil a number of tasks have to follow an extensive round trip of different services that may take up a long period of time."[16)]

Other researchers have demonstrated how important transportation is to gaining access to urban goods, particularly employment, education and other elements vital to well being. One US study found that the "availability and affordability of reliable transportation — either through public transportation or individual ownership of automobiles — appears necessary to support a successful transition from welfare to work."[17)] An Iowa study found that "vehicle access enables households to meet their basic needs, but may exacerbate their problems through the creation of additional demands on resources."[18)]

Speed kills. In 1999, around 800,000 people died in traffic accidents worldwide, at an estimated annual cost of US$500 billion. The World Health Organisation reports they are a leading cause of death in economically active age groups, killing more children in Africa than HIV/AIDS and more young adults (15–44 years) than malaria. Moreover, a child in the lowest socio-economic group in the UK is six times more likely to be killed or seriously injured than a child in the highest income group.[19)] Parents in developed countries respond to these dangers by driving their children to school, thus making it more dangerous for those children who continue to come by foot or by bicycle. This vicious circle also hurts their physical (sedentary habits leading to obesity-related problems) and mental (lack of familiarity with normal public spaces and relations with acquaintances and strangers) health.

Research in the UK found that reducing traffic speeds to 20 mph reduced all accidents by 70% and accidents involving children by 80%.[20)] Similarly, a literature review conducted by the US Department of Transportation, concluded that "It was estimated that only 5 percent of pedestrians would die when struck by a vehicle travelling at 20 miles per hour or less. This compares with fatality rates of 40, 80, and nearly 100 percent for striking speeds of 30, 40, and 50 miles per hour or more respectively. Reductions in vehicle travel speeds can be achieved through lowered speed limits, speed reducing road design, police enforcement of speed limits and associated public information."[21)] Current policy, however, does not take this into account.

Moreover, Van Hove[22)] and other researchers have noted the importance of mobility to reducing poverty and social inequality. Indeed, it is not suburbs' design that makes them so soul-destroying for recent immigrants or lower income groups, but the lack of mobility implicit in the distances between residential, employment and service centres, and the lack of decent transit and other options. Changes to Bogotá's transportation system and the civic education efforts that accompanied them have been associated with reduced accident and homicide rates.[23)] They also provided immediate improvements in quality of life, gifting users with up to two hours a day of "new" time, formerly spent on travel. (Such time savings can be realistic when actual

16 Harris *et al.,* (2004), pp. 7–8.

17 Lucas, Marily and Charles Nicholson, 2003. Subsidized vehicle acquisition and earned income in the transition from welfare to work. Transportation 30, 2003, p. 483.

18 Needles Fletcher, Cynthia, Steven B. Garasky and Robert B. Nielsen, 2005. *Transportation Hardship: Are You Better Off with a Car?* Journal of Family and Economic Issues, Vol. 26 (3), Fall 2005, p. 323.

19 Whitelegg, John and Gary Haq, 2003. *The Earthscan Reader on World Transport Policy and Practice.* Earthscan: London, pp. 21–22.

20 Hillman (1993), cited in Harris *et al.,* p. 8 found for example that in 1990 four times as many children were driven to school as in 1971, a situation that contributes to rising obesity and to car dependency.

21 US Department of Transportation, *Literature Review on Vehicle Speeds and Pedestrian Injuries,* National Highway Traffic Safety Administration, DOT HS 809 021 October 1999, Final report. http://www.nhtsa.dot.gov/people/injury/research/pub/HS809012.html, June 2008.

22 See Van Hove on experiences with fighting poverty in Rotterdam by improving mobility of the residents of poor and economically distressed zones of the port.

23 Rojas, Cristina. "*Forging A Culture Of Citizenship In Bogota City*", presented at the workshop "Conflict, Cooperation and Sustainable Development", Dalhousie University and University of King's College, Halifax, Nova Scotia, June 1–3, 2003. Also presented at the workshop Citizen Participation in the Context of Fiscal Decentralization: Best Practices in Municipal Administration in Latin America and Asia, Tokyo and Kobe, September 2–6, 2002, organized by IADB and JICA (2003).

travel times are substantially above the 'average' of one hour a day, as mentioned above.)

Transportation decisions that favour speed and "flows" over other criteria also have a profoundly negative impact on the quality and the availability of public space. For centuries, streets have been multi-purpose places where people could walk, skate, bike, talk, play games, share the news, and meet in small or large groups, for personal or civic purpose. Sidewalks, small squares, empty lots and other spaces in urban territories have traditionally served as places for community building and civic engagement. The fact that they are increasingly encroached upon by cars, whether in movement or parked, has eaten away at the civic functions of public spaces, wherever car use has grown.

2.2 *Towards liveable, mobile and sustainable cities*

In 1970, only 30% of the world's population lived in cities. By 2006, this had risen to 50%, and in 2040 it will reach 70%. This shift brings with it enormous consequences and challenges, compelling us to think about how to steer future urban development. The main question is: What kind of city do we want to live in? And what kind of development will get us there? As described above, transport-related problems in cities are increasing. To deal with them, citizens and local authorities need a shared vision of the future city they desire, and about how to start to make real changes.

One fine example of how a city can shift from being plagued with problems to a city that people want to live in and are proud of, is Bogotá (see Box 4 in this chapter). During the early years of this century, mayors Enrique Peñalosa and Antanas Mockus had a vision and changed the city in just a couple of years.

To develop a vision capable of guiding the city to a better, more sustainable future requires incorporating multiple perspectives: the local and regional economy, liveability, aesthetics, transport, social contacts, equity, safety and other issues. Collective processes for reflection,

Table 3: Smart growth versus sprawl

	Smart Growth	Sprawl
Density	Compact development.	Lower-density, dispersed activities.
Growth pattern	Infill (brownfield) development.	Urban periphery (greenfield) development.
Land use mix	Mixed land use.	Homogeneous (single-use, segregated) land uses.
Scale	Human scale. Smaller buildings, blocks and roads. More detail, since people experience the landscape up close, as pedestrians.	Large scale. Larger buildings, blocks, wide roads. Less detail, since people experience the landscape at a distance, as motorists.
Public services (shops, schools, parks)	Local, distributed, smaller. Accommodates walking access.	Regional, consolidated, larger. Requires automobile access.
Transport	Multi-modal transportation and land use patterns that support walking, cycling and public transit.	Automobile-oriented transportation and land use patterns, poorly suited for walking, cycling and transit.
Connectivity	Highly connected roads, sidewalks and paths, allowing relatively direct travel by motorized and human-powered modes.	Hierarchical road network with numerous loops and dead-end streets, and unconnected sidewalks and paths, with many barriers to human-powered travel.
Street design	Streets designed to accommodate a variety of activities. Traffic calming.	Streets designed to maximize motor vehicle traffic volume and speed.
Planning process	Planned and coordinated between jurisdictions and stakeholders.	Unplanned, with little coordination between jurisdictions and stakeholders.
Public space	Emphasis on the public realm (streetscapes, pedestrian environment, public parks, public facilities).	Emphasis on the private realm (yards, shopping malls, gated communities, private clubs).

Source: Comparing Smart Growth and Sprawl (Ewing, 1996; Galster, *et al.,* 2001), available on-line at the Victoria Transport Institute's Travel Demand Management Encyclopedia, http://www.vtpi.org/tdm/tdm38.htm.

debate and finally conclusions are essential for citizens to define what kind of city they really want to live in. Cities such as Toronto, Hamilton and Vancouver (Canada) have created comprehensive methodologies that make the most of traditional (word-of-mouth, face-to-face) and current (web pages, blogs, surveys, etc.) methods to help citizens from all walks of life, including new immigrants, to think about how they want their city to develop. This process often involves hearings at neighbourhood, city and regional levels, and produces a major public policy document that then becomes the basis for urban planning laws, regulations and procedures.

It is very important to clearly define the processes necessary for each city to develop a vision,

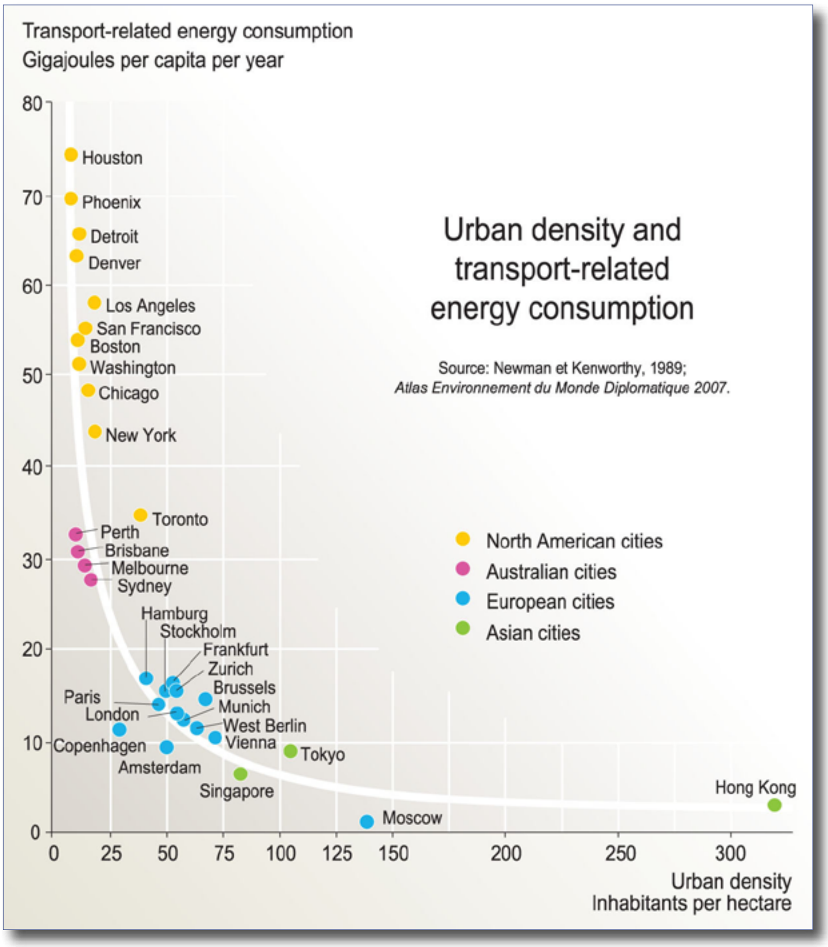

Figure 17

The denser the city the less energy is required for private transport. Because American cities are so extensive and low-density, they require three times more energy than more compact European cities and six times more than Asian cities.

Source: Newman and Kenworthy, 1999. Sustainability and Cities: Overcoming Automobile Dependence. Island Press, Washington DC, USA, ISBN 1-55963-660-2

Box 4: Learning from Bogotá: Public transport can guide solutions to major problems

Bogotá, the capital of Colombia, shows how a city can turn major problems into an opportunity to re-vision and generate a vision of a city for people. Nowadays, Bogotá (7 million inhabitants) serves as a model for many large cities in the developing world. Enrique Peñalosa, mayor from 1998 to 2001, led this vision and the process that turned it into a reality.

The problems Bogotá was struggling with when Peñalosa became mayor remain all too present in many cities. In 2005, Peñalosa summarized these: “Bogotá was a typical large city in a developing country, with terrible traffic jams and a feeling of hopelessness among the population. There were almost no public spaces, parking bays had been carved into most sidewalks or cars simply parked on sidewalks. As car numbers grew, more flyovers were built, and a JICA (Japanese International Cooperation Agency) report even proposed a US$550 million elevated highway through the city centre. Public transport was totally chaotic, with mostly individually owned buses racing crazily against each other for passengers, blocking traffic, dumping passengers in the middle of main roads. Bicycle use was extremely dangerous and the number of cyclists insignificant.”

Figure 18

Bogotá; map of bicycle network (detail).

Instituto de Desarrollo Urbano, Bogotá

Peñalosa’s vision helped turn Bogotá around

“In Bogotá, Colombia, we have been trying to create a shared vision for our seven million inhabitants. The vision has a number of characteristics. We want a dense city, yet with buildings no higher than six or seven stories, where low-cost, high-frequency public transport is viable; abundant cultural offerings; people in public spaces; severe limits on private car use during rush hours, so that pedestrians and bicyclists encounter low pollution levels and low risk of being hit by a motor vehicle; sports facilities, libraries, parks, and plazas near all homes; an ample exclusively pedestrian road network; and wide, tree-lined, well-lit sidewalks. We want dynamic organised communities, with a sense of belonging. We want a city that will not increase road space in response to traffic jams, but rather will further restrict private car use. We want a city that clearly devotes more space and resources to children than to motor vehicles."

Figure 19

Bogotá; separate bicycle path for cycle use in two directions.

Photo by I-CE, Roelof Wittink

Every Sunday now in Bogotá, 120 km of main roads are closed to motor vehicles for a period of seven hours to create a circuit where 1.5 million people or more, from all walks of life, can take to the street to cycle, jog, walk or socialise. The circuit length more than doubled between 1996 and 2000. Hundreds of kilometres of quality sidewalks were built, roads were narrowed, street crossings are brought up to grade, signalling to drivers that pedestrians, rather than cars, have the priority and forcing them to slow down. One of the city centre's main avenues became exclusively pedestrian. The city government developed more than 1,200 parks and plazas all over the city, three large new libraries and 14 smaller ones. (2005) The World Bank Group

Every day, 40% of cars must stay off the streets, during two-hour peak traffic in the morning and two hours in the afternoon. The city also built more than 300 km of segregated bicycle tracks in less than three years. From virtually 0% to more than 4.5% of the population now uses bicycles for their daily transport needs. Many more are occasional users.

One project that contributed substantially to improving the quality of life was a bus-based transit system called TransMilenio. It moves over one million people daily along 66 km. Of these, 21% used to go to work by car. It is an expanding system, financed by a gasoline tax, and is planned to transport more than 85% of the city's population by 2018. Bicycle parking facilities have been integrated into the bus system's stops and transfer stations, to expand the area, and the people serviced by TransMilenio.

Problems in Cape Town (South Africa) are comparable to those of Bogotá some years ago. Poor black people living in the so-called townships spend one-third of their income on 'public' transport. This makes it hard to travel to the business district to access jobs, food, education and other basics. Low-income groups do not enjoy full participation in the community and in their society. Because the problems of both cities were quite similar, the politicians of Cape Town visited Bogotá to learn from their Latin American colleagues.

Figure 20

Bus Rapid Transit system TransMilenio is a success in performance and even citizen rating.

Photo by Carlosfelipe Pardo

together with an identity and its consequences and decide what costs are acceptable to achieve which benefits. Peñalosa identified two poles in thinking about the city of the future: urban sprawl and compact cities. A car-centred transport system, such as Los Angeles (US) or Caracas (Venezuela) generally leads to urban sprawl with lower urban densities, bringing higher congestion, air pollution, energy use, oil dependence and per capita costs for transport.

North American planners increasingly distinguish between "smart growth" and "sprawl", as Table 3 illustrates (Comparing Smart Growth and Sprawl, Victoria Transport Policy Institute, based on Ewing, 1996; Galster *et al.,* 2001).

More compact, medium- to high-density urban models, such as those found in Europe and Asia, can keep average journey distances short, which is beneficial for walking and cycling. Higher densities also create the basis for better public transport, thus providing quality mobility for people who do not own a car or would prefer not to use it for every journey.

Moreover, compact cities can also offer more and better spaces for pedestrians and cyclists, on streets, in squares and parks.[24)] Journeys are more pleasant and people enjoy spending more time in public spaces, which, when properly designed and cared for, create important opportunities for civic life by bringing together people with different lifestyles and backgrounds to exchange ideas, products, or simply to engage in shared activities.

"The way we build our cities and organize city life can be a powerful tool for constructing a more egalitarian and integrated society. Where citizens lack so much in terms of amenities and consumption, it is quicker and more effective to distribute quality of life through public goods such as parks, plazas, sidewalks, than to increase the personal incomes of the poor. In public space we meet as equals, regardless of hierarchies" (*Cycling, A Smart Way of Moving*, Shimano/I-CE, Jan. 2006).

Rigid rules for envisioning our ideal city of the future would be unproductive. However, we can learn from experiences, failures and successes all over the world and combine these into our own vision. Chapter 3 expands on these ideas using the visions developed by Jane Jacobs and Jan Gehl as examples.

2.3 Sustainable transport policies improve equality, quality of life

The role of transport in any vision for a sustainable city of the future is essential. The problems in most big cities in developing countries can be described as follows: half the world's population lives in cities, the majority are poor or very poor, many people have difficulties affording the necessary transportation to find work, generate income, get to school, or go to a hospital. Aside from walking, the bicycle is often the only means of transport available to the poor. Yet in some countries even the purchase of a bicycle remains beyond the reach of a significant part of the population and there are often no proper cycling facilities.

However, particularly in Latin-American and Asian cities, more and more people do have access to a car or motorcycle, but excessive dependency on the car for all transport needs produces problems for all, including car-owners.

This section describes, very briefly, how with a more holistic and integral view of urban traffic and transport we can get more understanding of what needs to be done to tackle these problems.

2.3.1 The basic functions of the transport system

The challenge for traffic planners is to meet the transport needs of individuals and society in a way that the positive characteristics of each mode can contribute optimally to social and economic well being, and that quality alternatives are being offered to reduce the problematic use of transport modes.[25)] This could be labelled as one of the strategic goals of a

[24] In fact sprawled cities can offer as much space to pedestrians and cyclists, but it is used less. Compact cities tend to work better, because 'people attract people' as Jan Gehl puts it.

[25] Transport modes may be problematic on two levels:
Individually: Situations in which the transport mode does not match well the user's mobility or access needs. For daily commutes over long distances (*e.g.* 35 km), it is clear that cycling for the entire trip is problematic. Some modes may simply be unavailable or unaffordable;
Collectively: Situations in which the (massive) use of certain modes is harmful to social or environmental conditions or where they are inefficient. In this respect,

sustainable transport policy. In order to understand how and to what extent cycling can be an appropriate mode to meet the transport needs of individuals and society, we first look at the basic functions of the transport system, examining it on three levels:

Level 1: The travel market (the need to travel)

The spatial distribution of socio-economic activities and their time frames determine to a large extent the need to travel. Unfortunately there are many socio-economic and cultural factors, such as economic up-scaling and globalization, which influence travel needs and go far beyond the reach of physical planning possibilities. Land use planning is an important factor, however, and can help to prevent unnecessary growth in the need to travel.

Level 2: The transport market (different transport modes meet different travel needs)

Different modes of transport can be chosen to match the distance to be covered, the spatial context and the availability and accessibility of different modes. Transport strategies should aim at promoting those (combinations of) mode choices that offer the highest benefits for society at the lowest costs.

Level 3: The traffic market (efficient operation of each modal system)

Once an individual has chosen to travel using a certain transport mode, the trip should run as smoothly and safely as possible. This requires safe infrastructure, a network connecting origin and destination, and so on. These are the elements that typically form part of the classic traffic engineering model. Figure 21 shows a diagram that gives insight into relations between the three levels.

In Section 2.1, we examined the many negative side-effects of massive car use in cities. But there are other reasons why cars cannot be the preferred form of transport in our cities today. Some trips are too short to justify car use. Some routes are used so intensively that collective transport is cleaner and more efficient. Many people simply don't have access to cars, even where one is available to the household. Whole segments of the population cannot use cars (children, the elderly, some handicapped people, etc.). There are also limits inherent in the transport system itself. City and transport planners must therefore ensure that other travel options are available on the transport market. This is particularly the case where they seek to counter or mitigate the negative impacts on the city of mass motorization. Transport policies should be based on the principle of serving people, not vehicles.

car use can be problematic or necessary investments (*e.g.* metro, rail) may simply be too high.

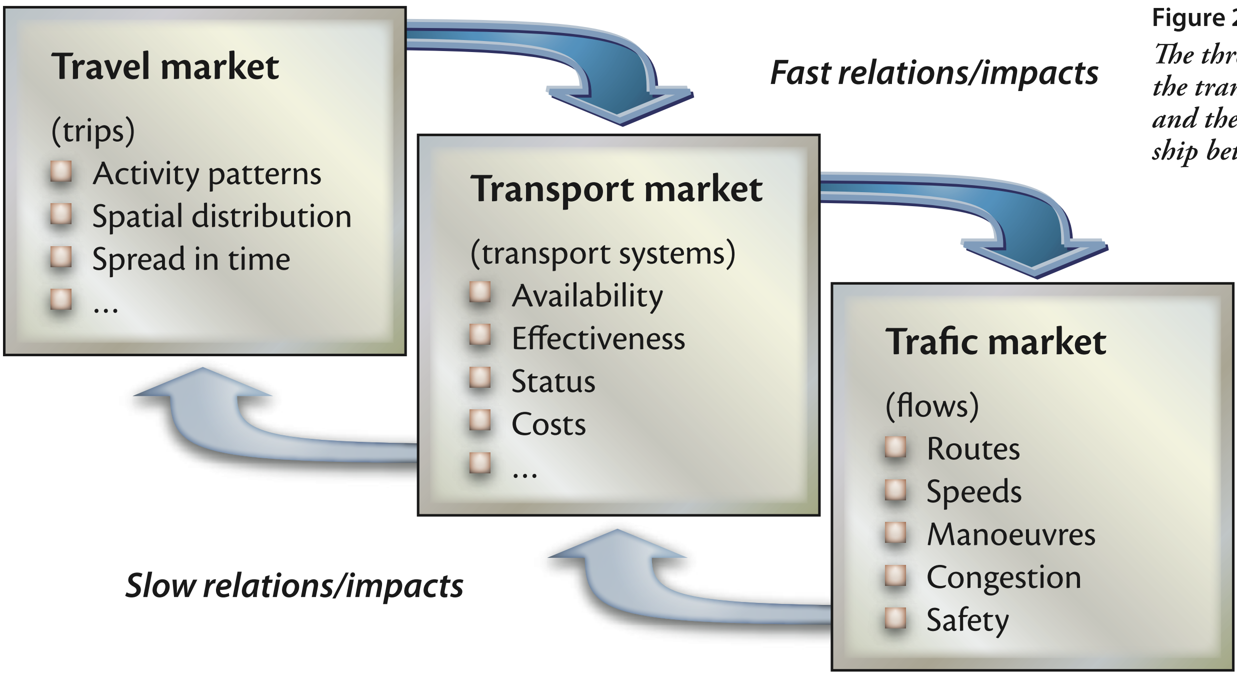

Figure 21
The three markets of the transport system and the relationship between them.

Figure 21 reveals potential action points for policy makers who want to improve the traffic and transport system. In all three markets, interventions can positively or negatively affect the city. Clearly, the traffic market is the domain of traditional traffic engineering. Physical planning of road infrastructure is typically managed by governments. The transport market is the domain of transport planning and policies and offers opportunities for action by civil society organisations and other stakeholders. The travel market is influenced by economic, social and cultural developments. In this case, the most obvious area of intervention is land use and urban development policies and plans.

2.3.2 The (potential) role of cycling in the urban transport system

Cycling can play a role in solving urban transport problems. Looking at the three markets, what measures can encourage people to cycle more? This question must be answered at all three levels and also for the relationships between them. What kind of activity is the individual engaged in? What kind of trip does this require (the travel market) ? Is the bicycle suitable (the transport market)? Is there a bicycle available and at what cost? How comfortable and safe will the ride be (the traffic market) ? Another key question is what other travel possibilities are available and how competitive is cycling compared to these other transport modes. This all makes an analysis of the strengths and weaknesses of the different modes highly enlightening. It answers the question *for which type of trips* (purpose, distances, etc.) is cycling competitive. The assessment should allow the policy makers to discuss the optimal mix of modes.

Already we can make some basic observations about comprehensive cycle planning that aims to maximize the potential for cycling. Land use planning (see Chapter 3) should be based as much as possible on the *principle of proximity,* to keep daily destinations within cycling distance. This means that destinations should be concentrated at nodes in the urban fabric and along bicycle routes. Moreover, bicycle routes should connect these nodes and take people to existing destinations. Circumstances should contribute to the bicycle being perceived as a realistic (if not the best) option for urban trips. *Safe, comfortable and attractive* bicycle infrastructure should enable each cyclist to travel quickly and safely.

If we look at the transport market and the competitive position of the different modes, we should compare the status of cycling in developing countries, particularly Africa, with walking, public transport and motorized two-wheelers, for two reasons. One is that for the foreseeable future a large part of the population in developing countries will have no access to cars, because they simply can't afford it. The second is that it is not very realistic to expect that in societies with relatively low levels of car use there will be much room for replacing car commutes with cycling. Here the impact of improved conditions for cycling on car use, if any, is primarily indirect. The creation of a bicycle-friendly urban environment may temper people's aspirations to achieve car ownership, and raise awareness that for many trips cycling can be an option for car owners as well.

On the other hand in a growing number of cities in developing countries such as Brasilia, Sao Paulo or Mexico City car-ownership and car use are approaching levels similar to those of many European cities. For instance in Sao Paulo (2002), 32.5% of all trips was by car (Household Survey, Sao Paulo) and rising. In London (2003), 42% of all trips were made in cars, down from 47% in 1993.[26)] In wealthy Singapore (1999) only 20.2% of all trips were by car.[27)] So while some drivers may be reluctant to switch, congestion and costs are making cycling more attractive, particularly when cities offer a cycling-friendly environment.

To optimize bicycle use and its contribution to a city's social, economic and environmental performance, we need a better balance between cycling, walking, private and public transport. This is essentially a political choice. Just as building for cars has brought these vehicles flooding into every nook and cranny of our beleaguered cities, planning and integrating cycling can increase its modal share. Where this is carefully done, by reducing space available to cars and enhancing and increasing space

[26] Dunning, Jacqui. World Cities Research. Final Report on World Cities, Commission for Integrated Transport, March 2005.

[27] Ibid.

for walking, public transport and cycling, some car trips may be eliminated altogether, through more judicious planning of routes, and some will actually shift to other, more sustainable and city-friendly modes. This will have additional impacts on other transport modes, since the quality of cycle and walking trips, in terms of safety, directness and comfort, tends to rise as the volume of cars using the same road space falls. A conscious bias in favour of integration and more balanced distribution of scarce road and public space is essential to counteract the strong bias among traffic engineers and some politicians today, in favour of cars.

Restoring a better balance is vital to quality of life. "In surveys done in relatively affluent and fast modernising cities like Delhi, it has been found that even now 60% of the people commute by buses, which occupy less than 7% of the road space, while cars which crowd over 75% of the roads, transport only 20% 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*."[28)]

Even in countries with relatively low car ownership, we find that an attempt to correct this bias by providing sufficient road space to other modes (including cycling) may conflict with traditional car-oriented road designs. Thus, a strategy to promote cycling will also affect the space available for private cars, although assigning some road space to semi- and fully segregated bicycle facilities may improve flows of motorized traffic, thus make the use of available road space more efficient.

The key question is what will it take to provide good quality, affordable transport to the poor and to avoid or undo the negative effects of disproportional dependency on the private car. One answer that comes to mind is low-cost public transport systems. Compared to cycling, however, a public transport-based strategy generally requires much higher investment per person/km. Moreover, public transport trips tend to be less efficient for shorter distances (up to 15 km), because it can take as much time to reach the bus stop or train station (or get to one's final destination) as it does for the ride itself. For short distances, including feeder trips, people must still walk. Giving them the option of cycling would therefore expand their options for trips up to15 km. Upon that it would also enlarge the catchment area of public transport around entry and exit points, thus making public transport accessible for a larger proportion of the population. In countries with less bicycle use, free-choice cycling (that is, where people with more travel options and cycle by choice) is mainly significant for trips up to 5 km. This rises as users become more adept and accustomed to cycling as a transport mode.

2.4 Benefits of and barriers to cycling

This section examines the benefits of and barriers to cycling, at the individual and social levels.

2.4.1 Benefits to the individual

Cycling offers the individual three main benefits:

Benefit 1: Improves access and mobility choices

By far the most important reason to cycle is that it is a practical way to get around. In congested cities, cycling may be the fastest transport option. The bicycle therefore offers time savings and makes it possible to travel more and further. When cycling replaces walking both accessibility and mobility improve. By bicycle one can move easily three times as fast as on foot and thus travel three times as far in the same time. This enlarges the accessible area enormously. With the right accessories, bicycles can also carry a hefty cargo, thus making trips for local shopping, school and other errands much more comfortable.

Benefit 2: Exercise and health

Riding a bicycle every day is good exercise and improves one's health. For office workers, students, women in sedentary jobs, with the resulting increased risk of obesity and other similar conditions, the daily exercise provided by a cycle commute substantially reduces the risks of health problems such as high cholesterol, diabetes and depression. A University of Amsterdam study found that typically a regular cyclist (defined as three cycle trips of 6 km per

[28] Narain, Sunita. Editorial: Urban growth model needs reality check, Centre for Science and Environment, India. Fortnightly News Bulletin, 12 October 2006.

week) enjoyed the same health as someone ten years younger who does not cycle.[29] Indeed, recently a group of German researchers analysed the contents of more than 7,000 studies of cycling's effects on health.[30] Cycling:

- At a moderate pace burns from 500 to 700 calories per hour.
- Generates endorphins, the "happy hormones", reducing depression and reinforcing the immune system.
- Reduces the risk of a heart attack and other illnesses.
- Boosts the amount of "good" cholesterol and reduces the "bad".
- Improves back health.
- Tends to regulate blood pressure, improve lung capacity and oxygen absorption.
- Strengthens bones and keep muscles in good shape.
- Obtains results without straining joints, since cycling is low impact.

Benefit 3: Cost savings

A third benefit is that cycling saves money that would otherwise be spent on public or private transport. Cyclists can thus spend more on other activities, increasing their possibilities.

2.4.2 Benefits to society

Cycling also benefits society, particularly when it increases to significant levels. The main benefits are discussed in this section.

Benefit 1: Fewer emissions

Bicycles generate no air pollution, no greenhouse gases and hardly any noise. Reducing emissions and noise are critical to slowing global warming, cutting down on asthma, other upper respiratory and cardio-vascular diseases, and reducing sleep disorders. In both developed and developing countries, upper respiratory illnesses, particularly asthma, are increasing dramatically. While emission standards and cleaner vehicles can greatly reduce certain emissions, reducing carbon dioxide, nitrogen oxides, and ground level ozone through tailpipe-focused measures alone has proved exceedingly difficult.

Benefit 2: Better use of public space

Cyclists are more efficient users of scarce road space than private motor vehicles, helping to combat congestion. While fully occupied public transit vehicles (apart from pedestrians) are the most efficient users of road space,[31] cyclists require less than one-third of the road space used by private motor vehicles. Even cycle rickshaws use considerably less road space per passenger than motorized taxis and single occupancy private motor vehicles. A car requires 15 times the space to park as a bicycle.

Benefit 3: Improving social equity

In some developing country mega cities, reaching centres of employment from low-income settlements is an arduous journey, which in some cases consumes over one-quarter of a family's disposable income[32] and more than four hours each day. As shown previously, for trips under 3 km, the poor of Surabaya are already more dependent on motor vehicles than Germans, who have incomes 40 times higher. This is imposing an enormous, needless burden on the poor, inhibiting their ability to participate in the workforce, and gain access to education and health care. Cycling can play an important role in providing fast and affordable transport for the poor.

Benefit 4: Good combination with public transport

Viable and safe walking and cycling are also crucially important in allowing people to reach public transport facilities, but in many cases little attention is paid to these access modes. Investment in high quality walking and cycling facilities for the poor benefits every member of society. It creates spaces where people of all incomes can meet as equals. Where income disparities are very high, this is very important.

The combination of cycling and public transport can also provide a good alternative to car use. For many, public transport alone is not a

29 Eindrapport Masterplan Fiets; Dutch Ministry of Transport 1998.

30 Health Centre, German Sports University, Cologne, "Cycling & Health – Compendium", No date. http://www.zfg-koeln.de, 2007.

31 This also depends on operating speeds, frequency and the need for specific infrastructure.

32 Mahadevia, D, Poverty, Livelihood and Accessibility, in Cycling in Asia (draft version), compiled by Tiwari, Arora and Jain, Interface for Cycling Expertise, 2008.

good substitute for the private car. The private car offers door-to-door service, while public transport always needs a trip to access the system and a trip to reach the final destination from the station. However, when safe cycle parking facilities are provided at public transport stations, the combination of the bicycle and public transport can be a very good alternative to the car.

Benefit 5: Improving road safety and security

There are an estimated 1.1 million traffic deaths worldwide every year. According to the World Health Organisation, traffic accidents are the second leading cause of death among young people in developing countries. In these countries, the vast majority of traffic accident victims are pedestrians and cyclists, although with increasing motorcycle use, motorcyclists are fast becoming the majority of road fatalities in many rapidly developing Asian countries such as Vietnam. Increasing the share of cycling and providing users with safe facilities can substantially improve road safety. Not only is it possible to reduce the number of accidents for existing cycling trips, but it is even possible to reduce the number of accidents while cycling increases, as these figures from the Netherlands show.

Cycling can also enhance security in the public domain as it adds to the presence of approachable people on the streets. A critical mass is required for safe streets. Indeed, this principle is well established in injury prevention and traffic safety literature. Jacobsen (2003) found "safety in numbers", *i.e.* that "Risks are substantially lower in cities where a higher proportion of the population cycles or walks to work", while in Denmark, where cycling is popular and safe "fatalities per million km cycles are about a third of the UK rate…"[33)]

Benefit 6: Stronger local and national economies

Virtually every trip begins and ends with walking or cycling, whether between a parking lot and an office building or a home and a bus station. At five kilometres per hour, having to walk a kilometre out of your way adds 12 minutes to a trip. The proportion of travel time spent on human-powered trips is in many cases a substantial part of the total travel time. Improving travel time, for example by cycling instead of walking, is as important to improve travel efficiency as measures to improve the flows of cars. This makes fast routes for walking and cycling an essential part of any efficient transport system. *In some countries it takes as long for people to walk from their homes to the nearest bus stop as it takes to fly from Sao Paulo to Rio de Janeiro.*

The economic benefits of enhancing cycling are evident according to several Dutch inventories. In Houten (the Netherlands) half of all visits to the shops in the city centre are made by bicycle.

Figure 22

Seamless modal integration: Safe cycle parking facilities at a Transmilenio station in Bogotá. Bicycle parking facilities at railway or bus stations enhance public transport. The combination of cycling and public transport becomes more competitive with private cars.

Photo by I-CE, Roelof Wittink

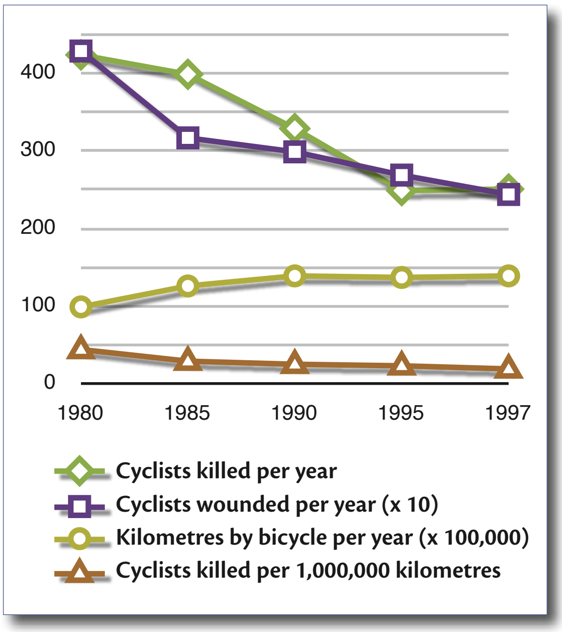

Figure 23

While cycle use increased in the Netherlands between 1980 and 1997, the number of cyclists injured or killed in traffic decreased.

Source: I-CE

33 Jacobsen, P L 2003. "Safety in numbers: more walkers and bicyclists, safer walking and bicycling", *Injury Prevention* Vol. 9, pp. 205–209. For more information, see the figures provided in Chapter 14, on research methods.

The city centre remains attractive, because it is not overloaded by cars. People spend their entire food budget in town (in total 100 million Euro). In the non-food sector they spend half their budget in Houten (50 million Euro). This shows how a well-planned town can satisfy most of citizens' needs and avoid many long-distance trips.

Other inventories show that in many Dutch cities, citizens use their bicycles twice as much as their cars to visit the shops in the city centre. All cyclists together spend as much money as the visitors who come by car.

Other very concrete economic benefits include:

- Reduction in road construction, repair and maintenance costs;
- Reduction in costs due to greenhouse gas emissions;
- Reduction in health care costs due to increased physical activity and reduced respiratory and cardiac disease;
- Reduction in fuel, repair and maintenance cost to user;
- Reduction of costs due to increased road safety;
- Reduction in external costs due to traffic congestion;
- Reduction in parking subsidies;
- Reduction of costs due to air pollution;
- Reduction of costs due to water pollution;
- The positive economic impact of bicycle tourism;
- The positive economic impact of bicycle sales and manufacturing;
- Increased property values along greenways and trails;
- Increased productivity and a reduction of sick days and injuries at the workplace
- Increased retail sales in pedestrian friendly areas.[34)]

2.4.3 Barriers to cycling

Asked why they don't cycle, people seldom express a dislike of cycling. Rather, they speak of inadequate or inexistent facilities, the dangers, the low status of cycling or not having a bicycle. They indicate that if these barriers were removed, cycling would become a realistic option for them (this does not necessarily imply that they would actually cycle, but it does point to a tendency). This section lists the main barriers and preconceptions that prevent people from cycling. Some, such as climate or geography, cannot easily be overcome, while others are more easily dealt with.

Barrier 1: Poor road safety, insecurity and bicycle theft

Poor road safety is closely linked to the lack of cycling-inclusive planning and design. When there are no facilities for cyclists, they have to share the road with motorized vehicles or to use the sidewalks. Both options can be dangerous or unattractive. Travelling along busy streets, cyclists are vulnerable to cars moving at high speeds and drivers' inattention. On sidewalks, mixing with pedestrians results in conflicts and, when these issues are not dealt with adequately, cyclists both bother and suffer from the presence of street vendors, kiosks, street furniture and lamp posts.

Another aspect of safety involves the risk of bicycle theft. If safe parking facilities are not available, cyclists risk losing their bicycles. For many, this becomes a powerful reason for not buying or using bicycles.

A sense of insecurity poses an additional barrier to cycling, especially for women in quiet parts of town or after dark, where natural vigilance by pedestrians and other public space users is inadequate. This consideration has important implications for the placement of cycle infrastructure and suggests it should be in well lit areas with a maximum of use and supervision, day and night.

Preconceptions/Misconceptions: Sometimes, however, the sense of vulnerability that people (usually non-cyclists) ascribe to cycling in cities reflect poor information on accidents. In the British Medical Journal (2000), an analyst brusquely destroyed misconceptions about cycling accidents as follows: "The inherent risks of road cycling are trivial. Of at least 3.5 million regular cyclists in Britain, only about 10 a year are killed in rider only accidents. This compares with about 350 people younger than 75 killed each year falling down steps or tripping. Six times as many pedestrians as cyclists are killed by motor traffic, yet travel surveys show annual km walked is only five times that cycled; a km of walking must be more "dangerous" than a km of cycling. In both cases,

[34] Campbell and Wittgens (2004), p. 4.

of course, the activity itself is harmless — but it's in the way. Although a km of driving is ten times safer than a km of cycling, a km of urban driving is ten times more likely to kill a pedestrian than such a km cycled."[35] One can add to this, that when we compare risk according to time spent in traffic, differences between modes are less obvious. It is relevant to mention this, as the average time spent for travelling is more or less the same for all modes.

[35] Wardlaw, Malcolm, *Three Lessons for a Better Cycling Future.* British Medical Journal, 23 December 2000., pp. 1582–1585.

Barrier 2: Physical limits and distance

Barriers arising from special needs, distances, or other concerns may be more difficult to overcome in the short term and require more planning and participation. Most people will prefer another transport mode, for example, for a trip of 20 km or to do the weekly or monthly shopping, which involves the transport of large amounts of goods.

Solutions: Sometimes relatively simple changes can overcome these barriers: for those concerned about getting dirty if they cycle to work, moving at a slower pace, carrying a change of clothes, or

Box 5: Cycling and walking: neglect by design

Cycling is a perfect transport mode for short trips, but in some of the Asian cities, for example, 60% of short trips under three kilometres are made by motor vehicles (ITDP, 2003), usually motorcycles, mopeds, or paratransit. Three reasons are:

1. In many cities there are few pedestrian or cycling facilities. Over 60% of the roads in Jakarta, for example, have no sidewalks, and those that exist are obstructed by telephone poles, trees, construction materials, trash, and open sewer and drainage ditches.
2. The traffic system has been designed to accommodate fast cars, at the expense of pedestrian and bicycle safety. Many Asian cities make minimal use of traffic lights, zebra crossings and medians which make it safer for pedestrians to cross. As a result, the number of roadway fatalities per vehicle is many times higher in Asia than in Europe or the US.
3. Barriers for cyclists and one-way streets have been used to facilitate long-distance motorized trips, but simultaneously impose huge detours on short-distance cycling and pedestrian trips. People wishing to cross a main shopping street often find it easier to take a taxi two kilometres than to walk across the street. In Surabaya, a World Bank financed study estimated that these measures generate an additional daily 7,000 km of needless vehicle traffic.
4. Cycling (and walking) are simply neglected in many transport designs. All too often, cities offer no cycle paths, no safe crossing facilities and no parking facilities for bicycles.

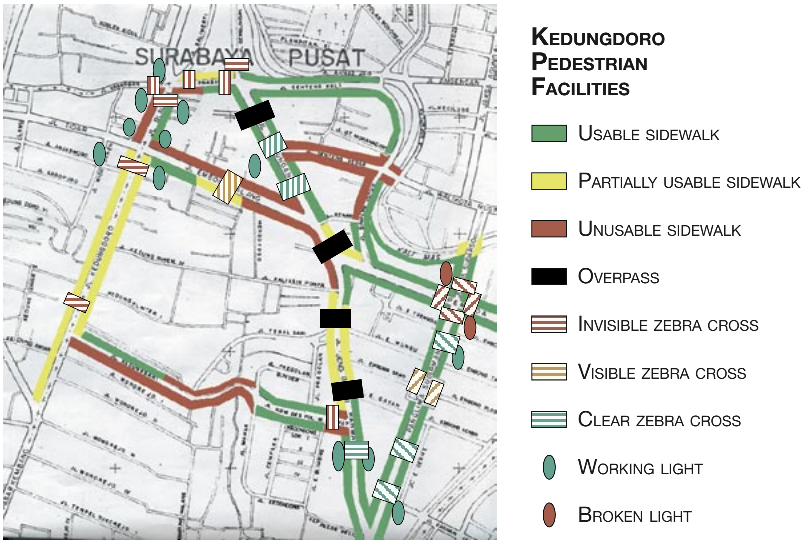

Figure 24

Pedestrian facilities in Surabaya (Indonesian). Lack of proper pedestrian facilities makes walking uncomfortable and often dangerous, forcing pedestrians to make detours. In many cities the same is the case for cycling. This is one reason why so many people use motorized modes for very short trips (ITDP).

having access to showers at destination may be simple solutions. Providing suitable accessories for shopping — quality baskets, panniers, elastic fasteners, carts, children's wagons and bags — can overcome hesitation to shop or travel with children by bike. Similarly, integration of bikes on buses, subways or trains can help overcome the barrier posed by a steep hill or highway on an otherwise pleasant cycling route.

Preconceptions/misconceptions: Often people focus on cases where cycling is not possible rather than where it is possible. When cycle planning started in Bogotá in the 1990s many people said that Bogotá was too big and distances were to long to cycle. The statistics however showed that more than 50% of all trips were less than seven kilometres, making them good candidates for cycling.

Barrier 3: Climate and geography

Many people feel that the heat in Asian, African or Latin-American cities discourages cycling. They don't want to arrive at their destinations sweaty and hot. Note, however, that average temperatures in many Asian cities are similar to those in Europe during the summer, when cycling trips are at their peak. Peak temperatures and humidity can nonetheless deter cycling, as do other weather-related aspects, such as heavy rains or snow. Geography can also be a problem, particularly in cities built on hilly terrain, with steep streets, which make cycling less appetizing, especially in combination with high temperatures or carrying goods.

Solutions: Many solutions are now available to overcome these kinds of barriers. Sometimes simply using the right clothing (outdoors stores catering to the hiking, trekking and backpacking crowd have many great solutions). A tree planting scheme can be implemented to provide cyclists with shade and pavements can be used that do not radiate heat. In hilly terrain, bicycles with gears generally do the job. Bike racks on buses, electrically powered bike taxis, cable cars for cyclists and electric bicycles can help overcome barriers.

Campaigns to overcome these limitations, teaching people how to dress for rain and cold for example, can also make a significant difference. Companies, institutions, parks and other facilities can also provide showers or washrooms near bicycle parking facilities, with room to change into a dry set of clothes.

Preconceptions/misconceptions: In many cases, however, ideas about 'unsuitable' weather and geography are self-fulfilling prophecies. In the Netherlands, many drivers mention rain as a deterrent to cycling and are very surprised to find out it only rains 6% of the time. Similarly, there are avid urban cycling groups in San Francisco and Vancouver, two of the world's hilliest cities. And Santiago, Chile, where some people say cycling is not viable due to the hills is actually rather flat, with very gentle slopes up into the foothills of the Andes (which are tall indeed!) and very little wind resistance.

Barrier 4: Affordability and availability

In many countries, for some people cost is a barrier to bike use, as is the lack of (suitable) bikes. Design of both bicycles and the right accessories, especially for carrying groceries, children, books and other cargo, is particularly important to children and women.

Solutions: A supply of suitably priced bicycles near potential users can be essential to increase use. This may require bicycle sales outlets in low-income residential areas, since these are often the groups most prone to use bicycles. These groups may lack the funds, however, to purchase a bicycle. Another solution to this problem can be a micro-credit system offered by the retailer directly or by some financial third party (often Grameen[36])-style alternative banks or publicly owned banks). People can then pay over time, even using the money saved by not having to bus fares or gasoline costs. Often the bicycle can be paid off relatively quickly, freeing up savings for other uses.

Companies concerned about their carbon footprint and with serious corporate social responsibility policies can also contribute, by purchasing bicycles and making them available to employees, providing simple loans programs, or applying innovative strategies such as that of Humana Inc., a major health insurer (US). Humana not only provides free bikes to its own

[36] From Wikipedia: The Grameen Bank is a microfinance organisation and community development bank started in Bangladesh that makes small loans known as micro-credit or "grameencredit" to the impoverished without requiring collateral. The word "Grameen", derived from the word "gram" or "village", means "of the village".

Figure 25
The mayor of the Dutch city of Groningen discusses cycling with the mayor of Gabarone, Botswana/Africa. In Groningen, a city with 180,000 inhabitants, 38% of all trips are made by bicycle. Within the city ring road, one of every two trips is made by bike. Car owners regularly use their bicycle in daily trips, as demonstrated by the mayor and his colleague.
Photo by I-CE Roelof Wittink

employees; during the US' 2008 elections it provided bike-sharing to both the Democratic and the Republican national conventions.[37)]

Barrier 5: Attitudes and cultural constraints

Among the most difficult constraints to overcome are those involving attitudes. In many societies, the bicycle is considered a poor man's vehicle. Its status is low, making middle and high income users reluctant, for fear that others may think they cannot afford "better" transport. Some cultures consider it inappropriate for women to cycle (this is rather exceptional, however) or women simply don't know how. Sometimes cycling-friendly countries assume "everyone" grows up knowing how to ride a bike, thus ignoring the fact that immigrants (sometimes up to half a city's population, as occurs in Toronto) need training.

Solutions: In European countries, such as the Netherlands and Denmark, cycling is not associated with any particular status. Business people and prominent politicians, such as the prime minister, cycle to work. Many employers don't allow people living nearby to come by car, parking space is reserved for those coming from afar, and others are expected to come by bicycle or by public transport.

Different people will have different answers about when and where the bicycle is a realistic option. Usually the answer depends on a combination of knowledge and perceptions. A bicycle promotion strategy should therefore deal with the necessary changes to the physical road environment, but also pay attention to people's views. Perceptions are influenced by road safety, costs and savings, travel times, weather, and so on. Perception, however, is not necessarily based on facts. Sometimes people simply don't realize that cycling could be an option: often, in fact, it is easier, safer, faster and more practical than they suspect.

Civil society organisations can play an important role in correcting perceptions. An excellent example is the film, Cycling Friendly Cities, by the Colombian *Locomotives*[38)] partner, *Fundación Por el Pais Que Queremos*. It targets the perceptions of politicians and the public by showing that cycling is a vital part of transport systems in modern and affluent cities in the Netherlands and Denmark. Its message is that

[37] Reuters, Pedalling a health Initiative, http://www.reuters.com/article/pressRelease/idUS183012+15-May-2008+BW20080515, http://bike-sharing.blogspot.com/2007/09/humanas-freewheelin-ridin-high.html and Toronto Centre for Active Transport newsletter, http://www.torontocat.ca/main/node/332, 23 September 2008.

[38] The first phase of Interface for Cycling Expertise' bicycle partnership program, 2003–2007.

cycling is for transport and not just recreation, and for everyone, not just those on lower incomes.

Cycling classes within the school system and available to the public at large are another key element in addressing the cultural changes necessary to make cycling both popular and safe. Often these are offered by professionals within city parks and recreation or physical education departments. Women's groups and civil society groups are also active leaders in providing this kind of service.

Another way to influence attitudes on cycling is the organisation of Carfree Sundays (*Ciclovías/Ciclorecreovías/Recreovías* in Spanish), popular in Bogotá, Rio de Janeiro, Quito, Santiago and other cities. These involve closing highly visible streets to motorized traffic and throwing them open to cyclists and a wide range of human-powered modes — wheel chairs, strollers, skates, skateboards, or plain old walking. These kinds of events, particularly when practised on a large scale (a million people or more participate in Bogotá's CicloVía every Sunday), are highly effective. Weekday drivers suddenly discover the bicycle and become more aware of cyclists when they drive. Children and women, in particular, can practice riding on the road, rather than trying to navigate a parking lot or sidewalks in their efforts to learn. Residents see that their dangerous road suddenly becomes a friendly space for social life and play. The benefits are enormous, above all for educating a wide range of people on how the different transport modes can interact in a friendly, orderly fashion.

Barrier 6: Biased thinking

Citizens expect more action from politicians to promote environmentally friendly modes of transport. At the same time, politicians often think there is no public support for these measures.

In recent decades, public opinion has shifted to strongly support measures to promote environmentally friendly transport modes instead of car-centred measures. Politicians and transport planners often underestimate this support.

Even in the United States, the heart of the car-centred urban planning model, when asked "Which of the following statements describe you more: (a) If it were possible, I would like to walk more throughout the day either to get to specific places or for exercise or (b) I prefer to drive my car wherever I go?", 55% of respondents said they would rather walk, versus 41% who preferred to drive. Similarly, when asked "Which one of the following proposals is the best long-term solution to reducing traffic in your state: build new roads, improve public transportation, such as trains, buses and light rail, or develop communities where people do not have to drive long distances to work or shop?", two-thirds preferred either developing communities in ways that mitigate the need to drive (30%) or improving public transportation (35%), with just 25% supporting the building of new roads.[39]

Studies by Werner Brög (founder of Socialdata, an international transportation research and marketing firm) found that most citizens in European countries experience the consequences of car traffic as hardly bearable (54%) or unbearable (22%, (Brög 2003). During the 1990s, Brög's findings strongly influenced the Dutch government's strategy. In the Netherlands' National Mobility Plan, there was a significant shift toward promoting cycling, to develop sustainable safe traffic and to create liveable city centres. During this period, a national cycling project group supported municipal efforts in this sense with funding, advice, manuals and exchanges.

Solutions: Individual initiatives, such as writing letters to the newspapers or to politicians, organizing collective bike rides, raising cycle-related issues at public planning meeting, can do much to change these erroneous opinions. Above all, active, well-organized citizens' groups capable of demanding and getting more and better cycle-related facilities are the key to correcting these kinds of opinions. Where possible, additional studies, plebiscites or other initiatives can also help, but should be carefully weighed to ensure they will achieve the desired results.

[39] Beldon Russonello and Stewart, "America's Attitudes Toward Smart Growth," September 2000, quoted in Howard Frumkin *et al.,* Urban Sprawl and Public Health, Island Press: Washington, 2004.

2.5 Context is important to success

Officials, politicians and civil society organisations wanting to introduce and/or promote cycling as a transport mode have to be aware of the context in which they operate. Nice examples from small, compact cities in the Netherlands or Denmark may not be directly transferable to the reality of, for example, a developing country mega city. The city size and city structure may encourage or discourage bicycle use. Large urban densities imply that many destinations are within cycling distance, but if destinations are spread far apart, a campaign to promote cycling will be less effective (see also Chapter 3).

2.5.1 *History of local cycling*

Whether a city has a substantial level of bicycle use or it is just being introduced as a great new idea makes a difference. A history of cycling (or the lack of one) is important for the choice of a promotion strategy. In Asian countries such as India, where the bicycle has been used for decades by much of the population, bicycle use is threatened by soaring motorization rates. In such countries, a pro-cycling strategy should aim to protect and sustain existing levels. The presence of cyclists on roads makes it easier to argue for their 'fair share of the road space'.

In Latin America, on the other hand, cycling is often regarded mainly as a sporting or recreational activity or a merely a children's pass time. As a daily transport mode it is perceived as a rather new phenomenon in many cities, although this is not the case everywhere. Countries such as Brazil and Colombia have a long history of cycling for transport and in many smaller cities the bicycle remains an important mode of transport for construction and factory workers. Where commuter cycling is rather new, such as in the Peruvian capitol of Lima, it is harder to justify devoting more road space to cycling facilities, as least as long as levels of daily cycling remain low. Therefore, cycling

Box 6: Planning for cycling: an economic perspective

In a recent study, I–CE calculated the ***economic value of planning bicycle facilities in four cities***, one of which was Bogotá.

The costs of building bicycle paths, their maintenance, and promotion and education campaigns were calculated at US$178 million over a 10-year period, with construction costs estimated at US$200,000/km, for a high quality bicycle path.

Savings from reduced infrastructure needs, reduced congestion and reduced pollution due to the replacement of car kilometres over ten years totalled US$492 million, of which more than half came from savings on parking spaces.

Road safety was expected to improve by 50%, based on experiences abroad. This would bring additional savings worth US$643 million.

Savings on operating costs for road users foregoing car or bus use came to US$167 million.

The overall result was that benefits should reach US$1,302 billion over ten years, versus an investment of US$178 million costs. The benefits were therefore 7.3 times higher than the costs.

For more information: http://www.cycling.nl

Source: The Economic Significance of Cycling; VNG/I-CE, The Hague/Utrecht: 2000

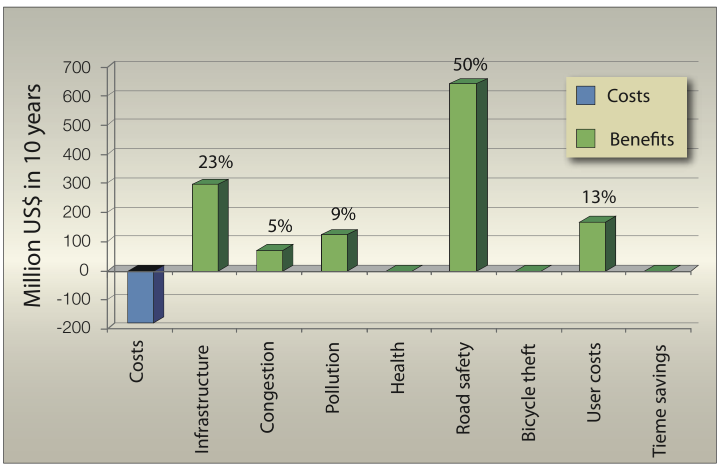

Figure 26
Cost-benefit analysis of Bogotá's bikeway project.
Developed by I-CE

facility implementation should be combined with campaigns to promote use.

In many African countries the situation is different again. Here the problem is that much of the population cannot even afford to own a bicycle. When cycling's importance to the mobility of the poor is recognized, the first target for cycle promotion strategies is to make bicycles available to those whose mobility is severely limited without it.

To conclude, if key conditions are not present, measures that are effective in one situation will be less effective in others. Any local bicycle strategy should be based on a good analysis of the existing levels of cycling and trends and on the local culture and the preconceptions that exist against cycling. Is cycling being threatened or is it on the rise? Which population segments use bicycles? What is the status of cycling? Is bicycle use captive or is it 'free choice'?

2.5.2 Professional traditions and regulations

Professional traditions among transport planners and engineers can also be a barrier to integrating cycling facilities. Over the past 50 years, transport planners and traffic engineers worldwide have been taught to think that cars are *the* transport mode. They focus on ensuring the smooth "flow" of motorized traffic. They struggle to accommodate ever increasing car use in existing road networks, creating a strong bias in favour of cars. Often they perceive other types of road use as a nuisance making their 'main task' more difficult, rather than as something worth sustaining and fostering.

Traffic regulations and highway codes and design guidance in many countries often reflect this bias. When city leaders opt for a paradigm shift from a car-oriented to a people-oriented transport policy, rigid design standards and legal regulations can stymie progress. Even professionals with good will may feel 'trapped' by existing regulations. When introducing cycling promoting policies, it is therefore important to analyse the legal status of cycling in highway codes and road design standards. If these are restricting the more cycling-inclusive road designs, then this issue must be addressed. In these situations it is very helpful to create (or agree upon) some room for experiments and pilot projects. Of course it is also important to create good conditions for such experiments, such as proper pre- and post-studies, and procedures to follow up effectively on successful experiments.

2.5.3 Policy transfers to other places

It is also important to realize that there are many factors that can influence the success of policy transfers[40] from one time or place to another. Studies have shown that these tend to be more successful when there is plenty of room for local players to change the imported policy, adapting it to their own idiosyncrasies. Flexible, open-ended proposals tend to be better received than rigid attempts to photocopy the original initiative in all its details. Civil society participation helps, because these organisations tend to build horizontal relationships based on cooperation, rather than hierarchy, which some actors may perceive as imposition.

In most countries it is easier to introduce change within informal practices, value orientations, informal codes, roles, and from there move to procedures, formal regulations and legal systems, and finally constitutional change, where necessary. But some countries have good laws, yet civil servants do not actively pursue their implementation. It is essential to understand that significant changes require modifications at informal and formal levels, and that where possible these should be developed together, in a complementary way so they reinforce each other.

Building strong and cooperative relationships between different levels of government and interested civil society groups — not only cyclists but also women's and community organisations, student and labour unions, and so on — is essential to build positive attitudes supportive to these changes throughout society.

2.6 Further reading

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[40] See especially, Rose, Richard. *Lesson-Drawing in Public Policy. A Guide to Learning Across Time and Space.* Chatham House Publishers, Inc: Chatham, New Jersey, 1993.

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Table 4: The main lessons for success of transplantation

Proposition	Relevant lessons
Imposition versus *adoption*	Depends mainly on attitudes among local actors, independently of origin or idea. Top-down origin may generate more opposition.
Xeroxing versus *adaptation*	Xeroxing (attempt to create exact copy) creates substantial problems, whereas leaving room for local adaptations reduces resistance and difficulty
Single model versus *multiple models*	Considering several models or a more loosely defined model makes it easier for the adopting location to accept, adapt and implement the proposal
Endogamy versus exogamy (countries with similar versus countries with different cultures)	Initial assumptions, that transfers between countries belonging to different "families" (from France to England, for example) would be more difficult proved false, whereas assumptions that from like to like (US to England) found that institutional differences tended to be "grossly underestimated". Preparedness for possible complications is very helpful.
Concrete procedures versus *guiding principles*	The thesis that the "generic character of a transplant facilitates the transplantation process" proved true. Where rules and procedures are too specific, they may become the central issue, rather than the new policy action under implementation.
System upheaval and/or performance versus protracted sense of policy dissatisfaction create *windows of opportunity*	This may favour the adoption of a new policy, programme or institution, by creating a ***sense of urgent need for change***.

Lake Sagaris, based on categories and comments in De Jong *et al.,* (2002), pp. 286–292.*)

*) De Jong, Martin, Konstantinos Lalenis and Virginie Mamadouh. The Theory and Practice of Institutional Transplantation Experiences with the Transfer of Policy Institutions. Kluwer Academic Publishers: Boston, 2002.

3. Ideas that shape urban form — and how urban form shapes us

Steven Schepel and Mark Zuidgeest

For related subjects

See ***Chapter 4*** on managing and implementing plans and policies.

See ***Chapter 13***, on social marketing and citizens' participation.

See ***Chapter 14***, on education, awareness-building and advocacy.

See ***Glossary*** on traffic calming and civil society organisations.

3.1 The crucial relationship between transport and the quality of public space

Human-powered transport (cycling and walking) and the quality of public space are crucial aspects in designing cities for people. Urban plans often neglect these, however. Cars and other motorized vehicles tend to dominate today's cities, leaving little room for people. Good urban planning can balance space for people, human-powered and motorized transport, creating a more liveable and attractive city.

This chapter should be seen as an invitation to take some time out, sit back with a delicious drink (hot or cold depending on your time of year!) and really think about the recent evolution of cities and ideas about them. We offer it also as a source of inspiration, full of examples and ideas to invite readers to break out of current boxes on their thinking and develop a renewed vision.

We start by discussing different theories on the relationship between urban form and travel patterns, in Section 3.2, showing how smart land use planning and design of (sustainable) urban form are important instruments to achieve much needed changes.

We then go on to explore the recent history of city development, following the rapid increase in car use during the last century in Section 3.3. This led to separation of functions and we give several examples.

In Section 3.4, we discuss two paradigm-changing visions of urban planning, developed by Jane Jacobs (US), a critical voice located in the heartland of car-centred urban planning development, and Jan Gehl (Denmark), whose innovative applications of people- rather than car-centred planning has received worldwide acclaim. Both emphasize the importance of thriving, safe, and attractive streets for city life.

We then go into the role of cycling and human-powered transport in urban planning in more detail in Section 3.5, identifying features key to the quality of public spaces. Sections 3.4 and 3.5 are intimately related, since good public space invites human-powered transport and the presence of pedestrians and cyclists is essential for the safety and attractiveness of public spaces.

Finally, in Section 3.6, we briefly discuss some outstanding examples of processes and design methods suitable for achieving (support for) urban plans that take the role of public space and human-powered transport fully into account.

3.2 Urban form responds to and shapes travel

Theories on the relationship between urban form and travel patterns are based on the notion that travel is a derived demand. This means that people want to engage in activities that cannot all take place at the same location, and are therefore spatially distributed over a larger area. The result is travel, a "disutility", that is, something that has no benefit in and of itself, but rather enables people to participate in desirable activities. Because of this, travel should be overcome at the lowest possible cost

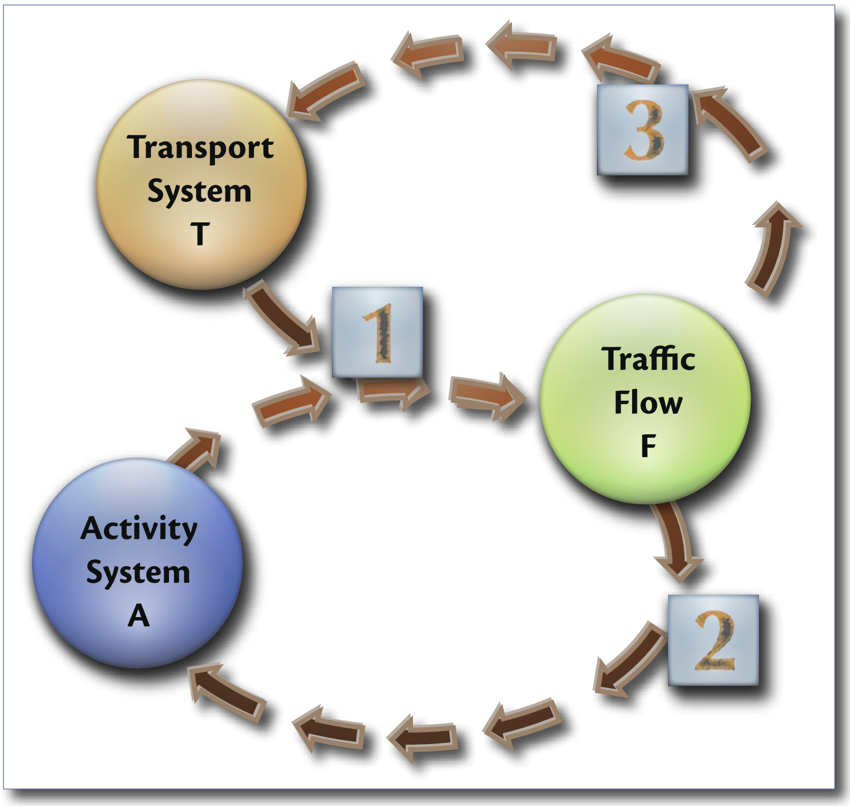
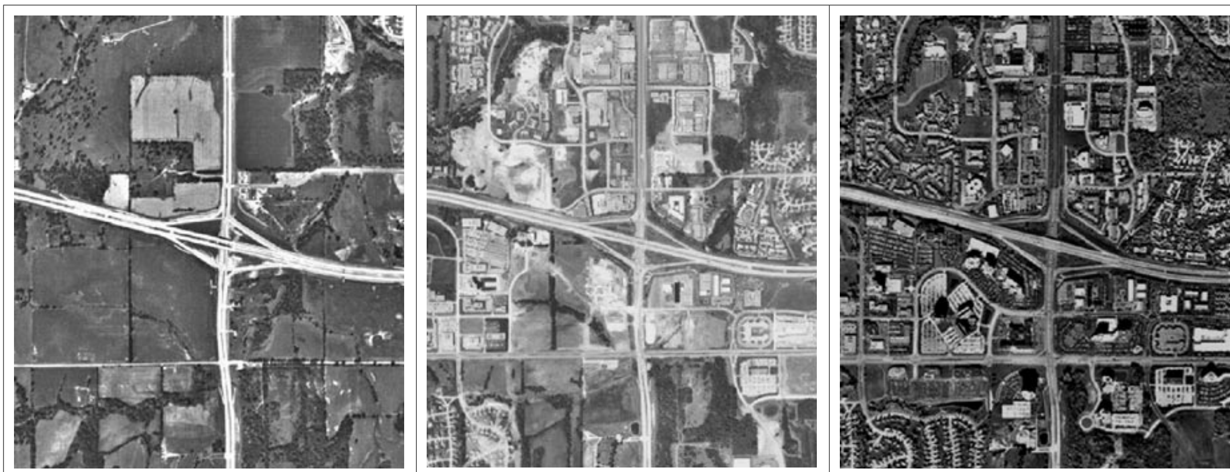


Figure 27

Interaction of Transport and Activity Systems.

Source Manheim (1980)

Box 7: Spatial and temporal interaction between the transport system and activity system



year 0 (a)	year 10 (b)	year 25 (c)

Source: Dantas & Ribeiro (2004).

Dantas and Ribeiro (2004) provide an interesting example of interaction between the activity and transport systems for a highway corridor in Brazil. This figure shows a highway segment (Figure a) upgraded at year 0. Over time, the improvements to the highway segment create changes to the surrounding environment. Figure b shows how land use (*e.g.* more densification and diversification due to increase in traffic), environment (*e.g.* more noise and air pollution as traffic density increases), demographics (*e.g.* migration of population due to new activities) and economy (*e.g.* more economic activities due to decrease in travel costs) gradually change throughout the region. Subsequently, in year 25 (Figure c), further interactions and changes are observed.

For more information on these researchers' work on transport/land use relationships, see also:
http://ir.canterbury.ac.nz/bitstream/10092/219/1/12604293_Main.pdf,
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=860810

Similar dynamics can be observed in urban transport – activity systems. Land use/activity planning influences trip frequencies, trip lengths, mode choice, possibility for introducing mass transit systems, etc. Likewise transport system performance influences location choice of people and businesses.

(in time and distance) and should maximize comfort, safety, and so on.

In their efforts to achieve sustainable urban development, scientists and policymakers use this notion to change travel patterns. Thus, smart land use planning and design of (sustainable) urban form become instruments to:

- Reduce the need to travel;
- Change travel modes in favour of more sustainable modes;
- Reduce trip distances;
- Reduce energy consumption.

Network characteristics and land use patterns (Figure 27) generate spatial interaction patterns, thus travel. So understanding how land use patterns (activities, locations, densities) and the transport system interact is crucial in assessing (possible) impacts of transport policies.

Manheim (1980) defined the urban activity system as the totality of social, economic, political and other transactions taking place over space and time in a particular region, while the transport system consists of the facilities and services that allow traffic flows in an area. Figure 27 shows the interaction between an activity and the transport system. People, trip makers, use the transport system to reach the locations of their activities; hence the activity system and transport system interact (number 1 in the figure). The resulting traffic flow patterns can also influence the activity system (number 2), for example restaurants moving close to road infrastructure or companies moving out of highly congested areas. Traffic flows may again influence the transport system (number 3), for example when new public transport routes are introduced along busy corridors.

3.2.1 Land use patterns determine transport needs

The demand for transport in cities is determined largely by the spatial arrangements of different forms of land use. In most developing countries, rapid urban expansion driven by in-migration or deliberate segregation leads to many new arrivals being forced to live far away from job opportunities in the city centre. Informal economic activities also produce a travel demand pattern with spatial and temporal characteristics that differ from those generated by the more formally organized economic activities in developed cities. Polarized income distribution common to cities in the developing world also affects mobility levels, types and travel patterns. The diverse demand for urban transport is often not satisfied, for example, by the kind of high-capacity radial transport corridors that serve western cities (adapted from Pacione, 2005).

The relationship between land use and transport is encapsulated in the distinction between the (UN, 1996):

- Traditional walking city;
- Transit city;
- Automobile-dependent city.

The transport problems in developing cities can be characterized for the most part by their rapid transition from walking city to automobile city without simultaneously developing high-capacity public transport systems and policies to cater for pedestrians and cyclists, as generally occurred in cities in developed countries (it must be noted that measures to rationalize private automobile use must accompany these improvements to shift trips towards public and non-motorized transport). At first sight, the compact urban form of most developing cities appears well suited to public transport and human-powered transport systems. As these cities grow bigger however, the advantage of sustainable transport modes falls, as distances increase and people become more spread out (less concentrated) among peripheral urban settlements, beyond the range of existing systems (adapted from Pacione, 2005). Public transport use in many developing cities is very high, but service may be low in frequency, wait or travel times, or quality, because no policies restrict car use. Congestion then inhibits the smooth running of public transport.

Indian cities, for example, as described in Pucher *et al.,* (2005), have grown in population, while spreading outward. The lack of effective planning and land use controls has caused development to explode far beyond old city boundaries and sprawl into the once distant countryside. This has greatly increased the length of trips for most Indians, making them more dependent on motorized transport. Lengthy distances make walking and cycling less feasible, while soaring traffic makes walking and cycling less safe.

Empirical Evidence on the Key Influences

Theoretical reflections on the potential effects of urban form typically examine the spatial distribution of important activity locations, such as residences, jobs and shops. Movements such as New Urbanism (US) typically see reducing distances between these types of locations as a way of reducing trip lengths and changing travel patterns, but this is not entirely clear.

In an extensive literature survey on how urban form influences travel behaviour at the neighbourhood, city and regional levels in the Netherlands, Snellen (2002), in her PhD dissertation, demonstrates that it is very difficult to draw general conclusions. However, three major factors keep reappearing as being most important on all scales and in all types of studies:

1. Density of development;
2. Mix of land use;
3. Local accessibility to public transport.

These factors are very much in line with the theoretical discussion mentioned above. As Snellen (2002) states, given that travel is a derivative of activity participation, distances between activity locations should be shortened to reduce travel. The main tools to achieve this are increasing density and improving the land use mix. Theoretical discussions also underline the need to make alternative travel modes such as walking, cycling and transit more attractive. Other measures include transit access and better urban design (particularly more interconnected networks and attractive streets).

These theoretical observations are useful, but just because better designs reduce distances between these urban functions does not necessarily mean that people will behave as expected. Other factors beyond the control of land use planners influence people's choices. Indeed, the evidence suggests that at least part of time saved will be "spent" on travelling more. The specifics of this relationship with regard to bicycle trips have not yet been researched, particularly in cities in developing countries. There, urban structures are often more heterogeneous, sometimes informal and unplanned, people have fewer travel choices. Moreover, other factors, such as socio-economic level, safety, topography, culture and climate, play important roles in people's decisions.

In a study on the potential mobility effects of different urbanization scenarios in the Netherlands, Verroen (1995) illustrated the interaction between three main urban factors: density, land use mix, and local access. This author built scenarios based on variations in several aspects of urban form, for example mono-functional versus mixed land use, mono-centric or polycentric, concentration or deconcentration, etc. using a transport model. Verroen (1995) concluded that a concentrated development of polycentric, mixed land use, urban areas would yield the best results. Interestingly, the compact city concept, which was the prevalent policy of the time, did not come out as the best scenario. However, it should be noted that the differences between the scenarios were small (Snellen, 2002).

Work by Bannister (2006); Williams (2007); Kenworthy (2006); Newman and Kenworthy (1999); and Snellen (2002), suggest several other characteristics of urban form that may promote more sustainable transport patterns, among them neighbourhood type, distance from residence to urban centre, settlement size, proximity to transport networks, road network type, provision of local facilities, availability of residential parking, concentration of jobs, decentralized urbanization patterns for the urban region, etc. These characteristics are all known to influence levels of motorized mobility, and may therefore be considered positive influences when it comes to choosing human-powered transport modes, including cycling.

Although some critics argue that scientific proof of the relationship between urban form and sustainable transport patterns is lacking, because of the inherent complexity of 'proving' the relationship (described at length in Banister, 2005, and Snellen, 2002), the information available clearly favours contained, compact urban designs, with mixed uses in close proximity to each other (*i.e.* those that avoid functional land use zoning) and reduced urban sprawl (Williams, 2005). This kind of urban design also favours human-powered transport modes, such as cycling.

Kenworthy (2006), accordingly, combined all these factors into a vision, presented as ten key dimensions, to create a sustainable city (in his own language 'eco-city'):

1. The city has a compact, mixed-use urban form that uses land efficiently and protects the natural environment, biodiversity and food-producing areas;
2. The natural environment permeates the city's spaces and embraces the city, while the city and its hinterland provide a major proportion of its food needs;
3. Highway and road infrastructure are de-emphasized in favour of transit, walking and cycling infrastructure, with a special emphasis on rail. Car and motorcycle use are minimized;
4. The central city and sub-centres within the city are human centres that emphasize access and circulation by human-powered transport modes, and absorb a high proportion of employment and residential growth;
5. The city has a high-quality public realm throughout that expresses a public culture, community, equity and good governance. The public realm includes the entire transit system and all the environments associated with it;
6. The physical structure and urban design of the city, especially its public environments, are highly legible, permeable, robust, varied, rich, visually appropriate and personalized for human needs;
7. The economic performance of the city and employment creation are maximized through innovation, creativity and the uniqueness of the local environment, culture and history, as well as the high environmental and social quality of the city's public environments;
8. There is extensive use of environmental technologies for water, energy and waste management — the city's life support systems become closed loop systems;
9. Planning for the future of the city is a visionary "debate and decide" process, not

a "predict and provide", computer-driven process;

10. All decision-making is sustainability-based, integrating social, economic, environmental and cultural considerations as well as compact, transit-oriented urban form principles. Such decision-making processes are democratic, inclusive, empowering and engendering of hope.

A focus on these ten issues should reduce automobile dependence in cities, building more sustainable urban form and creating more liveable places, according to Kenworthy (2006). There are ten key elements in the context of four crucial conditions:

(a) Environmental technologies: ideally closed-loop systems should be applied;
(b) Economic growth needs to emphasize creativity and innovation and to contribute to, and feed off, the growing environmental, social and cultural amenities;
(c) The public realm throughout the city needs to be high quality; and
(d) Cities should apply sustainable urban design principles.

Finally, all these dimensions should operate within key processes 9 and 10, which involve vision-oriented, reformist thinking (debate and decide) rather than extrapolation of existing trends (predict and provide), and a strong, community-oriented sustainability framework for decision-making (Kenworthy, 2006).

Urban form and cycling

To date, the relationship between urban form and cycling trips has not received explicit attention in the literature. Rather, these are considered among possible explaining variables in the relationships presented. Snellen (2002) reports on a study conducted by MuConsult, a Netherlands transport consultancy, which offered some interesting findings on the relationship between spatial structure and travel patterns in the Netherlands. MuConsult (2000) claims that 40% of the variance in the number of trips can be accounted for by selected characteristics of the spatial environment, the household and the individual. The proportion of variance in the number of trips explained is lower in the case of human-powered transport modes, including cycling, and public transport, than for motorized trips. Furthermore, the proportion of variance explained is higher for certain kinds of trips, such as grocery shopping and home-to-work commutes, and lower for social and recreational trips.

MuConsult identified key neighbourhood characteristics, among them street type (home or 30 km zone), density, and 'walk- and cycle-friendliness', which influenced the number of kilometres travelled, while street type and the accessibility of shopping facilities influenced the number of trips. Interestingly, dwelling type and the presence of a garden were also influential. The set of spatial characteristics used in this study did not, however, significantly improve the explanatory power for kilometres by bicycle. In this case, the value added by including spatial characteristics, amounts to about 4–15% within this 40%. This means a large part of the variation cannot be significantly explained by spatial factors and must therefore be considered in relation to social demographic, cultural and other factors.

This research must be considered in context: cycling-inclusive planning is standard in the Netherlands. If we compare Dutch cities, cycle friendliness is less explanatory for differences in cycle use than, for instance, cultural and demographic factors. Many policies, norms and design-standards are national and applied everywhere. Should we, however, compare Dutch cities with cities in, let's say, Spain or Colombia, we would probably find that cycle-(un)friendliness is an important factor in explaining the differences in cycle-use.

Moreover, in this kind of research it is always very difficult to identify cause and effect. If we compared Portuguese cities with Dutch cities on cycle use, 'cycle-friendliness' might correlate with cycle-use, but we would also find a correlation between the percentage of the population that speaks Dutch and cycle use.

One conclusion is therefore that in a relatively cycling-friendly country such as the Netherlands, the impact of further improvements is increasingly marginal. Restricting car use and ensuring a cycling-friendly road environment are, however, a primary condition to increase bicycle use, but on its own it may not be enough.

Under the auspices of Interface for Cycling Expertise, the Cycling Academic Network is currently researching the relationship between urban form and cycling trips in more detail for cities in India.

3.2.2 Three archetypes: walking city, public transport city, car-dependent city

In the typical walking city, activities are close to each other and easily accessible by NMT, and functions are not spatially segregated.

The public transport city has public transport corridors that reduce the need for residences and workplaces to be close together as long as transport stops and stations are suitably positioned. Zoning of land use by function thus becomes more apparent.

An excellent example of a public transport city is Curitiba (Brazil). Here, for many decades, urban planning and land use policy has been set up to make public transport use more attractive. In this city along the corridors of high-capacity bus lanes (BRT-lanes) extremely high urban densities are planned with around 300 inhabitants per hectare[41]. Urban densities everywhere else are much lower. Together with other aspects of successful planning, this has led to a very high usage of the BRT-system.

[41] IPPUC.

Typically, car-dependent cities have low urban densities and high car use. Some have a small, pedestrian city centre with higher density and very different transport patterns, connected by transit corridors and surrounded by car-dependent, uniformly low-density suburbs.

Clearly, urban form significantly affects mobility. The right urban form can positively influence social equity, accessibility, ecology, economic performance, clean air and health, when it facilitates sustainable transport solutions. These encourage reduced reliance on the car, quality public transport, walking and cycling, and thus cut back on transport-related emissions, pollution and accidents.

Most developing countries are experiencing rapid urban growth, uncontrolled suburbanization, uncoordinated land use, inefficient infrastructure, and transport development. Increased use of private vehicles and decreased use of human-powered transport cause traffic congestion and air pollution. Better land use planning and proper control of such planning is key to finding successful solutions. Compact, dense and mixed land use developments combined with planned infrastructure for the bicycle and public transport as well as policies that do no longer prioritize private cars (as is

Figure 28
A BRT-corridor in Curitiba and the land use policy and zoning that has made this system so successful.
Photo by Karl Fjellstrom; graph by Jeroen Buis

currently still the case in most cities in developing countries) are necessary to stimulate the use of sustainable transport modes.

Dimitriou (1992) notes that a 'new realism' movement is slowly emerging in most developing countries. Transport policy-making and planning based on 20th century patterns based on transport system optimization to serve economic growth goals are increasingly being left behind in favour of a more sustainable approach, which uses urban transport as an agent for ongoing change. This opens the way to integrated land use transport planning in favour of sustainable modes, such as the bicycle.

3.3 Cars and urban life: a history of love and hate

Cars offer enormous transportation possibilities. At the same time, unrestrained growth of their use and parking has a devastating influence on the usability, safety, and enjoyment of public space in cities, towns and villages. Drivers are isolated from street life in their steel boxes and speed up wherever possible. Other road users have little choice but to give way, even if they by far outnumber drivers. Parking takes up free space, while roads disturb street life and divide neighbourhoods.

New York was built along its avenues. Paris was totally broken up to build the boulevards around the end of the 19th century, when Barcelona and Buenos Aires got their *avenidas*. These main roads originally served as finely wrought arteries of urban life. They were places for people to see and be seen, to meet, shop, make deals, play, and learn about the world.

Then surging traffic turned them into transport gutters lined with long rows of parked cars. Today, these main roads no longer foster cohesion.

Not only does car traffic increasingly dominate the streetscape and urban life. Inevitably it begins to outgrow the available space. So domination turns into erosion. Living, working, and shopping next to a main road becomes unattractive.

Solutions usually attempt different kinds of separation: long-distance transport versus local traffic, high-speed versus low-speed, trafficflow versus delivery and parking, main roads versus pedestrian areas. The following three subsections give examples of the different ways separation has been used. The last subsection offers Jane Jacobs' views on the role of the car in cities.

3.3.1 Radburn, a small-scale example

A well-known example of separation on a small scale is the Radburn layout. Clarence Stein developed it in 1925 for residential areas in Radburn, a new town in New Jersey (near New York, US). In this layout, every house's front door opens onto a footpath, while cars are kept at the end of the back garden, reached by a dead-end road or alley.

The footpaths all lead to schools and other amenities in the middle of a residential area. One could call this a 'school-route oriented' layout. In practice, however, the front door is seldom used. Most people use the backdoor, whether or not arriving by car (or bicycle). Even children do not stick to the footpaths. They prefer the back yard for most activities.

As a variant, in 1959 Reichow launched a plan called *Autogerechte Stadt* (car-friendly city). Although the same kind of separation (cars on one side of the house, footpaths on the other) is applied, there is one important difference. The car is given the central role and footpaths lead into the countryside. The car has replaced the school for orienting design.

Later the Radburn principle was also applied to residential areas with apartment buildings. An example is the Holendrecht estate in Amsterdam South East. Public transport and (parking of) cars are located in a central axis, while paths through communal gardens, between apartment buildings, form a system of green routes.

3.3.2 CIAM: the analytical approach to town-planning

Separation fits very well into the analytical approach to town planning introduced by CIAM (Congrès Internationaux d'Architecture Moderne). From 1928 on, CIAM brought together the forerunners of the so-called 'International Style' of the period, among them well known architects such as Le Corbusier, Aalto and Rietveld, and town planners such as Ernst May (Frankfurt) and Van Eesteren (Amsterdam).

To solve the problems of unsafe and unhealthy cities, they proposed subdividing the urban fabric into clear-cut districts, each with a single function (residential, industrial, commercial, or recreational). These were to be connected by freestanding roads for smooth car traffic and mass public transport systems. The most extreme example was Le Corbusier's provocative plan to replace Paris with what he called *La Ville Radieuse* (The Radiant City), a Utopia he described as follows:

> *"Suppose we are entering the city by way of the Great Park. Our fast car takes the special elevated motor track between the majestic skyscrapers: as we approach nearer, there is seen the repetition against the sky of the twenty-four skyscrapers; to our left and right on the outskirts of each particular area are the municipal and administrative buildings; and enclosing the space are the museums and university buildings. The whole city is a park."*[42)]

Brasilia (Brazil) is an outstanding example of the CIAM philosophy and its separate functions. Every function has its specific space: restaurants are in the restaurant district, hotels in the hotel district, and so on. It's no surprise, then, that Brasilia is one of the world's most car-dependent cities.

3.3.3 Amsterdam-Bijlmer: steeple and grave of traffic segregation

South-East of Amsterdam a new suburb, called Bijlmer, was constructed in the 1960's. The concept, with its large buildings in an urban park landscape resembles very much the ideas of Le Corbusier's Radiant City. Dwellings were built in long meandering apartment-blocks, standing 12 stories high in a park-like environment. The traffic around these buildings was completely segregated. Pedestrians and cyclists found their way on the ground. Motorized traffic moved on elevated urban highways. Cars were parked inside parking garages, connected to the apartments by inside corridors. An elevated light-rail line connects the suburb with the inner city (Figures 29, 30, 31).

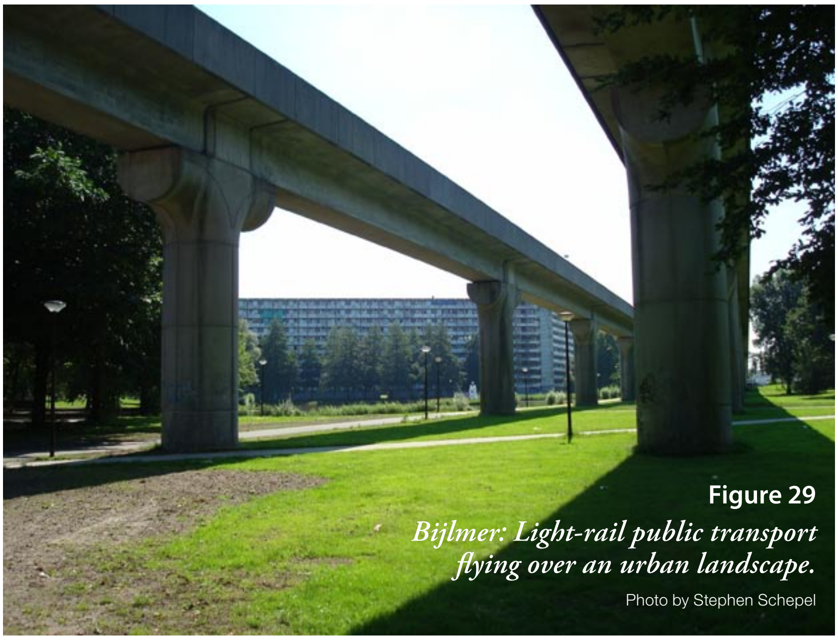


Figure 29
Bijlmer: Light-rail public transport flying over an urban landscape.
Photo by Stephen Schepel

Figure 30
'Old' Bijlmer: Motorized traffic on elevated urban highways without level road junctions.
Photo by Stephen Schepel

Figure 31
'Old' Bijmer: Underpass for pedestrians and cyclists.
Photo by Stephen Schepel

[42] Quoted in Jane Jacobs, The Death and Life of Great American Cities (1961).

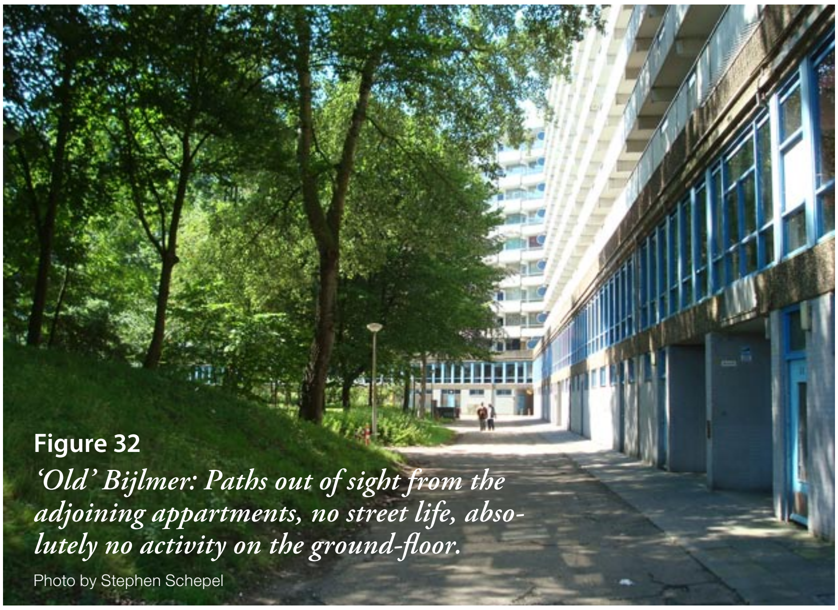


Figure 32
'Old' Bijlmer: Paths out of sight from the adjoining appartments, no street life, absolutely no activity on the ground-floor.
Photo by Stephen Schepel

Figure 33
'New' Bijlmer: A newly built street with groundfloor entrances.
Photo by Stephen Schepel

Figure 34
'New' Bijlmer: Low rise housing replacing some of the appartment blocks.
Photo by Stephen Schepel

The plans looked ideal on paper. But soon after completion the drawbacks became clear. Many paths are (too) empty, and out of sight, or (too) far from people looking out of their windows. The urban landscape harbours lots of spooky places. As a result many pedestrians and cyclists don't feel safe, not only after dark, but also at daytime. Street life doesn't have a chance. (Figures 32, 33)

Although the apartments themselves were very well designed, and offered good value for money, they were never popular.

Since the 1990s, the Bijlmer suburb has been completely transformed.

In some places the apartment buildings are still standing, while new streets have incorporated ground floor entrances, encouraging street life, and creating chances for activities on the ground floor during the day.

Many apartment blocks were torn down, and replaced by low-rise housing and streets with traffic calming measures (Figure 34).

3.4 Visions of public space in urban planning

This section highlights key principles developed by two famous thinkers about the role of streets and public space, that of Jane Jacobs (see Box 8) and Denmark's Jan Gehl.

Jane Jacobs: The complexity and multiple use of the street fabric

In The Death and Life of Great American Cities (1961), Jacobs criticizes the analytical approach of town planning, which not only was resulting in traffic separation, but also dividing towns into separate, mono-functional areas. She emphasises that "To understand cities, we have to deal outright with combinations of mixtures of uses, not separate uses, as the essential phenomena." Wide choice and rich opportunity are, for her, the point of cities. To her this also means that we should not cut up cities into separate 'islands':

> *"This very fluidity of use and choice among city people is precisely the foundation underlying most city cultural activities and special enterprises of all kinds. Because they can draw skills, materials, customers, or clienteles from a great pool,*

Box 8: Jane Jacobs: "Erosion of cities by automobiles or attrition of automobiles by cities"

In 1961, Jane Jacobs published her classic meditation on urban planning, The Death and Life of Great American Cities. Here we offer an extract with her views on the impact of two opposing processes, "the erosion of cities by automobiles, or attrition of automobiles by cities."

"The problem that lies behind consideration for pedestrians, as it lies behind all other city traffic difficulties, is how to cut down absolute numbers of surface vehicles and enable those that remain to work harder and more efficiently. Too much dependence on private automobiles and city concentration of use are incompatible. One or the other has to give. In real life, this is what happens. Depending on which pressure wins most of the victories, one of two processes occurs: erosion of cities by automobiles, or attrition of automobiles by cities.

To understand the pros and cons of any city traffic tactic, we have to understand the nature of these two processes, and their implications. We also have to be aware that surface traffic in cities exerts pressures upon itself. Vehicles compete with each other for space and for convenience of their arrangements. They also compete with other users for space and convenience.

Erosion of cities by automobiles entails so familiar a series of events that these hardly need describing. The erosion starts as a kind of moderate nibbling that gradually turns into hefty bites. Because of vehicular congestion, a street is widened here, another is straightened there, a wide avenue is converted to one-way flow, staggered-signal systems are installed for faster movement, a bridge is doubled as its capacity is reached, an expressway is cut through yonder, and finally whole webs of expressways. More and more land goes to parking, to accommodate the ever-increasing numbers of vehicles while they are idle.

No one step in this process is, in itself, crucial. But cumulatively the effect is enormous. And each step, while not crucial in itself, is crucial in the sense that it not only adds its own bit to the total change, but also accelerates the process. Erosion of cities by automobiles is thus an example of what is known as 'positive feedback'. In cases of positive feedback, an action produces a reaction, which in turn intensifies the condition responsible for the first action. This intensifies the need for repeating the first action, which in turn intensifies the reaction, and so on, ad infinitum. It is something like the grip of a habit-forming addiction." (Jane Jacobs, The Death and Life of Great American Cities, Pelican edition, 1964, pp. 362–363).

In considering suitable tactics and principles of attrition, it is worth taking another look at the process of erosion. Erosion of cities by automobiles, while anything but admirable in its effects, presents much to admire in certain of its principles of operation. Anything so effective has something to teach, and is worth respect and study from that point of view.

The changes required or wrought by erosion always occur piecemeal — so much so that we can almost call them insidious. In the perspective of a city's life as a whole, even the most drastic steps in the process are piecemeal changes. Therefore, each change is absorbed piecemeal, as it occurs. Each erosive change requires changes in the habits which people follow to get around in a city, and changes in the ways that they use a city, but not everybody needs to change his habits at once, nor does anybody (except those displaced) have to change too many habits at once.

Attrition of automobiles requires changing in habits and adjustments in usage too; just as in the case of erosion it should not disrupt too many habits at once. (Jane Jacobs, Ibid. p. 383)

One of the unsuitable ideas behind projects is the very notion that they are projects, abstracted out of the ordinary city and set apart. To think of salvaging or improving projects, as projects, is to repeat this root mistake. The aim should be to get that project, that patch upon the city, rewoven back into the fabric — and in the process of doing so, strengthen the surrounding fabric too (Jacobs, Ibid., p. 406).

Box 9: Jan Gehl: "People come where people are"

Like Jacobs, the Danish architect and urban planner, Jan Gehl, has also contributed to a paradigm shift in thinking about what kinds of design incite vibrant active cities that people enjoy. Here we offer extracts from his book, *Life between Buildings,* dedicated to the use and benefits of public space.

"A summary of observations and investigations show that people and human activity are the greatest object of attention and interest. Even the modest form of contact of merely seeing and hearing or being near to others is apparently more rewarding and more in demand than the majority of other attractions offered in the public spaces of cities and residential areas.

Life in buildings and between buildings seems in nearly all situations to rank as more essential and more relevant than the spaces and buildings themselves. (Jan Gehl, Life Between Buildings, Danish Architectural Press, 2001, p. 31.

Studies from many countries show indicate that the quality of outdoor space significantly influences use of public space. Not surprisingly, bad conditions are restrictive, while favourable conditions and an attractive layout open up possibilities.

Something happens because something happens because something happens. That life between buildings is a self-reinforcing process also helps to explain why many new housing developments seem so lifeless and empty. Many things go on, to be sure, but both people and events are so spread out in time and space that the individual activities almost never get a chance to grow together to larger, more meaningful and inspiring sequences of events. The process becomes negative: nothing happens because nothing happens." (Jan Gehl, Ibid., p. 77).

Gehl quotes examples from Appleyard and Lintell's ground-breaking study, written up in their book *The Environmental Quality of City Streets*. They compared the frequency of outdoor activities and contacts between friends and acquaintances (dots, respectively lines on the illustration) in three parallel streets in San Francisco with volumes of motorized traffic.

"The fact that a marked increase of outdoor activities is often seen in connection with quality improvements emphasizes that the situation found in a specific area at a certain time frequently gives an incomplete indication of the need for public spaces and outdoor activities, which can indeed exist in the area. The establishment of a suitable physical framework for social and recreational activities has time after time revealed a suppressed human need that was ignored at the outset.

Just as it has been noted that automobile traffic tends to develop concurrently with the building of new roads, all experience to date with regard to human activities in cities and in proximity to residences seems to indicate that where a better physical framework is created, outdoor activities tend to grow in number, duration, and scope." (Jan Gehl, Ibid., p. 39).

Looking at ***urban development in the second half of the 20^th^ century*** Jan Gehl reaches this saddening conclusion:

"Life is literally being built out of these new areas, not as a part of a well-thought-out planning concept but as a by-product of a long series of other considerations.

While the medieval city with its design and dimensions collected people and events in streets and squares and encouraged pedestrian traffic and outdoor stays, the functionalistic suburban areas and building projects do precisely the opposite. These new areas reinforce the reduction and spreading of outdoor activities that over the same span of years resulted from changes in industrial production and from a number of other social conditions.

If a team of planners at any time had been given the task of doing what they could to reduce life between buildings, they hardly could have achieved more thoroughly what has inadvertently been done in sprawling suburban areas, as well as in numerous 'urban' redevelopment schemes"(Jan Gehl, Ibid., pp 49–50).

they can exist in extraordinary variety, and not only downtown, but (also) in other city districts that develop specialities and characters of their own. And in drawing upon the great pool of the city in this way, city enterprises increase, in turn, the choices available to city people for jobs, goods, entertainment, ideas, contacts and services."[43)]

In her view, effective neighbourhood physical planning should aim to:

1. Foster lively and interesting streets.
2. Make the fabric of these streets as continuous a network as possible throughout a district of potential sub-city size and power.
3. Use parks and squares and public buildings as part of this street fabric; use them to intensify and knit together the fabric's complexity and multiple use. They should not be used to island off different uses from each other, or to island off sub-district neighbourhoods.
4. Emphasize the functional identity of areas large enough to work as districts.
5. If the first three aims are well pursued, the fourth will follow.[44)]

She stresses the importance of city streets with wide sidewalks.

"Some city sidewalks are undoubtedly evil places for rearing children. They are evil for anybody. In such neighbourhoods we need to foster the qualities and facilities that make for safety, vitality, and stability in city streets. This is a complex problem: it is a central problem of planning for cities. In defective city neighbourhoods, shooing the children into parks and playgrounds is worse than useless, either as a solution to the streets' problems or as a solution for the children.

The whole idea of doing away with city streets, in so far as that is possible, and downgrading their social and their economic part in city life is the most mischievous and destructive idea in orthodox city planning. That it is so often done in the name of vaporous fantasies about city child care is as bitter as irony can get."[45)]

On traffic separation, Jan Gehl (Denmark, see Box 9) distinguishes four prototypes, with Los Angeles (most separation) and Venice (most integration) at opposite ends of the spectrum. In between are Radburn, described above, and Delft (The Netherlands), the town where 'woonerf'-streets were introduced. The woonerf (home-zone or garden street) has been laid out to given priority to pedestrians, cyclists, and playing children, whereas motorized traffic is kept compatible by restricting speeds and limiting volumes.

"If the speed of movement is reduced from 60 km/h to 6 km/h, the number of people on the streets will appear to be ten times greater, because each person will be within visual range ten times longer.

This is the prime reason for the noteworthy activity level in pedestrian cities like Dubrovnik and Venice. When all travel is slow, there is life in the streets for this reason alone, in contrast to what is found in automobile cities, where the speed of movement reduces the activity level. The further away cars are parked, the more will happen in the area in question, because slow traffic means lively cities."[46)]

[43] Jacobs, Ibid., p. 126.
[44] Jacobs, Ibid., p. 139.
[45] Jacobs, Ibid., p. 98.
[46] Gehl, Ibid., p. 77.

Figure 35
The many high quality pedestrianized streets in the city centre of Copenhagen (Denmark) are favourite places to spend time and buzz with (economic) activity.
Photo by Lloyd Wright

Figure 36

Suburbia in Houston (US). Total dependence on cars for every trip, no matter how short, has reduced human interaction to a minimum and turned a potential community into a social desert.

Photo: Jeroen Buis, 2007

3.5 Cycling-Inclusive Planning for urban cohesion

Urban cohesion requires the presence of cyclists, pedestrians and other 'ordinary' (human-powered) road-users. This in turn calls for public space that is thriving, safe, and attractive.

Neighbourhoods are not self-contained entities, and they shouldn't be. As Jane Jacobs explained, the essence of city life is that its people have many contacts for all sorts of purposes, and in all directions. The more, the merrier. These contacts produce cohesion. A well-designed public space can offer good conditions to make and renew contacts.

This is why it is so important to treat public space as a network of continuous routes tying neighbourhoods together, while being useful and attractive to cyclists, pedestrians and other 'ordinary' (human-powered) road-users.

An example of this approach to planning public space is the 'Kid-Grid' concept by Ineke Spapé (see http://www.soab.nl, then press UK flag for English version). This consists of safe and attractive routes that connect facilities important to children. The result is more people use these facilities, more often.

To explore these ideas further, and based on the example of Houten, where cycle routes have become the backbone for the town plan, we present the concept of habitat areas.

3.5.1 An innovative design approach: thinking in terms of habitat not highways

In an urban area only a minimal number of roads should be designated as main roads or highways, while the remaining public space should be designated as habitat areas.

As initially conceived, major roads and highways were meant to absorb large flows of cars, freeing up other streets from excess volumes. Notwithstanding, although cars may travel at reasonable speeds, there should be many crossings where pedestrians and cyclists can cross easily, safely, and without much delay. Otherwise both the number and gravity of accidents soars where these projects are developed.

Moreover, this concept should be complemented by the creation of habitat areas that give priority to pedestrians, cyclists and social activities. Cars may be allowed, at reduced speeds. Houten shows in practice that a habitat area can be fairly large. People can walk or cycle from one end to the other (over 3,500 m) without ever crossing a road with busy car traffic and/or vehicles moving at speeds of over 30 km/h. In many countries today, this concept informs targets, such as that of the Netherlands, where a national policy has established the goal of making 50% of all existing urban areas 30 km/h zones.

Major through roads are usually treated as traffic arteries with a continuous profile and higher speed limit. Local circumstances often require designs providing for greater safety and connectivity between the different modes. For example, when a through road crosses a busy junction used by cyclists and pedestrians, a specific design giving different sorts of road users more equal treatment may be required, to ensure that all users adjust and that there is eye contact among them.

3.6 Six keys to determining the quality of public space

Some professionals argue (rightly) that a public space that allows freedom of movement to children is a good public space for most of the people. On the occasion of the Child Street 2005 conference in Delft, called KiSS, Kid Street Scan Schepel, Kips, Zomervrucht and Schouten devised a list of criteria for child-friendly public space, (see http://urban.nl/CHILDSTREET2005/downloads/KISSintroduction-handout.pdf). Although originally conceived to ensure child-friendliness, the criteria actually apply to other 'ordinary' users of public space as well.

The six aspects for quality public space include:

1. Protection
   - Social safety;
   - Traffic safety.
2. Walkability
   - Easy crossing;
   - Ample room for walking;
   - Connections to other neighbourhoods.
3. Cyclability
   - Easy crossing;
   - Amenities for cycling;
   - Connections in all directions.
4. Criss-Crossability
   - Freedom of movement all along the street.
5. Attractiveness (Enjoyability)
   - Interesting, and attractive streetscape;
   - Possibilities for initiatives on, and next to, the public space.
6. Usability
   - Suitability of the street surface for many sorts of social activities;
   - Space for special purposes (like playgrounds) within reach, along safe routes.

All of these aspects should be treated together in any plan for (re) arranging public space. Many measures influence more than one aspect, for instance limiting speeds or volumes of motorized traffic, providing ample room for walking and cycling, drawing extra attention to points where pedestrians and cyclists are crossing, restricting parking to places where it is least bothersome, and giving room to private initiative all along the routes created for ordinary human-powered road users.

3.7 Urban planning and design for quality of life: work on different levels or "layers" for integral designs

Human-powered road users are often the last to be considered in urban planning and design. This section discusses the use of different design layers and bottom-up design, which starts from the needs of pedestrians and cyclists, and a process for developing an urban plan for cycling facilities.

How conflicts between different interests are handled will define whether planners achieve their goals of improving quality of life or generating bitter conflicts that can divide communities and cities for a long time. Plans to (re) arrange public space usually meet resistance and the whole process can ground to a halt amidst the babble of tongues created by policy makers, experts from different disciplines and representatives of interest groups.

The origins of such conflicts almost always lie beyond the limits of the plan itself. They should therefore be tackled on higher policy levels, and larger scales of design.

Boudewijn Bach (2006) notes that working in layers of different scale can serve to introduce a lingua franca (common language), much as English works in India, French in West Africa, Mandarin in China, and Spanish/Portuguese in Latin America.

He distinguishes:

Level	Planning scale
Building (individual property) level	3–30 m
Location and plots (neighbourhood) level	30–300 m
Urban district (municipal) level	300–3,000 m
Metropolitan level	3,000–30,000 m

Experience shows that much misunderstanding can be remedied when deliberations occur on a single scale within these layers of urban structure. Spatial quality, on the other hand, is only achieved when the design is worked out in detail and given concrete shape at a lower level.

For example:

- An urban bicycle plan should be devised at the metropolitan level;
- A bicycle route should be laid out at the urban district (municipal) level; while
- Street design should be resolved at the neighbourhood level.

Thus, planning, and designing on different levels can be a powerful aid to solving these urban problems and create an attractive and usable public space.

Figure 37
Houten: A residential road (30 km/h) crosses one of the main cycle routes. Cyclists can speed on while car-drivers have to reduce speed (because of the curve) and yield to cyclists.
Photo by Hans de Jong

3.8 Further reading

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4. Getting organised: managing and implementing the policy-making process

Tom Godefrooij, Hans de Jong, and André Pettinga

4.1 Introduction

This chapter deals with how to organize and develop cycling-inclusive policies. It is about strategic goal setting, the stages of policy development, advocacy, the successful involvement of stakeholders, their roles, tasks and responsibilities. So, in essence, this is about organizing this process to bring together all the individuals and organisations who care, to produce a cycling policy widely supported by the community and different government agencies.

As explained in previous chapters, there are many reasons to recognize cycling and walking as full-fledged transport modes, integral and indispensable parts within the urban transport system.

So how do we create genuinely cycling-inclusive urban development and transport policies? Actions and interventions depend on the context. Ultimately, interventions can only be considered successful if their effects line up with the aims and aspirations of both government and the (majority of the) people. To make success less haphazard, it is helpful to generate these interventions in a carefully developed process of policy making and implementation. Transforming traditional car-centred transport and urban policies into sustainable cycling-inclusive approaches requires a paradigm shift, which will not happen overnight.

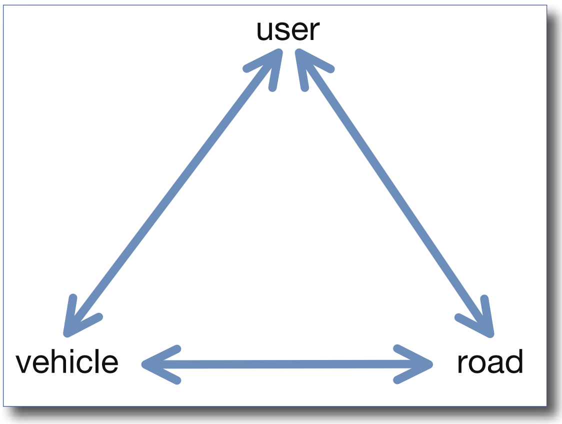


Figure 39

Interaction between user, vehicle and road is crucial.

Many interests are at stake. Traditions and attitudes persist. And changes require consensus, time and money. People must wake up to the benefits of cycling for their personal life and mobility. Advocates must make an effort to remove physical, mental and cultural barriers. A successful bicycle promotion policy therefore has to address the complete user-vehicle-road system. In many cities, where pedestrians account for a large percentage of daily trips, trying to move "active transport" up the political agenda can broaden alliances and strengthen the chances of success of pro-cycling policies.

Strategic cycling planning involves considering all elements key to reaching strategy objectives. These may include activities that only indirectly promote cycle use, but nonetheless contribute to creating the necessary attitudes or cultural environment. Activities may target the *user* (her/his perceptions, knowledge, values and needs), the *vehicle* (availability and quality) and the *road* (functions and design).

4.2 Hierarchy of goals: one size does not fit all

Many activities are not a goal in themselves, but are supposed to contribute to a higher goal. As an example: the strategic goal could be to make transport more sustainable. To achieve that one of the tactical goals may call for increasing cycling. To implement this tactical goal will involve defining more concrete

For related subjects

See ***Chapter 12***, on social marketing and citizens' participation.

See ***Chapter 13***, for a more in-depth discussion of advocacy, education, and awareness-building.

See ***Chapter 14***, on collecting the data necessary to nourish an effective policy-making process.

See ***Glossary*** on civil society organisations.

Figure 38

The first step into a successful project: bring all involved people and organisations together.

Photo by GTZ SUTP

Box 10: How local authorities respond to (new) cyclists on their road networks

- They may neglect cycling as a social phenomenon (implicitly denying its economic relevance).
- They may appoint someone in the traffic department to work part-time on bicycle "problems".
- They may appoint a bicycle specialist (civil servant) to work full time on cycling issues.
- They may appoint a bicycle co-ordinator, responsible for getting the most out of the various planning agencies and public works departments.
- They may ask a consultant or civil society organisation to develop professional cycling plans, projects, initiatives.
- They may re-organize the traffic department and train employees, thus making them all capable of dealing with cycling issues in all kind of plans.
- They may put in place one or more specific organisational units for the planning and design of cycling infrastructure (called 'cycling engineering cells' in India).
- They may install a (temporary) task force group with special cycling targets, which go beyond infrastructure.
- They may train staff of all local departments to develop their 'own' cycling-inclusive plans and interventions.

operational goals, such as improving road safety for cyclists, constructing a cycling route network and increasing people's awareness on the practical advantages of cycling. What gets defined as strategic, tactical and operational will largely depend on the level of abstraction. From an organisational perspective, the operational level could be organised as projects, whereas the tactical level is often organised as a programme.

Planners can find many different ways to solve problems and achieve their goals. Very often there is no single solution that will solve all problems. Moreover, specific problems associated with other issues may hinder or promote their solution. Goals can be set on strategic, tactical and operational levels. Promoting cycling can contribute to achieving strategic goals, such as sustainable urban development, healthier people or poverty alleviation. Tactical goals may include involving relevant sectors, such as health or education officials, in promoting cycling, or to raise awareness amongst the public. Operational goals connect directly to concrete activities such as the execution of a publicity campaign or the construction of cycling facilities.

A good understanding of this hierarchy of goals may help to identify the optimum point for certain interventions. It is also helpful to identify potential allies and match argumentation to different kinds of stakeholders, depending on their level of interest and stake in the process. Developing and agreeing upon a tree of goals is, therefore, a worthwhile tool to clarify at all levels the reasoning behind any undertaking.

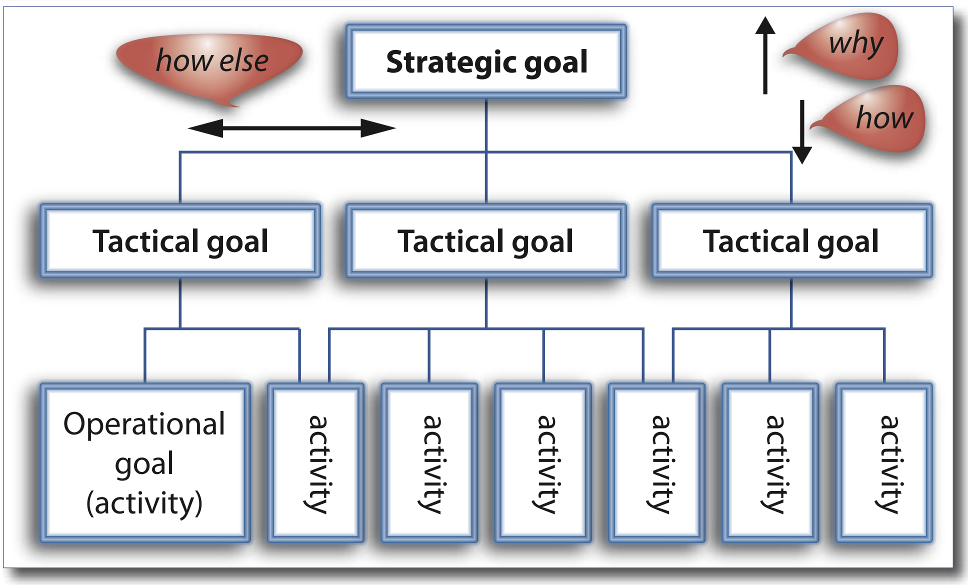


Figure 40

A hierarchy of goals may help to understand the relationship betweenseveral goals, aims and objectives (whatever you call them).

Diagram by Tom Goodefroij

4.3 Factors key to successful implementation

Successful policy implementation has some indispensable ingredients:

1. *Well thought out policy content.* This requires the necessary expertise to develop a good analysis of the problems and arrive at solutions that will have the envisaged effects.
2. *A good organisational structure* in which tasks, competencies and responsibilities of all those involved are well defined. Conflicts over competencies or unclear responsibilities may become a substantial barrier to policy implementation.
3. *Political support and commitment.* This political commitment bears directly upon the availability of financial resources for the necessary interventions and investments. This political commitment should preferably be robust and not swayed by the issues of the day, to ensure sufficient continuity.
4. *Public support.* Unforeseen public opposition may well ruin successful implementation, while the opposite is also true. The active involvement of a wide range of stakeholders can optimize the effective implementation of policies.

4.4 Stages in the process: the policy cycle

A second element crucial to successful policy implementation is a good understanding of process phases and proper organisation of feedback loops. Figure 43 offers a process diagram, based on the concept that every stage has its own inputs and outputs. The same elements can be presented as a 'policy cycle', underlining the ongoing circular process.

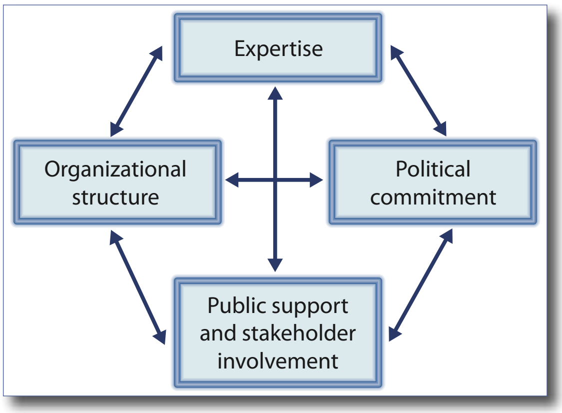


Figure 41

Interaction between different factors involved in decisions in transport.

Figure 42

The former Minister of Transport of the Western Cape, South Africa, Tasneem Essop, launches a bicycle promotion tour in Cape Town, South Africa. Politicians have a significant role to play in promoting cycling.

Photo by ITDP

In this cycle, there should be feedback loops between all stages. For example, the analysis of the problem may result in a redefinition of the problem. The evaluation of the pros and cons of certain interventions can result in the need to generate even more options, but also to go back and analyse the problem again. Practical issues that arise during the implementation phase can also require revisiting earlier steps. And so on…

For each stage of the process, it is important to consider the right balance between expertise, political commitment, organisation and public support. The importance of these ingredients can vary according to stage, type of problem, and socio-economic context, so the mix is context dependent and should vary over time.

4.5 Actor analysis

Every activity should focus on one or more target groups. Interventions will be more effective the more closely activities are tailored to the specific groups that are targeted. These include politicians, the public, cyclists, traffic planners, the business community, schools,

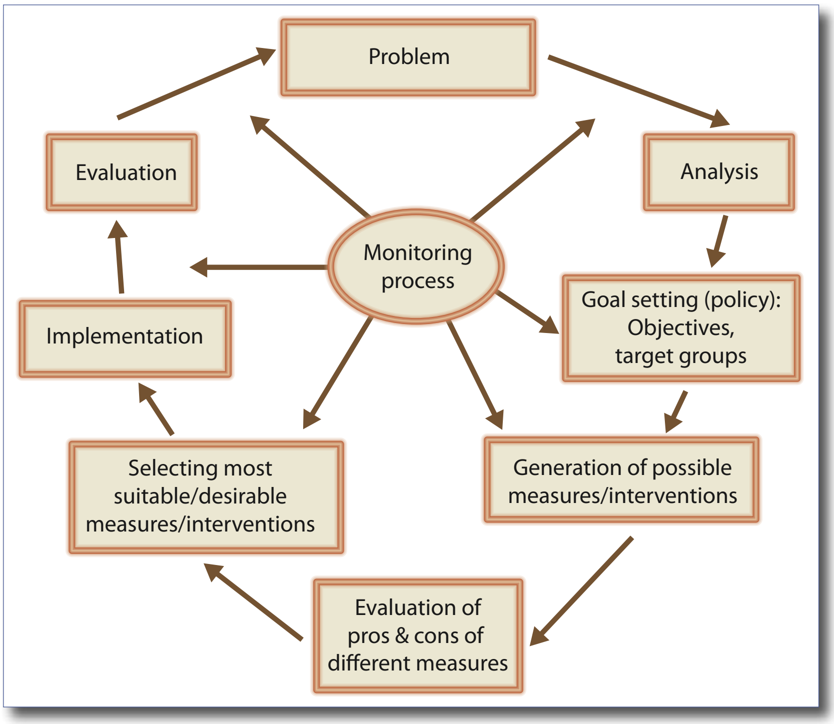


Figure 43
Main stages of the policy cycle.

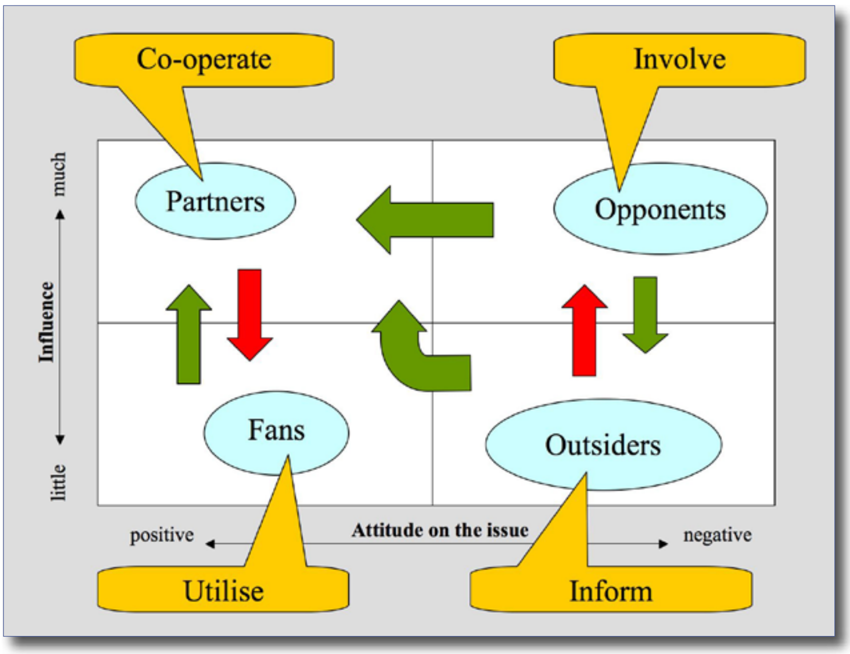
To better understand the situation, an actors analysis can be helpful. A representative group of planners, users and other interested parties works together to identify and analyse each actor /stakeholder/target group according to their primary and derived interests. Who are potential allies, supporters or opponents? And how influential are they? The matrix in Figure 44 offers an excellent structure for analysing the different target groups and their position at any particular moment of the process. Using it you can identify where key players stand today and where you would like to move them, throughout the participatory and planning process. Depending on the level of influence and their positive or negative attitude towards the issue, actors can be identified as *partners, opponents, fans* or *outsiders.* Of course these are only rough categories, but it may help to decide on how to approach them to advance one's case.

supporters or members of bicycle user groups. *Each target group requires its own approach*:

- Don't bury superficially interested target groups in stacks of detailed information;
- Show supporters their contribution is worthwhile;
- Recognize experts' skills, even in the event of disagreement on the policy level;
- Give politicians political choices; don't mire them in technical discussions;
- Civil servants deserve nuanced treatment: they are not responsible for political matters, but can be very influential.

Figure 44 presents a matrix that locates different actors according to their attitudes and their influence within the policy process. The green arrows indicate desired movements, whereas the red arrows indicate movements one should try to prevent. We want opponents to become partners, fans or, if all else fails, outsiders. Note also that sometimes fans are important to push partners into more solid commitments and that new partnerships can also bring in more fans. For example, a partnership with associations of walkers can expand the support for cycling-inclusive policies that propose more use of road space for cyclists, thus freeing up parks and sidewalks for pedestrians. It is useful to produce two versions of this matrix as part of the initial actors analysis: one of where we stand today, another of where we would like to move people within the next six months to one year of the policy planning and implementation cycle.

Figure 44
Basic structure of an actors' analysis.



It then becomes clear whether it is worthwhile or even necessary to put a lot of effort into approaching specific groups, and what can be achieved by doing this. The initiators of these processes must ask why address a specific target group and how best to reach its members. A real understanding of their interests will make this easier.

Start from a clear idea of objectives, target groups and the best approach for each, and move from there into concrete interventions. Remember that there are many more factors, beyond those mentioned above. Other considerations include the means available, the skills and (personal) qualities of those who must do the job, estimated cost effectiveness, and so on.

Partnerships and alliances are particularly important, because they can add crucial resources to the policy development process, or reduce costs by adding knowledge, a supporters' base and other elements that would otherwise require considerable effort and resources to reach. Most groups have gatekeepers, key leaders whose explicit support can validate a new position among whole communities or groups of other actors. Networking stitches these groups together and keeps them "in the loop", thus building an informed community through organic processes that can yield key support at crucial points in the policy development process.

Approaches vary according to circumstances, particularly resources, and target groups. Very often they also reflect timing. The approach might also vary with respect to content. Different target groups respond to different arguments. Road safety arguments may be most effective with parents' groups or officials responsible for this issue, whereas arguments based on the social implications of transport (access to jobs) may be more convincing to politicians. The environmental approach may appeal more to some civil society organisations or officials responsible for policy in this field. The solution of congestion problems (traffic management) may appeal more to officials involved in this issue at the municipal level. And so on. Note that the sensibilities of the different parties involved will change over the years.

It is important to distinguish between arguments underlining the problematic side of cycling (the dangerous position of cyclists on the road) and those that highlight cycling's potential for solving major social problems, such as poverty, congestion and environmental issues. The choice of which argument to use depends absolutely on the (perceived or assumed) sensibility of the counterpart.

4.6 The process versus the project approach

Both process and project approaches have different, complementary roles to play in building cycling-inclusive planning. Managing a process is different from managing a project. A project has a clear timeframe and a well described outcome. Planning and managing a project is a rather straightforward exercise, defined in terms of time, budgets, quality requirements, information and organisation.

Developing cycling policies is more a process than a project, however, although projects can and should be a part of this process. The main reason why planners cannot manage the development of cycling policies as a project is that the outcome is not clear beforehand and various stakeholders have to be involved. Involving different actors implies that they will influence the outcome. In fact, support for the cycling policies developed depends on the input that parties have provided to the process.

A cycling policy development process should explicitly give room to relevant stakeholders to 'reshape' starting ideas and concepts, to ensure a shared sense of ownership of the resulting policy. It is important to empower relevant interest groups and stakeholders to ensure their input. This approach will build a more solid foundation for implementing the chosen measures.

Another reason to organize and manage cycling policy development as a process rather than as a project is the need for flexibility. Society is changing constantly and so is the socio-economic and political context. Windows of opportunities will open and close, threats have to be dealt with, and as a result how strategic and tactical goals are achieved must change along the way. It is essential to allow for learning-by-doing. Some strategy initiatives will emerge, and action programs will continuously be adjusted to actual developments. Monitoring policy development will not only look for solid implementation of activities, but also ask if these remain the right activities. The implication, however, is that parties involved must accept a certain degree of uncertainty, and a less straightforward or linear plan.

Yet projects will and should be an important part of the process. These are all activities that can be defined in terms of time, budgets, quality requirements, information and organisation. They can involve specific plans and designs for a bicycle network and cycling facilities, plans for traffic calming, and the implementation of these plans. Educational and promotional activities can and should be organized as a project. These projects should be planned within a clear timeframe, with clear budgets, a project manager, proper staffing and well defined quality requirements. Otherwise policy implementation will fail.

4.7 User group participation

4.7.1 What user groups can contribute

User groups play a very special role in developing and implementing cycling policies. They often catalyse agenda setting and raise awareness. They can voice the interests of the users and they can be a critical watchdog to monitor progress.

Cyclists' organisations know what cycling requires and the restraints that must be lifted. Experiences from the Locomotives program, run by Interface for Cycling Expertise, has shown that civil society organisations and activists can have a strong impact on the awareness and willingness of authorities to recognize cycling's importance to urban transport and economic development.

When it comes to concrete implementation of road facilities, the communities immediately affected by works should be involved. The ultimate reasons for such community involvement are threefold: First, people should have a say in the shaping of their immediate living environment for the sake of democracy. Secondly, and even more importantly, such community involvement will result in better plans, better solutions to problems, and the avoidance of costly mistakes. Thirdly, when target groups feel a shared sense of ownership, support for implementation will increase.

It is beyond the scope of this Handbook to provide a detailed description of the multiple ways of facilitating user group participation in cycling-inclusive transport planning policies. Some of the most common methods include:

- Focus Group Discussions to identify problems and make an inventory of these challenges;
- General User Groups/Task Forces/Panels[47] articulate and prioritize user needs;
- Competitive or other forms of funding allow user groups to participate more fully or to undertake specific initiatives (education, cycling Sundays, safe routes to schools, etc.) within a national or regional cycling plan;[48]
- Local User Groups/Task Forces/Panels actively involved in the planning and implementation of cycling interventions; and
- User Associations may play a major role in the maintenance and operations of the built cycling infrastructure.

In the Sub-Saharan Africa Transport Program (SSATP) projects, for example, there were several challenges to making user participation effective:

- Heterogeneity of the community made it difficult to sustain users' interests in

Figure 45

Group sessions are very effective to identify problems, challenges and the benefits that make change worthwhile. The opinions of road users, technical experts and others involved contribute vital information that can enhance success and significantly reduce risks.

Photo by I-CE

[47] A panel is similar to a focus group, in that it includes users with different skills, age, socio-economic levels and backgrounds, women as well as men. It differs from a focus group in that organizers of the planning process strive to maintain and involve a core within the panel in the long-term process. This allows for normal turnover, but also builds in some capacity to accumulate knowledge and increase commitment. Often we are measuring not only how people think at our starting point, but also which arguments, processes, initiatives will most move them along, so keeping a group of this nature going over time can yield excellent results.

[48] In the US, national highway funding includes a fixed percentage for national, regional and local cycling and walking initiatives, while in the UK, the Safe Routes to Schools program is run by a national charity, that in turn finances local projects, as do local city councils. In the Netherlands, the national cyclists' union is largely self-financed, by membership dues, but is also hired to partner with or do research for initiatives at different levels. In Canada, some city governments have their own full-time staff working in tandem with local Bike User Groups, known as BUGs, to encourage more and safer cycling.

projects, unless there was a shared definition of the problem and mutual trust;

- Historically set attitudes, regarding the fact that these were traditionally government responsibilities, created reluctance among users to participate;
- Continuity of participation was difficult to achieve; and
- Allowances paid to the participants created difficulties for assessing the motives for participation and continuity. However, when the practice of paying allowances stopped completely, participation seemed to improve.

Some lessons learned from the SSATP were:

- Effective user participation is central to community empowerment and to the continuity of positive policies towards cycle users. If not properly structured, user participation can be costly, cumbersome and frustrating. When structuring UP, it is important to strive for a balance between complete citizen controls of the projects on the one hand and total professional control on the other.
- Effective user participation requires fully trained professional staffs who are sensitized to its importance and truly believe that it can make an effective contribution to the project interventions at all levels.
- Large-scale public awareness campaigns are costly and have limited impacts without a proper follow up. The best approach is targeted awareness campaigns combined with ongoing work with lasting organisations (the more deeply embedded in their communities the better) and cycle interventions, over the long term.

4.7.2 Advocacy

How can you successfully involve active citizens, whether they're cyclists demanding safer, more comfortable cycling routes or residents concerned about noise or other problems on their streets? How can you turn conflicts into creative proposals that genuinely respond to what people want, and not just "what's good for them"? Advocacy and its role is part of the answer to these questions.

Wikipedia defines advocacy as 'the act of arguing on behalf of a particular issue, idea or person'. Both the terms 'advocate' and 'advocacy' have specialist meanings in certain contexts, and among some groups. In a political

Box 11: Key factors for a successful project: participation

The following advice and tips are based on experiences worldwide and informed by the 'Dutch approach'. It is wise to examine and adapt them to your own local situation or project.

Three conditions for success:

1. Citizens and their organisations must be involved and committed. They must be prepared to think along with authorities and they must be confident that their work will be reflected in the final plan, its implementation and subsequent evaluation. Above all, they must be confident that they will not be excluded at crucial steps of the process. Working together, experts, politicians and future users are stronger and more able to successfully confront any problems that may arise during implementation.
2. The authorities/municipality must have a positive attitude. Above all, they must know how to listen and dialogue. It is important to involve any interested individuals at different stages, but above all to form strong, ongoing organisations. That way, the common language, trust and understandings developed in one process carry on into the next, making it easier and often less expensive to move ahead on new, often groundbreaking policies.
3. Mutual trust is vital. Politicians, city councillors, civil society participants, staff and civil servants such as traffic engineers, urban planners and so on must know and trust each other.

To facilitate the process and discussions, sometime it is wise to appoint a neutral facilitator who is accepted by all involved parties or to work with civil society organisations who have developed substantial expertise and credibility through their experienced handling of participatory activities. Working through a third-party, such as a consultant, civil society organisation or academic body also helps to build more horizontal communications and relationships, another feature that makes cooperation, dialogue and effective policy making and project building far easier.

Tips for authorities and municipalities

1. Never present a ready-made plan: give citizens the chance to participate in making the plan.
2. Involve all interested parties as early as possible: citizens and their organisations, and other groups, such as the police, for instance, since they have a lot of information and they know the complaints.
3. Take care that money is available to carry out plans, including facilitating the process. No false promises.
4. Work within clear rules that have been discussed and agreed upon from the start, and that establish what is possible and what is not.
5. Always look ahead, to future developments.
6. Be flexible.
7. Coordinate: within the municipality, make sure different activities in different spheres are coordinated. It may even be necessary to appoint a process-coordinator.

Tips for interested parties (cyclist user groups, neighbourhood associations, shopkeepers, etc.)

1. Be prepared for a serious commitment: Be prepared to put sufficient time and energy into the process and be prepared to compromise. Take care for continuity in the project team.
2. Be prepared to 'fight' for things you consider important.
3. Seek advice, support or second opinions wherever possible from other local, regional or national user groups, project teams who have been involved in similar projects elsewhere, academics, even abroad.
4. Seize the opportunity to get involved in politics, not from a party perspective but from an issues perspective.
5. You must be interested in traffic and urban issues, beyond your own immediate positions, and knowledge of your neighbourhood and metropolitan environment is necessary
6. Look carefully at the design and technical drawings; measure the width of bicycle paths and lanes; the capacity of bicycle parking facilities; the implementation of awareness campaigns, etc.
7. Make the most of the communications tools available to inform your immediate members, other interested people and groups, and the general public. Work to keep them informed throughout the process and seek opportunities to receive and process feedback too.
8. As much as possible, take planners and designers out onto the streets and into the intersections, to look at how things function in situ. Good-looking plans and designs often fail to consider key factors that will be self-evident in a group inspection/evaluation.

Successful processes nourish successful projects: five steps

1. Start with an inventory of the situation today: what are the main problems, are there accidents, complaints? Are there cyclists involved? Part of the inventory could be done by involved user groups and different stakeholders. The role of the politicians in this first step is particularly useful as it builds important support for the process. Look also at what works. This provides positive reinforcement to pioneers and creates local points of reference, which tend to be very powerful in overcoming the argument — "well, you can do that in a developed country, but not here."
2. The next step is to collectively analyse the situation: what are the root causes of the problems? Often you need specialists to assist, by identifying "black" spots and other road safety issues, for instance. Everyone involved should be invited to give an opinion: members of the cyclists' union, local residents, road users including bus and car drivers, cyclists and pedestrians, police officers, traffic engineers, urban planners, etc. All opinions, meanings, experiences, inventories and results from analyses are brought together before starting on the third step.
3. Determine the main goals of the project or process and the measures. What standards should measures meet? What impact should measures have? What should change? What do people want for the future? The goals could be phrased as "cutting accidents in half" or "boosting cyclists' modal share to 10% by 2015."
4. Next, design and then implement the project, whether it consist of a network of bicycle-friendly routes, a specific cycle route, a bicycle promotion campaign, bicycle parking facilities at bus or Metro stations, etc. Designs will normally be the result of work by professionals or consultants, but make sure to include specific moments for presenting

them to future users (cyclists and users of the space that will be affected by the change). Keep lists of people who come to meetings, write letters, express an interest and keep them informed. Not everyone will come to everything or have an opinion on every item. But participation often involves people just knowing that if they want to give an opinion, if they're worried or have a question, their concerns form part of the process and will be taken seriously. This will help to make sure that the proposed measures solve the problems and meet the goals identified — and don't create new problems or sources of conflict! Those involved must genuinely feel that these measures will help to meet the goals collectively established during step 3.

At this stage, politicians are also important: in most cities, it is their responsibility to make the right decisions, to choose the measures and to find funding of the project.

5. The final step: step back and take a long hard look at the project or campaign once it has been completed. Does it work as you expected? In other words you evaluate. You can learn from it and others can learn from your experiences. Note that projects seldom work exactly as planned — reality is a long way from the drawing board. Taking the time to note what worked well — and this may include some lucky mistakes that produced unexpected advantages — will nourish future projects.

context an 'advocacy group' is an organized collection of people who seek to influence political decisions and policy, without seeking election to public office.

Bicycle user groups and other civil society organisations (CSOs) with similar objectives are stakeholders in cycling, low cost mobility and human-powered transport. They promote the interests of non-motorized road users and work to influence and change existing government policies governing urban development and transport. To achieve this, they interact with authorities, other stakeholders and the public. In this training handbook, we use the term advocacy to refer to organized groups, usually of cyclists or other interested people, acting to achieve recognition of their specific interests in policy development.

By nature, advocacy is very much an ongoing, flexible interaction driven partly by external developments. As such, it is difficult to plan, both with regard to the abilities required and the concrete product. Practicing advocacy is therefore different from executing a project. Advocacy may be happening at the margin or in the slipstream of regular (*e.g.* project) activities, but can also be deliberately organized. It has much to do with organisations' self-perceptions and the roles they choose to play. In this sense, advocacy is more defined by how organisations operate, rather than by what they do.

Many of the issues we have discussed above are relevant for advocacy organisations: they should have a clear vision and choose their goals and objectives accordingly, they should organize themselves, make an actors' analysis for the issues they are advocating, and develop a clear view of their specific role in the process of policy development and implementation.

There are many possibilities for user organisations to influence decision-making. Advocates can choose opposition and confrontation, but they can also seek consultation and cooperation. Often these approaches are part of a natural continuum: a group may have to deal with or even trigger a conflict — a demonstration to protest a dangerous stretch of road or a cycle path that does not work well. But if planners and/or politicians handle the situation well, these groups can and should go on to work cooperatively on a wide range of subsequent projects and processes. Citizens' groups also typically have enormous expertise, whether professional or learned from practical, daily experience. They can, therefore, contribute expert opinions on specific issues. Far from being resisted or patronized, they should be included as they will strengthen the quality and public acceptance of the measures or project to be applied. Citizens' groups with large, active support bases tend to be more effective and more credible partners with authorities. Nonetheless, different approaches are not mutually exclusive and are often complementary. To be successful, an organisation must be seen and recognized. It has to communicate with decision-makers, find allies, develop and use expertise, and it needs as many supporters as possible.

Advocacy is an elusive type of activity that requires a reasonable level of strategic awareness of one's position and aims, including the development thereof. It is impossible to be comprehensive in this respect. The reality is complex and there is no simple recipe for success. Personalities, in the sense of *who* exercises leadership and *how* they exercise leadership can be crucial. Much depends on whether an organisation is seeing the opportunities (or even creating them). And any theory-based strategy will fail if there is a lack of enthusiasm, flexibility, social skills, determination, endurance, intuition, vision. It would be too much to expect one person to bring together all these qualities. The organisational, structure, therefore should encourage teamwork and the sharing of complementary skills. Coalitions and networks can often enhance impact, while reducing the potential for errors.

4.8 Vertical co-ordination

Political authorities and their technical advisors at different levels of government can be involved in cycling enhancing policies. The chance to be successful will increase when authorities at different levels are well coordinated and their roles and efforts complement each other. We call this 'vertical coordination'.

Although to a large extent cycling is a local issue, regional and national governments have a role to play, if only to create favourable conditions for successful policies at the local (urban) level. Obvious issues for national and regional governments are legislation, the development of policy guidelines and design standards, and the supply of proper funding. Besides these rather 'neutral' issues, national and regional governments may have their own reasons to promote cycling, as this may be instrumental for a number of policies at the national level, such as environmental, educational and, increasingly, health policies and the safeguarding of the accessibility of important economic centres in the country or region. Moreover, there are certain subjects that can be addressed more effectively at a higher level of government, such as integrating cycling and public transport, creating fiscal incentives to promote bicycle use, or funding national promotion campaigns.

How this vertical integration should be done very much depends on each country's governmental structure, civic traditions and culture. For most, a national cycling strategy identifies key national level tasks, such as co-ordination, funding, research, monitoring, and developing guidelines and legislation. Setting performance targets for local authorities with regards to (the implementation of) cycling policies can be decided at a national level. In many countries this appears to be a good way to stimulate local authorities to develop good policies. If such target setting goes together with funding facilities both for experimental schemes and pilots and for regular funding, higher level governments can contribute enormously to the effectiveness of local efforts.

Regardless of the governmental culture, vertical coordination should involve both 'top down' and 'bottom up' components. City governments should be involved building a better understanding of what the problems are in the implementation process and what is needed to improve their effectiveness. For the drafting of guidelines and standards, input from the local level will enhance the usefulness of the guidelines.

4.9 Further reading

'Communicatiebeleid MasterPlan Fiets' (communicatieplan in Dutch); follow up plan of first MPF-report called 'Validatie en Probleemherkenning); draft written by Awareness, consultancy for policy marketing; November 1992.

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5. Five main requirements for cycling-inclusive infrastructure

Dirk Kuijper, Bas Braakman

5.1 Introduction

This chapter introduces the five main requirements for bicycle-friendly infrastructure. It is based mainly on information from two Dutch manuals: “Sign up for the bike” and “Design manual for bicycle traffic”, real bibles for urban planners and designers of bicycle infrastructure.

For related subjects

See ***Chapter 3*** for ideas on urban form and how they shape activities.

See ***Chapter 6*** on matching designs to conditions.

See ***Chapter 7*** on Designing residential streets.

See ***Chapter 8*** on Designing main roads and highways.

See ***Glossary*** on habitat areas, traffic calming, cycle routes, cycle paths and lanes, etc.

Figure 46
Two of the key documents which describe in detail design guidelines for cycling-inclusive infrastructure.

5.2 The characteristics of bicycle and rider

If designing for cycling, the designer needs a basic understanding of the characteristics of bicycle, cyclist and cycling. These characteristics can be summarized in seven points:

- The bicycle is powered by muscles: a bicycle-friendly road design keeps energy-loss to a minimum.
- The bicycle requires balancing from its rider: the cyclist will sway forward to stay upright and needs some width to do so. Turbulence caused by cars and lower speeds require more space.
- The bicycle has no crumple zone: cyclists are vulnerable and every effort should be made to give them a “spatial crumple zone” to make anticipation and prevention possible.
- The (average) bicycle has hardly any suspension: cyclists prefer a smooth road surface.

Key terms used in Chapters 5–8

In preparing this Handbook we have worked hard to develop an internationally useful glossary of bicycle and related terminology. Given the multidisciplinary, multi-cultural approach of our team, we have also acted from the conviction that to some degree we must (re)define some key concepts. We remind readers that bicycle or bike is the object on which we travel, while to cycle is the action. In some cases we have opted to use the term "cycle" as the generic noun, because it includes all wheel-based, human-powered vehicles (including the tricycles, rickshaws and other work-based vehicles common in cities around the world). In all cases, we use bicycle, cycling and cyclist in the sense of human-powered vehicle users, reserving the terms motor cycle, motor cyclist, and so on, for motorized users. For more information and useful terms, we invite readers to browse the glossary of this handbook. Similar glossaries are being prepared in other languages. In a number of countries the designation "non-motorized transport" is used. As this is a negative designation, indicating an important category of road users by what it is not, we have preferred designations such as "human-powered transport" or "active transport", which are more positive. To keep reading straightforward, we have sometimes chosen to use "cycling" to refer to the whole broader category of human-powered transport.

Cycle Lane: A lane marked on a road with a cycle symbol, which can only be used by cyclists. Cycling lanes are usually limited to one-way travel, in the same direction as the adjacent traffic flow. Where parking is permitted, the bike lane is usually between the parking lane and the through traffic lane (TAC, 1999). In some instances bicycles share a designated lane with other specified vehicles such as in a Bike/Bus lane.

Cycle-Only Paths: These are separate paths for cyclists commonly constructed in urban parks, where they are usually constructed parallel to a footpath and are open to various types of wheeled vehicles (bicycles, in-line skates, scooters, wheelchairs, Vélo Québec, 2003).

Cycle or Bicycle-Pedestrian Path (Shared or Multi-Use Path): A path designated for the preferential or exclusive use of bicycles and pedestrians. Sharing requires that the stronger, faster vehicle (the bicycle) sacrifice many of its key advantages to care for the safety of more vulnerable users. We therefore recommend avoiding this type of measure except in situations where it is absolutely necessary or measures (such as signage and low usage levels) make this a feasible option.

Cycle, Bike or Bicycle Path or Way: A cycling facility that is physically separated and segregated from motorized vehicular traffic by an open space or barrier and either within the highway right of way or within an independent right of way. Note: often bikeway is used to refer to a segregated facility but some local authorities define a bikeway as any trail, path, part of the highway or shoulder, or any other travelled way specifically signed and/or marked for bicycle travel, including even a less formal facility such as a paved shoulder. It is important to specify in legislation, regulations, planning and other documents whether the facility is "segregated" from other, particularly motorized traffic. Note: typically segregated cycle paths are used to provide cyclists with safe passage through particularly busy (high flow, complex), high-speed roads of the city and are not required at every stage on a cycle route.

Cycle Parking: Bicycles can be locked to trees or street furniture such as signposts. In most instances installing equipment specifically designed for bicycle parking is preferred. Various designs and options are available for bicycle parking facilities. Key terms: Cycle stands: mostly units for 1 or 2 bicycles. Cycle racks: mostly units for 6 or more bicycles. Cycle lockers or boxes: for individual or collective use. Automatic cycle parking facilities (mostly paid): the cyclist hands in the bicycle at the entrance. Guarded cycle parking facilities (mostly paid): collective cycle storage with supervision during most of the day and evening.

Cycle Route: Basically a cycle route is the total of the consecutive road sections chosen by a cyclist between his origin and destination. As a design object, these routes typically involve a combination of quiet roadways, some segregated cycle paths and cycle lanes (which are only visually segregated by a painted line) providing the most direct connections within a city and between the various origins and destinations like the different neighbourhoods, boroughs, comunas and so on that make up metropolitan areas. A bicycle route can be signed to provide continuity with other cycling facilities or because it is a preferred route through a busy corridor. Cycle routes can be implemented predominantly for utilitarian use (such as commuting) and for recreational use.

Cycle share or sharing, public bicycles, bike share, Vélolib, etc. Short-term bicycle rental available at unattended urban locations; 2: bicycle transit (definition from the bike-sharing blog, http://bike-sharing.blogspot.com). It is important to note that there is a difference between traditional bicycle renting, offered as a private service, and public bicycles, which can be seen as part of the public transport system. This distinction may have an impact on organisation and funding of these kinds of programmes.

Cycling Advisory Group: A group of stakeholder representatives that advises on improving cycling conditions. Cycling Network Plan or Strategic Cycling Plan A Plan, usually developed through a participatory process, that includes objectives, promotional plans, and a map of the desired network of cycle routes, along with a budget and a schedule of the cycle infrastructure and other projects required to develop it.

Cycling Policy: A general course of action relating to cycling to be adopted by the government or an organisation.

Cyclist, utilitarian, commuter or urban: Terms often used to distinguish those who use their bicycle primarily as transport mode (normally several days per week) from recreational and sports cyclists.

- Cyclists ride in the open air: designers should offer as much protection from wind, rain and sunas possible.
- Cycling is largely a social activity: cyclists (like anyone else) want to ride side by side. Moreover, riding side by side is a must for parents to escort their children safely.
- People are the key factor: cycling is a multitasking activity. Designers should respect this, avoiding complex situations overloading the mental capacity of human beings.

These quality preferences can be translated into five main requirements for bicycle infrastructure:

1. Perception and being able to ride side by side create requirements in terms of *attractiveness* and *comfort*.
2. Minimising resistance requires *comfort* and *directness*.
3. Optimising mental capacity and allowing enough free space create requirements in terms of *comfort* and *safety*.
4. Cyclists' vulnerability creates requirements in terms of *safety*.
5. The need for complete, understandable cycling infrastructure creates requirements in terms of coherence (or consistency).

Generally speaking, if the minimum level of one or more of the five requirements cannot be met, the infrastructure must be modified. I will further explain the five requirements.

5.3 The five main requirements explained

5.3.1 First main requirement: coherence

As the word suggests, coherence means that the cycling infrastructure forms a coherent whole. Furthermore the network has to provide connections between the all origins and destinations for cyclists, especially the most important ones. So coherence is about giving people the opportunity of going somewhere by bicycle, combined with integration with other means of transport, Metro, bus, as well as making the whole journey by bike.

Elements that play a role in this regard include making it easy for people to find their way, consistent quality and the freedom to choose different routes. And at every journey's beginning and end, a place to park safely (Figure 47).

Figure 47
Wayfinding signs.
Photo by I-CE,Danielle Wijnen

5.3.2 Second main requirement: directness

Directness means that cyclists can use the most direct route, thus keeping detours to an minimum. If the travelling time by bicycle is longer than by car, people will tend to use cars. On the other hand, many motorists are willing to use the bicycle for short trips if it is quicker and more convenient. And cycling is healthy. For people without a car, the bicycle offers the opportunity to travel further than walking in the same amount of time, leaving time to do more. Using the bike is less expensive and cyclists seldom use much time looking for a parking place.

Figure 48
Shortcuts between roads.
Photo by I-CE, Danielle Wijnen

Figure 49
Two way bicycle traffic lane.
Photo by Payton Chung

All factors that influence travelling time should be considered, including delays due to traffic lights and crossing busy main roads, detours, sharp curves, and so on. It is important to shorten travel time and distance as much as possible.

Sometimes designers can create short cuts between roads (Figure 48);

allow two-way bicycle traffic on one-way roads; (Figure 49);

or create two-way cycle paths on both sides of main roads, to avoid crossing (Figure 50).

Figure 50
Two way cycle path in two sides of roads.
Photo by I-CE, Jeroen Buis

5.3.3 Third main requirement: safety

This requirement means that cycling infrastructure should guarantee the safety of cyclists and other road users in traffic. Cyclists are vulnerable, because they share the same space as motorized traffic, despite major differences in mass and speed. The cyclist does not have the benefit of external protection, such as bumpers and crumple zones.

Designers cannot change this inherent vulnerability, but they can influence the conditions in which cyclists travel. A key point is that encounters with fast-moving motorized traffic should be avoided as much as possible by means of a separation in time or space. Accident figures confirm the importance of this requirement. In towns and cities with a large number of busy intersections there are relatively more serious accidents involving bicycles than in urban environments with fewer busy intersections.

Safety is relevant on many different levels and can be influenced in a variety of ways. The requirements included in a sustainable safe traffic policy can guide the design process. Some of the main points of interest include (Figures 51 and 52):

- Building extensive residential areas, with mixed traffic and low (maximum 30 km/h) speeds;
- Minimizing the need to travel along relatively dangerous roads;
- Combining the shortest, safest routes;
- Providing clear signage and indications of the route so cyclists don't have to work at finding the intended route;
- Limiting the number of traffic solutions and using simple, easily understood designs;
- Separating different types of vehicles, where differences in speed are significant;
- Reducing the speed of motorized traffic at potential conflict locations.

Finally, cyclists are more vulnerable in dark or rainy weather: visibility in those conditions is a major issue that should not be forgotten. Designers can help by ensuring visibility amongs different road users long before they actually meet.

We provide some examples from Houten, which was declared the Dutch "Cycling Town of the Year 2008." Here you see in blue the bicycle network, connecting major destinations, such as the town centre, the railway station, schools and so on (Figure 53).

Figures 51 and 52
Level crossings for cyclists.
Photos by Carlosfelipe Pardo and Manfred Breithaupt

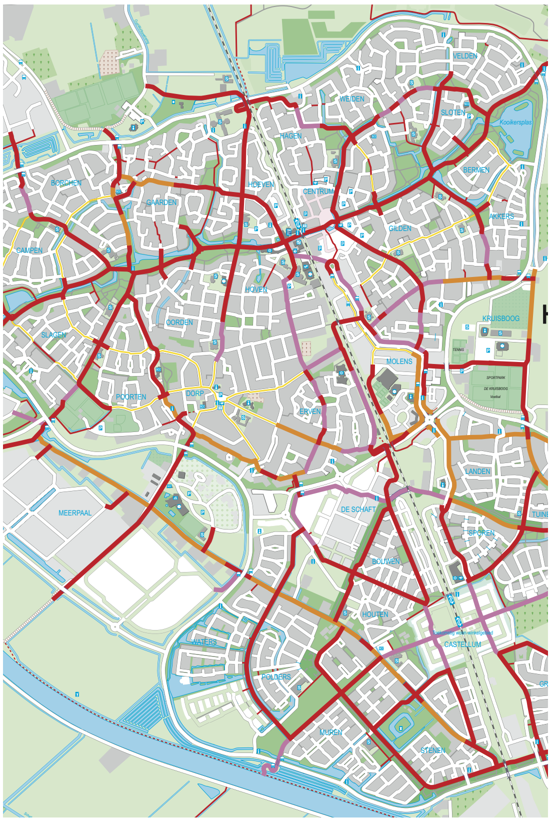


Figure 53
Map of Houten with main arterials and cycle network.
Courtesy of City of Houten

At intersections, cyclists enjoy right of way and to avoid conflicts, cars must slow down, because of the hump and the angular corner, which makes turning more difficult (Figure 54).

Figure 54
Typical cycleway in Houten.
Photo by Carlosfelipe Pardo

And cars give way! (Figure 55)

Figure 55
Crossing in Houten.
Photo by Manfred Breithaupt

In the event of significant differences in speed, Houten separates bikes and cars (Figure 56).

Figure 56
High-investment intersection – Houten.
Photo by I-CE, Hans de Jong

5.3.4 Fourth main requirement: comfort

This requirement addresses nuisance and delay caused by bottlenecks and shortcomings in cycling infrastructure, which require additional physical effort. We know that not only extreme exertion but also interrupted journeys make cycling less enjoyable. The discomfort of vibrations due to poor or inappropriate surfacing can also discourage cycling.

The main message is to make a smooth pavement, to minimize the chance of stopping and nuisance caused by other traffic and weather (Figures 57 a, b).

All users share the street, but the car is clearly the "guest" here and must respect the other users.

Figures 57 a, b
Cars as "guests" in Houten.
Photos by I-CE, Hans de Jong

5.3.5 Fifth main requirement: attractiveness

Attractiveness means that cycling infrastructure fits well with surroundings, making cycling easy and relaxed. People's behaviour, however, is determined by a wide range of factors, which may be more or less important to individual cyclists when it comes to deciding how to travel and by what route. Perceptions of cycling are highly personalized. It is important to listen to cyclists' complaints and respond to them with design improvements: no matter how good a design may look from a "technical" point of view, if cyclists don't want to use the result, it must be considered a failure.

Attractiveness includes the criterion "social safety", which is clearly associated with the surrounding design and context. People feel safest in busy places and potential offenders are deterred by the presence of passersby. Even the busiest cycle route can feel deserted and isolated in the evening or at night. For the designer this all means: the greatest yields in terms of social safety can be achieved at the level of network formation, by maximizing social control and supervision.

5.4 Applying the five requirements

These five main requirement must be applied at the four levels of cycling infrastructure design, and in the right order:

- the network,
- road sections,
- intersections,
- road surface.

At the network level, key factors include:

- Building complete networks and ensuring a seamless match with travel needs;
- Providing direct routes, in terms of both distance and time (*e.g.* by solving missing links in the network, providing short cuts where useful and possible);
- Avoiding conflicts with crossing traffic, usually motorized vehicles;

Table 5: Common problems and solutions

	Problem	Solution
1.	**Speed difference between bicycles and other vehicles**	■ Traffic calming (30 km/h zones, woonerf) ■ Enforcement ■ Segregation, parallel routes
2.	**Lack of dedicated space** Tiny gaps between moving vehicles and the curb/parked cars or between 2 lanes of moving traffic. Parked cars pulling in & out; opening doors	■ Provide dedicated space (segregated/shared) ■ Alternative parallel routes ■ Rumble strips on the road surface
3.	**Intersections** Long crossing distances High speeds Signalling favouring faster modes	■ Adjust/reconstruct intersections ■ Reduce speed on all sides ■ Pre-signalling for cyclists ■ Adjust phasing of signals
4.	**Difficult weaving movements** Cyclists turning right crossing lanes Cyclists going straight, traffic turning L or R	■ Reduce speed where modes are mixed ■ Weaving lanes ■ Dedicated crossings
5.	**Road markings: absent/partial/ confusing** Inconsistency encourages less disci-plined behaviour	■ Definition of policy/standards of: having traffic lanes, cycle lanes through intersections, white lines, logos, red surface, etc. ■ Minimize road markings within Habitat areas
6.	**Proximity of trucks and buses** Especially while turning Fast vehicles create draughts Passengers (dies) embarking	■ Special zones for trucks and buses ■ Minimum bus & cycle lane width ■ Careful design of bus stops
7.	Detours Discontinuities in existing facilities	■ Contra flows for cyclists ■ Run cycle tracks through intersections
8.	**Weak enforcement of traffic laws** Red light braking Speeding (especially motorbike couriers) Car encroaching on cycle tracks (at pinch points, parking, loading) Jaywalking pedestrians	■ Better laws and regulations ■ Enforcement of all laws and regulations ■ Segregation ■ Parking & loading windows ■ More green time for pedestrians ■ Educational campaigns to ensure all users understand the dif-ferent rules, the rationale behind them, and how they apply to the different transport modes
9.	**Cyclists not being seen**	■ Cyclist and driver education ■ Enforcement of proper lighting, reflectors, bells ■ Designs such as the “boxes” being used in Portland (US) that designate a stopping area for cyclists, where they are clearly visible to drivers ■ Avoidance of designs that tend to leave cyclists stopped in cars’ blind spots
10.	**General abundance of traffic and parking** Its general presence and sometimes erratic movements No place for social activities (incl. play) Noise & pollution	■ Implementation of an integrated and efficient public transport system ■ Traffic calming (30 km/h zones, Woonerf) ■ More car free areas ■ Diminishing the number of parked cars and strict enforcement
11.	Bad road condition Holes, trenches Glass and wet leaves Street ‘furniture’ – railings	■ Regular maintenance ■ Remove street furniture where cyclists could be crushed up against it by turning vehicles (tight) corners ■ Locate posts out of pedestrian and cycle routes and, where possible, bury utilities, thus reducing the number of posts for electricity and other purposes

- Working with easily recognized road categories;
- Minimizing physical exertion;
- Ensuring users feel safe from both traffic hazards and threats to their own safety.

At the road section level, key factors include:

- Providing direct routes in terms of both distance and time;
- Avoiding unnecessary curves and winding roads and paths;
- Separating cyclists from other vehicles in case of high volumes and major speed differences;
- Choosing routes that avoid a lot of noise and/or fumes, especially due to trucks and buses.

At the intersection level, key factors include:

- Offering direct routes, in terms of both distance and time;
- Where speeds vary significantly, taking care to build cycling-appropriate facilities into routes, which may require special bridges and tunnels;
- Minimizing stops and wait times;
- Ensuring cyclists are always visible to motorists;
- Eliminating designs that produce unexpected movements or large detours;
- Designing curves that take into account bicycle design speeds and applying speed reduction curves and other similar measures to reduce motorized traffic speeds.

At the road surface level, designers should ensure:

- Even paving, on all cycling and mixed use facilities;
- Skid resistance, for safety and comfort;
- Good drainage; cyclists have no idea how deep puddles may be, potholes are hard to see and very dangerous, especially at night or in poor weather, and so on.

In principle, the road environment should be designed to meet all these cycling-related quality requirements. Infrastructure that does not meet minimum standards for any of the five requirements should be modified. This usually involves balancing the different, sometimes conflicting priorities of the many people with different backgrounds involved in the process. Some are responsible for designing or building suitable facilities for cyclists, while others involve cyclists themselves and their representatives. Politicians can also set priorities, such as putting safety first, or trying to improve the competitive position of cycling compared to motorized traffic, by emphasizing directness.

The next chapters will explore network, road section and intersection design in more depth. The following table provides a 'quick and dirty' overview on how recurrent problems can be solved.

5.5 Further reading

For specific information, including sample designs and other material, please refer to the CROW, Design Manual for Bicycle Traffic, English version 2007, CROW, Ede, The Netherlands.

Other Resources and Design Manuals that may be useful include (from http://www.bikeplan.com/manuals.htm and other knowledge bases):

American Association of Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities; 1999; the basic design guide for bicycle facilities in the United States; Guide for the Development of Bicycle Facilities, AASHTO, Washington, USA, 1999. http://www.sccrtc.org/bikes/aashto-1999-Bikebook.pdf. Maintenance Manual, 1987, Includes a better discussion of trail maintenance than does the Guide for the Development of Bicycle Facilities; available from AASHTO, 444 N Capitol St, NW, Suite 225, Washington DC 20001.

Arizona Bicycle Facilities Planning & Design Guidelines, 1988; expands significantly on AASHTO Guide, adding information on bike trail railings, signal actuation, and detailed sign templates; from AZDOT Engineering Records, 1655 W. Jackson, Room 211 F, Phoenix, AZ 85007.

Bicycle Facilities Planning and Design Manual, 1995, The Florida Department of Transportation. Florida Bicycle Program, Florida Department of Transportation, 605 S. Suwannee Street MS 82, Tallahassee, FL 32301 (904) 487-1200.

Bicycle Transportation, 1983, John Forester, MIT Press, MIT, Cambridge MA 02142.

Bikeway Planning and Design Standards, 1987, (California's standards formed much of the

basis for the AASHTO Guide), CalTrans, 1120 N St, Sacramento CA 95814. For an online version: http://www.dot.ca.gov/hq/oppd/hdm/chapters/t1001.htm.

Converting Rails to Trails; Rails-to-Trails Conservancy, 1400 16th St NW, Washington, DC 20036.

Cycle Network and Route planning Guide, Land Transport Safety Authority, New Zealand, 2004 ISBN 0 478 24172 0, http://www.landtransport.govt.nz/road-user-safety/walking-and-cycling/cycle-network/docs/cycle-network.pdf.

De Langen, M., Tembele, R, Productive and Liveable Cities, IHE Delft University (The Netherlands), 1996, ISBN 9058091996.

Greenways: A Guide to Planning, Design and Development; 1993; by Charles A. Flink and Robert M. Searns; a how-to for greenway planners; Urban Edges, Inc., 1401 Blake Street # 301, Denver, CO 80202.

Highway Capacity Manual, Transportation Research Board, (USA), 2000. http://www.trb.org

London Cycle Network, London Cycle Network Steering Group, Director of Environmental Services, Kingston upon Thames, 1998 ISBN 1 902193 00 9.

Manual de Diseño de Ciclorutas, Bogotá (Colombia), 2000.

Manual for streets, Department for Transport UK, Th. Telford, Tonbridge (UK), 2007. http://www.dft.gov.uk/pgr/sustainable/manforstreets

Manual on Uniform Traffic Control Devices, 1988, U.S. DoT, Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402.

North Carolina Bicycle Facilities Planning and Design Guidelines 1992; expands on current AASHTO guidelines. 22-minute video explains well-designed bicycle accommodations, and good and bad facilities. To order a copy of the manual and/or the video, contact the Office of Bicycle and Pedestrian Transportation, PO Box 25201, Raleigh, NC 27611.

Oregon Bicycle and Pedestrian Plan; provides goals and objectives related to facility funding, planning, design, and maintenance and education, recommended practices, statewide design criteria for facilities, signing, and striping. Oregon Bikeway Program, Technical Services Branch, Oregon DOT, Transportation Building, Rm. 210, Salem, OR 97310 (503) 986-3555.

Pedestrian and Bicycle Planning Guide to Best Practices, Victoria Transport Policy Institute (http://www.vtpi.org), Appendices, 18 Feb. 2000, offers an excellent list of additional resources, on cycling and walking planning, with websites, examples of policies from different cities, etc.

Policy & Procedure for Bicycle Projects, 1988, free from the Ohio Department of Transportation Office of Bicycle Transportation, Rm. 418, 25 S. Front St., Columbus OH 43215.

Technical Handbook of Bikeway Design; comprehensive guide to planning and implementation of bicycle facilities in Canada. 169 pages with 142 illustrations. Also available in French. From Vélo Québec, 3575, St-Laurent Blvd., Suite 310, Montreal, Québec H2X 2T7. More information: http://www.velo.qc.ca/english/bikewaysdesign.php?page=handbook.

Tom Godefrooij: Segregation or integration of cycling in the road system: the Dutch approach, in Sustainable Transport, Rodney Tolley, 2003.

Tool of the Trail: a bibliography on planning, advocating, designing, building, maintaining and managing trails throughout America; edited by Paula Ward, published by American Hiking Society under a cooperative agreement with the National Park Service. American Hiking Society, PO Box 20160, Washington, DC 20041-2160.

Wisconsin Bicycle Planning Guidance. Bicycle/Pedestrian Coordinator, Div. Of Highways & Transp. Services, Wisconsin Department of Transportation, PO Box 7913, Madison, WI 53707-7913.

6. Identifying bicycle networks for better cities

Mark Zuidgeest, Anke Rouwette, Hans de Jong

For related subjects

For definitions of the Key Terms used in this chapter, see Chapter 5.

See ***Chapter 3*** for ideas on urban form and how they shape activities.

See ***Chapter 5, Box*** Problems and Solutions.

See ***Chapter 7***, on Designing residential streets, particularly the box on traffic calming.

See ***Chapter 8***, on Designing main roads and highways.

See ***Chapter 15*** for a more detailed treatment of data collection and other cycling-related research methods.

See ***Glossary*** on habitat areas, traffic calming, cycle routes, cycle paths and lanes, etc.

Good information about people's travel behaviour and mobility, particularly (potential) cycling, is important to making decisions about what infrastructure to provide for cyclists, and where. Typical questions, such as how many people cycle or wish to cycle, where they ride, for what purpose, and how competent they are to handle a variety of conditions, all provide important information useful to identifying a good bicycle network (LTSA 2004). To help build this picture, this chapter describes cyclists' trip origins and destinations, and ways to identify the routes cyclists take. Furthermore, the types and numbers of cyclists who use them or who may use them in the future are discussed. In Section 2, the chapter provides both simple and advanced methods for defining a bicycle network using this data. This chapter is partly based on an excellent introduction to this process by the New Zealand Land Transport Safety Authority (LTSA 2004), which is freely available through the internet. The last section introduces integrated bicycle planning, discussing how a bicycle plan can be integrated into an overall traffic and transport plan.

6.1 Planning the network: participatory mapping

This section describes a procedure that can be followed when identifying a bicycle network. Each of the steps provides useful data for the planning process. Ideally all steps are followed, preferably in collaboration with the different stakeholders involved in the process. The process of bicycle network planning can be summarized in five important steps (adapted from LTSA, 2004):

Assess cycle demand

1. Develop a base map of land use, trip origins and destinations;
    a. Map land use, typically using district planning data;
    b. Assess their importance as cycling trip generators;
    c. Map desire lines.
2. Map existing facilities, routes, cycle-related accidents and cyclists volumes;
    a. Map existing cycle facilities;
    b. Count and map cycle traffic and parked bicycles;
    c. Map cycle-related accidents;
    d. Consult and/or survey bicycle users;
    e. Assess trip purposes and types of cyclists;
3. Map main infrastructure barriers and identify missing connections.;
4. Assess and understand potential demand;

Prioritize bicycle network structure

5. Define and establish the priorities for a bicycle network structure using qualitative or quantitative methods.

Each of these steps is discussed in the following sub-sections. Depending on the local context, data and resources available, the steps in the presented methods can be followed in more or less detail.

Figure 58

Bicycle users have excellent local knowledge of routes and their associated strengths and hazards.

Photo by I-CE

6.1.1 Developing a base map of land use, trip origins, and destinations

Local planning documents map existing land uses and the hierarchy of roads. They also contain information about land use zones and growth areas, major residential subdivisions, commercial or community developments. They are a most useful source of primary data about likely origins and destinations of cycling trips. A higher concentration of cyclists can be expected near popular (cycling) destinations. In addition, information about possible/typical bicycle origins and destinations is very useful, among them:

- Residential areas;
- Tourist attractions and natural areas;
- Schools and universities;
- Offices and industries;
- Shopping areas and markets;
- Leisure and entertainment facilities;
- Public facilities;
- Public transport stations.

Map these locations using a basic road map, land use maps on paper or maps in a GIS-system. Highlight the locations that generate trips. Trip desire lines (straight lines connecting the main origin and destination location) can then be plotted by directly linking the main bike origins and destinations using manual or computerized methods (see subsection 6.1.5). This allows planners to make a qualitative assessment of where on the network, bike demand is likely to be significant.

If census data is also available, the (potential) strength of trip generation (number of trips) for different areas can be estimated and mapped (see Box 12).

Box 12: Creating and weighting trip desire lines

If the main origins and destinations of (bicycle) trips are known, highlight these locations on a map and connect the origins and destination by straight lines (the 'desire lines'). If census information is available, for example on the size of residential areas, the desire lines can be weighted to the strength of the OD relation. The relation between a large residential area and a large city market is stronger than the relation between a small business area and a market. An example of intuitive weighting of desire lines is shown in Figure 58. In a participatory setting with several stakeholders such a sketch drawing with weighted desire lines can be created. If detailed information on actual numbers of residents, working places or market visitors and their trip making behaviour is available, the size of the desire lines can be based on this data. A detailed introduction to such modeling of trip generation with census data is provided by Ortúzar & Willumsen (2001).

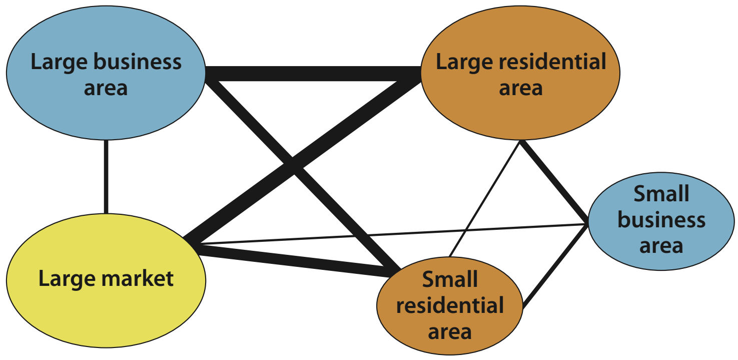


Figure 59: *Intuitive creation and weighting of OD desire lines*

6.1.2 Actual and potential demand

The origin-destination (OD) relation, indicated by a desire line, can be weighted by the strength of the OD relation (explained in Box 12). Remember that the desire lines do not identify the actual number of cycling trips in an OD relation (bicycle demand). The lines indicate the potential travel demand, based on relations between important origins and destinations for cyclists. To be able to translate this into actual or potential bicycle demand, we require additional information on actual or potential bicycle use in the area (from questionnaire data, for example). If a travel survey is available, information on OD trip rates can be used to map the strength of potential cycling relations. There may be no information available on the actual use of these ODs by cyclists (or other, possibly competing, modes). A travel survey could provide information on trip rates to help map the actual strength of bicycle relations.

Comparing the actual and the potential strength of these relations provides information on which require improvement. If there is little cycle use in the current situation a stated choice survey can be used to study the potential for cycling. In a stated choice survey respondents are asked if they would cycle if certain facilities are provided. A very good manual on stated choice modelling is the book by Louviere *et al.,* (2000).

Special attention could be given to school bike traffic, as in many countries schools represent points where bike users concentrate, making these trips very important as well as relatively easy to survey. School bike traffic is localized and may account for a significant proportion of the total cycling in many areas. If not, a poor cycling environment is likely to be suppressing use. Questionnaires and counting parked bikes are commonly used to assess bike demand at schools. By obtaining the number of students attending school on a survey day, the percentage of students cycling to school can be calculated. Questionnaire surveys can also provide information on route choice and (safety) problem areas. Survey results can also be incorporated into a safe routes to school or children to school program. This way of identifying school trips can of course also be done for any of the other bicycle destinations as listed above.

Mapping existing volumes, facilities, routes and accidents involving cyclists is a particularly powerful information tool for cycling-inclusive planning. Particularly in cities or areas where there is already (at least some) cycling and where cycling facilities are present, plotting a map indicating where these facilities (bicycle lanes, routes, parking, repair shops) are currently, may prove very useful. This data may indicate where demand is located, or at least where significant. Surveyors can record the numbers of cyclists, their travel direction, and possibly whether each cyclist is a primary school pupil, secondary school student or adult. Counting should generally be done during the morning or afternoon peak, but if necessary (not preferred) counts undertaken at other times can also be scaled up (see Chapter 15 for more on data collection). Locations and numbers of parked bicycles also provide useful information.

Where some cycling already exists, bike demand assessment could also include an inventory and mapping of bike accident or conflict data, existing cycling routes and facilities (their quality as well as use), and cyclists' opinions. Further on in the process, this information is useful for prioritizing decisions (particularly when financial and other resources are limited). Bike accident data records covering longer periods can point out routes that cyclists have difficulty negotiating safely. If such data is available and reliable (!) it can be mapped and used later, when selecting corridors for upgrading.

It can also be very practical to involve local bicycle users as stakeholders when examining existing and/or popular bike routes, with which they are familiar. Bicycle users usually have excellent local knowledge of the routes they use and associated problems. This can also be a very good way of identifying leisure cycling routes. Individual cyclists, unless they bike many different routes, can talk accurately only about the routes they know. To cover all areas, it is necessary to speak to a representative group of cyclists or a representative panel that is directly involved in different stages of the project or process. It is important to consult not only experienced but a range of cyclists from various age groups and from both sexes, to gather information on the needs and desires of less experienced cyclists or those with different needs.

Questionnaires can also be used to monitor existing cycling behaviour, simply by asking bicycle users about their trip purposes, trip frequency, average or typical trip lengths (to derive a trip length distribution (TLD), see Box 13), their preferences and social-economic background, etc. This information can also be used to 'identify' the potential for cycling, when asking people whether they would cycle if certain facilities were available.

Box 13: Trip length distribution (TLD)

A TLD divides trip lengths into several classes and shows the percentage of trips that falls in each class. As such the TLD provides useful information on typical distances people travel with a certain mode. Figure 59 shows the TLD for cycling trips to work in Dublin (Ireland). Almost 25% of the trips have a length between 4 to 6 kilometres, more than 15% of the trips have a length between 6 and 8 kilometres and around 10% of the cycle trips are even longer than 8 kilometres. If a TLD of all traffic is available, an estimation of potential for cycling can be made. The Dublin example suggests that all trips up to 6 kilometres in length are very suitable for cycling.

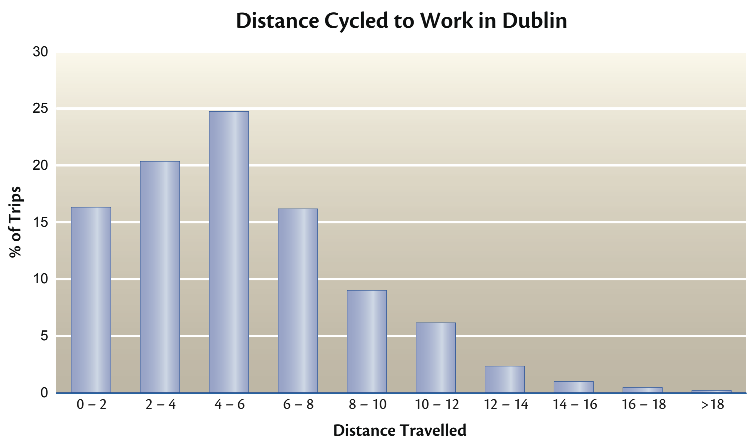


Figure 60: *The TLD for cycle trips to work in Dublin*

Source: http://www.dto.ie/web2006/cyclepolicy.pdf)

6.1.3 Mapping main infrastructure barriers and identifying missing connections

The main infrastructure barriers such as highways, swamps, railway lines, insecure areas, etc. obstructing logical bicycle OD connections can be identified and mapped. These barriers cause missing links in the existing network. As special provisions may have to be made to establish the desired bicycle connections, these barriers require special attention when developing the bicycle network.

6.1.4 Assess and understand potential demand

Potential demand (also called latent demand) describes potential new bike trips, which are currently suppressed, but could take place if cycling conditions were improved. Potential demand can be assessed in relation to specific route improvements or to the whole network. Measuring potential demand requires understanding factors that influence people's choice of the bicycle. Surveys of bicycle users and non-users, which ask about the main constraints when they decide to use or not to use a bicycle, are helpful in this case, see Box 14 which discusses the theory of constraints applied to bicycle network design. Decision-makers can bring some of these factors under control. For example in some situations, potential demand is likely to manifest itself when safe, good quality bicycle paths are constructed, or when promotional activities have been undertaken to take away prejudgements on cycling.

6.1.5 Define and prioritize a bicycle network structure using qualitative and quantitative methods

Planners can use three methods to define and prioritize bicycle networks, based on the data inputs discussed in sub-sections 6.1.1 to 6.1.4. However, each method will only produce the the outline of a possible network structure. This structure doesn't necessarily comply with the main quality requirements for bicycle infrastructure, that is, directness, coherence, convenience, efficiency and availability, intersection controls and other elements necessary, such as good levels of surveillance and therefore personal security; see Chapters 5, 7 to 9 on design of bicycle facilities.

Box 14: Critical constraint theory applied to cycling

The Theory of Constraints (TOC), which has been developed by Eliyahu Goldratt (Goldratt 1997) is mostly applied in management sciences to study constraints which limit the system's performance relative to its goal in organisations. These constraints can be broadly classified as either an internal constraint or a market constraint. In order to manage the performance of the system, the constraint must be correctly identified and managed. Over time the constraint may change (*e.g.* because the previous constraint was managed successfully, or because of a changing environment) and the analysis starts anew, hence arriving at an iterative process of removing most critical constraints consecutively. TOC can also be applied to cycling by studying critical constraints that prevent people from (more) cycling.

The TOC process can be described by the following steps (adapted for studying cycling):

1. Formulate the goal of your bicycle policy (for example 'More white. collar workers should be seen cycling to work');
2. Identify the first most important constraint why the target group is not cycling to work;
3. Decide how to lift the constraint and act accordingly, for example by providing guarded bicycle parking facilities at the work place.

If, as a result of these steps, the constraint has moved, return to Step 1, after which it might appear that absence of shower facilities at the work place is the next critical constraint.

Also when talking to your target group you might 'lift' constraints during the conversation itself by saying 'Suppose safe bicycle parking facilities would become available, would you come by bicycle?', after which the respondent might come up with his/her next critical constraint, such as: 'No, I would not, as I want to be able to take a shower after cycling to work'. The interviewer can identify this constraint again and again through different respondents to get a statistically sound ranking of critical constraints.

TOC for cycling has been applied by I-CE (Witholt 2004) in Dar es Salaam to study critical constraints of cycling by residents in certain areas. In their study the following type of constraints had been defined:

- Objective availability of transport modes: the presence or absence of public tranport;
- Travel time and perception;
- Travel cost and perception;
- Service level, comfort and perception;
- Choice limitations due to situation;
- Personal awareness: people can have wrong or no information at all about the trip they would like to make and therefore decide not to make this trip.

The TOC is accordingly performed by:

1. Asking what the main reason is for not using a bicycle at this moment;
2. Proposing a situation where the first constraint is no longer present;
3. Asking the same question as in Step 1;
4. Continuing this cycle until there are no constraints left.

These constraints are accordingly used to reveal three kind of groups of travellers, *i.e.* captives, latent potential users and potential users. By taking away the main constraints, the proposed policy will probably reach at least potential users and possibly latent potential users.

Local knowledge and expertise are required to make a further, detailed design, preferably by involving different stakeholders, decision makers, design engineers and other interested parties.

6.2 Three ways to identify a bicycle network

This section discusses three methods for identifying bicycle networks. The data collected in the first four steps of the network planning procedure, as described in the previous section, provide the necessary inputs. The three methods presented vary in terms of the amount of hidden expertise required to define the network. The first method, elastic thread, provides information on important (bicycle) OD relations. The second method, strategic outline, provides a systematic framework for mobilizing (local) expertise in defining a network. The third method, GIS-based network design, combines the first two in different maps, and provides a platform for discussion from different viewpoints and by different stakeholders.

Using the knowledge provided in this sourcebook, particularly on route design options, network structure parameters, and so on, planners can further design a network.

6.2.1 *Elastic Thread Method (Star Analysis)*

The Elastic Thread Method developed by Professor Boudewijn Bach (CROW 2006) identifies where residents of a certain group of families or households travel to. The design tool uses a map laid out on a piece of soft board or other similar material. The centre point of the cluster of families is linked to the main daily destinations using thin elastic bands. A separate map can be used for other modes than cycling.

All the elastic threads together form star-shaped patterns. Pins are used to make bundles of threads along the paths and streets people would logically take, thus creating a fairly accurate structural picture of walking and cycling movements in the study area. The number of elastic threads on one route indicates the number of people who would benefit from this route being short, safe and attractive. If planners suggest long detours, the elastic threads are tensioned and if a thread breaks it shows an excessive deviation from the preferred cycling behaviour. With the help of computer software, such as Star Analysis (developed in the Netherlands) or a common GIS, generating alternative bundles can be easier.

The required material for the paper-based Elastic Thread Method is (CROW, 2006):

Map at neighborhood level	1: 500 to 1,000
Map at district level	1 : 1,000 to 2,500
Map of a route	1 : 2,500 to 5,000
Base	soft board, cork, linoleum, or a similar material
Overlay	transparent sheet
Other materials	a box of short pins with coloured heads for each kind of destination, a box of strong black tailor pins and elastics (through which the pins can be stuck)

The Elastic Thread procedure uses the following steps (an example is provided in Figure 60):

Opening phase

1+2. Perform steps 1 and 2 of the network planning procedure as described in Section 6.1.1 and 6.1.2. Divide the residential area into residential blocks with an equal number of residents:
   a. For pedestrian links, the point of departure for the elastic thread from the centre is each zone of 50 to 100 homes;
   b. For cycling links, the point of departure for the elastic thread from the centre is each quantity of 200 to 400 homes;
   c. For cycling routes, the point of departure for the elastic thread is each gate or entrance in the neighbourhood for non-residential cyclists.

3. Draw destination points on the map.
4. Determine the number of mobility requirements to the relevant amenities for each home for each day or week.

Analysis phase

5. Lay a transparent sheet of plastic (overlay) over the map to be able to record the constructed bundles later.
6. Use elastic thread to construct the required radial links between origin and destination areas (only pin on one link in the case of more than one similar destinations; use another colour for departure centres).
7. Cut the elastic and pin it on with a surplus length.
8. Since short journeys in an area are usually made on foot and longer journeys by bicycle, the results will be more useful if bicycle links are only pinned on if they are longer than a certain minimum distance, *e.g.* 200 m and pedestrian links are only pinned on if they are shorter than a certain maximum. Of course this is only relevant when it is useful to distinguish between pedestrian and cycle routes, and the maximum distance chosen is determined by context: in some developing countries average walking distances are much longer than in Europe.

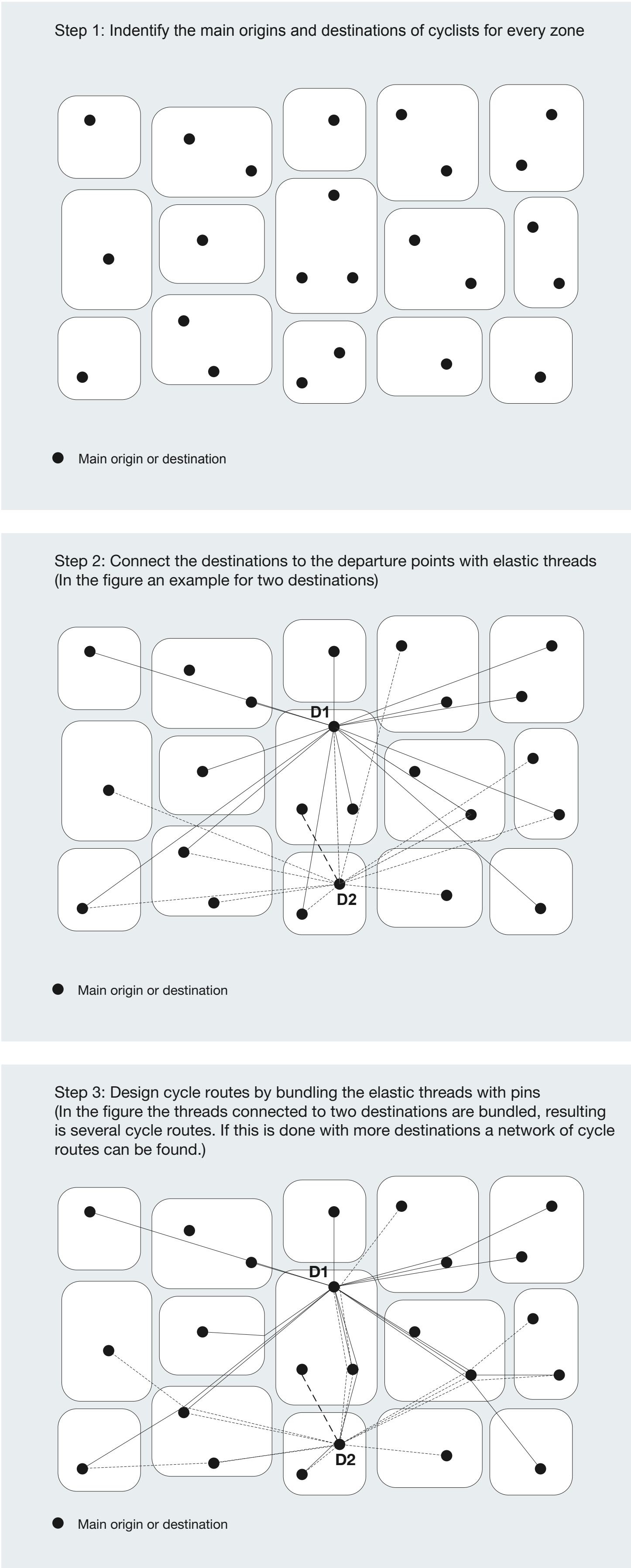
Bundling into routes

9. The required links are bundled according to the most logical or shortest routes. To do so, pins are struck into the corners of paths or plot blocks and the threads bundled around them.
10. When the most logical and shortest route bundle link has been found for each link, it is traced out with a felt-tip pen drawing the bundling patter on the overlay.
11. After the pins and elastic have been removed, the required links drawn onto the overlay can be analysed by laying the overlay on the maps showing other design variables. This confrontation provides the designer with quick insight into the following questions:
    a. Where are detours or barriers located?
    b. Where do safety conflicts occur, *e.g.* by crossing busy, wide and/or fast roads and/or heavy goods traffic?

Assessment phase or start of the design phase

12. By placing the various overlays (cycling to school, walking to shops, etc.) on top of

Figure 61: Elastic Thread Method applied. *Authors' ellaboration*



one another, designers can ask the following questions to gain more insight into the desired network structure:

a. Where are the largest bicycle flows?
b. Where are bicycle/pedestrian links most needed?
c. Where are public transport stops at the moment, which ones are easily accessible for a lot of people and which ones should be moved?
d. Where are the locations that are easily accessible for most of the people?
e. Where are entrances to public buildings or service locations in relation to the elastic threads?

The Figure 61 show an example application of the Elastic Thread method.

Box 15: Strategic Outline Method applied: Quito, Ecuador

In 2004, the municipality of Quito, Ecuador, started developing a draft cycle network, based on applying the Strategic Outline Method for the metropolitan area. The first phase of the network consists of a north — south cycle corridor (approximately 35 kilometres) and several east — west feeders (in total approximately 50 kilometres). Some of the feeders also connect the biggest universities of the city. The first phase of the network connects at different locations with the BRT-system (Trolé, Ecovía and Metrobus) and provides cyclists alternatives: cycle along a feeder towards a transfer point and take a bus to continue or cycle along a feeder until connecting with the north — south corridor and continue cycling along the north — south corridor towards the destination. Some parts of this first phase of the network have already be implemented in 2004, the remaining parts are now under construction and should be ready before 2010.

Figure 62
Photo by Bas Braakman (for I-CE)

6.2.2 Strategic outline method

The Strategic Outline Method developed by I-CE in the Netherlands (I-CE 2007) provides a quick scan and systematic framework for groups of experts to define a bicycle network on the basis of knowledge of the area and expertise in bicycle planning. As such, the method produces a map as a means of communication with stakeholders. It doesn't produce a network plan or blue print. The method functions as a starting point to mobilize local stakeholders' expertise, and could as such be integrated in the more detailed procedure described in Section 6.1. In a stakeholder workshop, a base map (road map or land use map of the area of interest) is used to indicate/map:

1. Main (potential) bicycle trip origins (main residential areas of certain socio-economic class for example);
2. Main (potential) bicycle trip destinations (main employment, industrial or commercial areas for example);
3. Main barriers (highways, swamps for example).

Based on the planning sketch map, which is produced and discussed in participatory manner, we can then draw the strategic outline of the bicycle network by logically linking the O's and D's, avoiding the main barriers. This starts the actual network design process, and routes and area connections can be refined, possibly by field visits.

The advantage of this method is that it is very simple, it builds ownership of the network design process among the stakeholders involved and doesn't require much time and resources, as compared to the elastic thread method. The method can produce a good sketch map in one or two evenings' work. The method builds on the participant/stakeholders' expertise of an area and of cycling. Ideally, if time is available, the Strategic Outline Method is expanded to a complete network planning procedure as described in Section 6.1.

An example of this method for Quito, Ecuador is shown in Box 15.

6.2.3 GIS-based network design method

A Geographical Information System (GIS) can be used to systematically map existing land use, bicycle trip origins and destinations, existing facilities, routes and cyclist volumes, identify main infrastructure barriers, and possibly even indicate and quantify latent demand. To do this, the data must be obtained in the field or obtained from municipal authorities (who often have a GIS system), and can then be fully or partly geo-referenced (this means that every location of a facility, origin or destination gets map coordinates). The maps with all this data can be automatically overlaid to obtain a base map that can be used in a strategic outline session. Alternatively, the Elastic Thread method can be simulated by producing OD desire lines (that represent the elastic threads, if needed even weighted to the strength of the relation). Such desire lines can be created automatically in standard GIS software.

Alternatively, a GIS can be used for automatically identifying missing links (using the Cycling Through method developed by I-CE, I-CE 2007), taking into account willingness to cycle over longer distances (expressed by the Trip Length Distribution, see Box 13) and attraction of different destinations. The method calculates OD patterns based on network distances as well as Euclidian (straight line) distances. "Euclidian" refers to a situation in which all origins and destinations are optimally connected, that is, without a detour factor. Differences between these patterns are then translated into demand densities on the surface and plotted with the help of the GIS. Missing links can be identified by following the places where the demand density is high, reflecting larger volumes in the case of perfectly connected zones. Figure 63 shows the outcome of an application of this method for Dar es Salaam. To use the method, a real Origin-Destination (OD) matrix for NMT/cyclist trips for at least part of the study area is needed.

A GIS package, such as the relatively cheap Manifold or the more expensive ESRI's ArcGIS, is necessary, and data is usually costly or difficult to obtain. However, if available this data and the software could be used to estimate a detailed network description.

Based on these steps a bicycle network may have been successfully derived. It is important to realize that local circumstances require creativity to solve methodological and practical problems on the spot.

Figure 63
Missing links in Dar es Salaam according to the "Cycle Through" method.
Figure by I-CE

6.3 Bicycle network integration into overall traffic plans

The bicycle network design, which is produced using the methodologies set out in the previous sections, may serve as an input into developing integrated multi-modal transport planning. The bicycle network is designed independently of information or requirements for other modes.

However, this design should be integrated into the overall development of a transport and/or traffic circulation plan. When plans for different modes are integrated, the overall plan becomes more coherent in terms of its measures for private cars, public transport, pedestrians and cyclists.

This section describes a method for integrating bicycle network design into an integrated traffic and transport plan. This produces a more coherent, balanced and integrated plan for all transport modes. In practice, integrated transport planning, which has been the approach in the Netherlands for the past 20 years, leads to broader support from all stakeholders, thanks to coherent planning and the early involvement of all those concerned.

Positive effects from good and well integrated transport plans often include increasing bicycle use, more prudent car use, safer conditions for children to travel to school, and more pleasant, safer shopping areas and public spaces for pedestrians. Moreover, traffic accident rates tend to decline. An integrated transport plan can also improve the attractiveness of public transport, thereby allowing it to compete more effectively against the car.

An integrated approach brings several disciplines together. The layout of a city centre is predominantly a case of urban planning and development, while accessibility to the city centre is often considered a matter of traffic engineering. An integrated approach stimulates collective decision-making by these different disciplines. In the Netherlands this approach was most successful where there was good teamwork among different disciplines and stakeholders, including local government, residents and pressure groups (see Box 11 in Chapter 4). Moderated workshop sessions, which guided and facilitated cooperation, contributed largely to the integration. The next section describes a method to achieve an integrated approach.

6.4 Building cycling into a coherent traffic and transport plan

Achieving coherence among the different transport modes is a condition for a successful bicycle policy. Practice in the Netherlands has shown that a well designed structure of main arterials reduces unnecessary car traffic and increases road safety for all.

In a coherently structured transport system, people who live only a short distance from their destination, such as a shopping or city centre, will be less inclined to use their car. By making direct, safe routes for cyclists and pedestrians, public transport and deliveries to businesses, these transport modes become much more attractive.

People who live only a few kilometres away from stores, industrial estates, office areas, parks, train/bus stations, schools, libraries, and other city attractions become more inclined to use bicycles. An indirect positive result of planning this way is that it leaves more room for people who are highly dependent on cars (particularly those whose mobility needs are more complex) to park nearer to their destinations.

The following procedure helps to integrate the bicycle network into the overall traffic and transport plan, based on methods similar to those discussed before.

6.4.1 Phase 1: Inventory of the present traffic and transport structure

An inventory of the present traffic and transport situation provides a good starting point. The existing or planned traffic and transport-network structure is described and mapped for pedestrians, cyclists, public transport and car users.

All kinds of other existing information, such as traffic counts, traffic plans for motorized traffic and data concerning public transport are also useful at this stage. Complementary information on bottlenecks that affect accessibility and road safety is also collected.

The available data, along with an inventory of stakeholders' problems and desires (residents, shopkeepers, companies, and others) provides the basis for a discussion of stakeholders' expectations and desires for future traffic and transport conditions. Most effective is to involve stakeholders from the start, by inviting them to meetings and asking for their views on the current situation. These discussions lead naturally to questions about their ideas on solving the problems and how to turn their wishes into reality.

In most cases, we recommend that process leaders not start by discussing possible measures or solutions. It is best to begin with an inventory of problems and wishes of the residents, shopkeepers or companies, as it is most effective to involve them in the process right from the beginning. After this inventory, process leaders should actively seek people's ideas and opinions about suggested solutions. Planning, preparing and facilitating such meeting(s) is important. If performed succesfully, this approach builds support for new policies and measures. And when the measures or actions have been implemented, people understand them better, identify more with measures, and opposition becomes less likely and less strong.

At the end of this phase, the planning team can set objectives in terms of accessibility, mobility and road safety based on their own viewpoints and those of other stakeholders.

6.4.2 Phase 2: Establishing "ideals" or shared visions

In this phase, group sessions define more specific "ideals" or "images" for different aspects of the traffic and transport plans, for example with regard to specific locations and different modes, such as cycling, public transport and cars. The best approach is to identify the most desirable situation from the point of view of each transport mode, or perspective, such as for residential or recreational areas.

These images can then be compared (by overlaying transparencies or using participatory GIS), to analyse potential conflicts, in the spatial and/or transport system: Is there potential for conflict, such as a school route crossing a road with through-going traffic? Confronting ideals makes it easier for all parties involved, including residents, to follow the process, to make better choices.

6.4.3 Phase 3: Confronting images

In the Netherlands' case, confronting the ideals or images developed with stakeholders stimulate good discussions. When measures have been discussed for one transport mode, the consequences for other transport modes then became clear. Integrated design clearly indicated the system's possibilities and impossibilities, strengths and weaknesses. The consequences of each decision, for example at intersections, from each perspective become much more clear.

This kind of experience revealed that the best way to solve current and future transport problems is to apply the integrated and participatory methods described throughout this chapter. These methods can help to achieve appropriate measures for the bicycle and public transport, and to encourage more sensible use of the car, which is clearly the result of a structured and integrated way of thinking. Cars continue to enjoy accessibility and at the same time cities invest in measures for pedestrians, cyclists and public transport users, which promote the use of these modes.

This phase produces an outline for the traffic and transport 'system' as a whole, building lasting, perhaps even binding, agreements among the involved parties, illustrated in Figure 64.

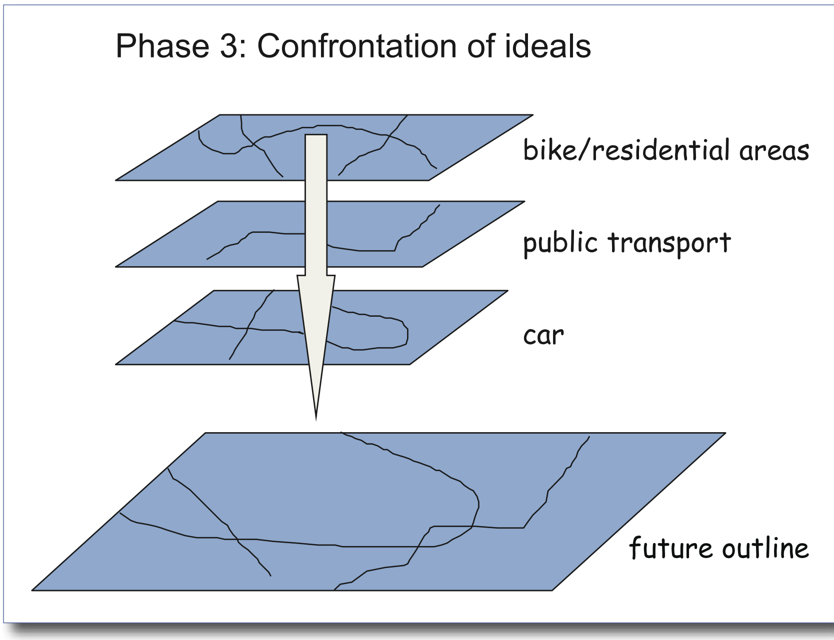


Figure 64
A solid base for the future traffic system: confrontation — or even better integration — of the most desirable measures for pedestrians/residential areas, cyclists, public transport and car traffic, helps you to develop the future outline of the main infrastructure for all road users.
Figure by Hans de Jong

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7. Design: making choices that fit local conditions

Steven Schepel, Tom Godefrooij, and Bas Braakman

For related subjects

For definitions of the Key Terms used in this chapter, see box in Chapter 5.

See ***Chapter 3*** for ideas on urban form and how they shape activities.

See ***Chapter 5,*** Box 5: Problems and Solutions.

See ***Chapter 7***, on Designing residential streets, particularly the box on traffic calming.

See ***Chapter 8***, on Designing main roads and highways.

See ***Glossary*** on habitat areas, traffic calming, cycle routes, cycle paths, and lanes, etc.

7.1 Road types and how they fit into urban systems

Defining general road categories is a difficult task, given that this is heavily dependent on local history and current traffic, city and other planning concepts. For practical use in the context of this Handbook, we have decided to use the following definitions. We recognize that these may vary, but hope that these basic definitions will allow professionals from different disciplines and cultures to communicate across these differences.

Figure 65

Finding a balance: The space available within a wide road through a residential area near Santiago's city centre was redistributed to provide ample room for pedestrians, attractive trees and other landscaping, which also enhanced users' comfort, offering a cycle lane, a cycle rack and room for vehicles to travel at speeds compatible with local activities. This infrastructure also communicates that cycle ways are good for neighbourhoods and vice versa.

Santiago, Chile, Tom Godefrooij, November 2007

7.1.1 *Residential and downtown, city centre or central business district streets: public space and local access*

These are typically one- to three-lane roads, often with parking allowed (sometimes on both sides of the road), providing access to primarily residential areas and/or primarily pedestrian commercial zones in central business districts. These streets connect and serve residential (habitat) areas. Here, walking, cycling and social activities should get priority, with special attention to the most vulnerable road-users. A street that is suitable and safe for children and the elderly, is suitable and safe for all.

Some areas are purely residential, particularly in suburban developments, but in many cities these areas combine a wide range of functions that create thriving, attractive centres, containing shops and markets, small offices, workshops, public buildings, schools, daycare centres, sports fields and other recreational facilities.

Most trips, including those in cars, start and end on residential streets (*e.g.* trips from home to the city centre or to recreational facilities). The preferred set of conditions typically allows some motorized traffic, usually for local access, but only so far as it is compatible with other envisaged activities.

Many cities have attempted to improve "flows" through congested city centres or Central Business Districts (CBDs) as they are sometimes known, by making most streets one way, thereby inhibiting

Figure 66

In many residential areas, local roads play a key role as public space, offering the services of local farmers' markets several days a week, as well as other non-transport uses.

Street fair in Sao Paulo, Lake Sagaris, March 2008

Figure 67

An example of a mixed, residential and shopping street in a Dutch town: social life enjoys top priority, but car traffic is possible. Short-term parking for cars is available and the street forms part of a major bicycle route, which connects the residential areas with the shopping street and other employment areas.

Photo by Hans de Jong

cyclists' circulation or forcing them to travel on sidewalks or against traffic. Among the best solutions to this dilemma is:

(a) to provide clear, attractive street signs and allow cyclists to circulate in both directions along all roads, including those that are one-way for cars;

(b) to replace parking lanes with cycle lanes to ensure cyclists can circulate freely without bothering pedestrians. See Chapter 7 and the CROW design manual, for a detailed discussion of designing for this type of function.

7.1.2 District main roads

These roads tend to have two or three lanes in each direction, or consist of one-way roads, three to four lanes wide. Often, there is a contradiction between their design, which invites speeds well above normal maximums, and the kinds of activities along them, as they run through residential, small- and medium-scale commercial areas. Integrating human-powered transport and particularly cycle use into these kinds of roads is a challenge, but can be very rewarding. Better conditions for pedestrians and cyclists typically improve safety and comfort for all, including motorizts.

This category includes the roads meant to collect and distribute motorized traffic coming from and going to habitat areas or other destinations. Such roads sometimes take the form of a circular road around a habitat area, consisting of several segments, each with its own entry road.

The number of main roads and highways should be kept to the minimum necessary to shield habitat areas from motorized traffic flows that don't meet the set of conditions established for residential streets.

Intersections along these roads should be designed to accommodate both motorized and human-powered traffic (HPT) coming from or

Figure 68

Puerto Madero in Buenos Aires (Argentina) is a good example of a high-quality pedestrian space.

Photo by Carlosfelipe Pardo

Figure 69

An example of a district main road with a maximum speed of 50 km/h. The raised intersection for pedestrians and cyclists to cross tells drivers to slow down.

Photo by Hans de Jong

going to residential streets. Between intersections, motorized traffic should flow relatively freely, so that total travel time along the route in question does not exceed travel time on alternative routes inside habitat area. Otherwise, these roads will fail to perform their function and residential streets are forced to accommodate an overload of motorized traffic. This causes serious problems, as residential streets are not (or should not be) designed and suitable for accommodating higher volumes of motorized traffic.

In larger metropolitan areas, some roads are specifically to ensure the smooth and rapid flow of motorized traffic, particularly over longer distances. Their purpose is to shield other roads from flows that won't meet the criteria set for them. See Chapter 8 for a detailed discussion of designing for both district main roads and highways.

Note that urban roads often switch category as they cross town. Priorities may change on the way to the city centre or when passing a business district or industrial area. Often, a highway turns into a district main road, which eventually becomes a residential street, or vice versa.

Figure 70

For pedestrians, crossing 9 de Julio, Buenos Aires' "signature" main road, can seem like an endless journey, but cross it they must, since the city's essential services and major monuments are distributed along it. Speeds, congestion, multiple users with seemingly conflicting needs, and elements central to cities' complex and sometimes contradictory identities all come into play when users, civil society groups or planners propose changes on roads such as these. (9 de Julio, Buenos Aires, July 2004).

Photo by Lake Sagaris

Figure 71
A metropolitan highway in Bogotá has been designed to ensure a smooth flow of motorized traffic. Alongside, a two-way cycle lane serves cyclists and a bridge separates slower traffic, all typical features of this type of road design.
Photo by Hans de Jong

7.1.3 Intermediate roads, boulevards and others requiring special treatment

This is the category that varies the most among different cities and across countries. Most Latin American cities have major roads through their downtown areas: 9 de Julio in Buenos Aires (Argentina) or the Alameda, in Santiago (Chile), for example. Often they involve five lanes or more running in each direction. Because these roads are transport hubs serving a wide range of needs, running through commercial and sometimes densely residential neighbourhoods as well, despite their size it would be inappropriate to treat them as highways, which is the category that their magnitude often suggests. Indeed, pedestrian, bike, delivery and other mixed traffic is one of their main characteristics, often combined with bus lanes (segregated or otherwise), metro service underground, and heavy car use.

Figure 72
Avenida 9 de Julio in Buenos Aires.
Photo by Carlosfelipe Pardo

Because of these multiple demands, it is particularly important to consider all transport modes in an integrated fashion when designing or updating design to improve the utility and safety of these kinds of roads. At the same time, attractiveness may be especially important, since these are often "signature" roads that to some degree define the city to its inhabitants, users and visitors.

It is beyond the scope of this handbook to provide detailed information on designing for the wide range of functions and requirements that this type of road facility may involve. Many of the guidelines in the next two chapters may be adapted and used in these cases, however. For more information on this kind of facility, which has become increasingly popular in recent years, see also: Alan Jacobs' book "Great Streets".

7.1.4 Highways: keeping motorized traffic flows where they belong

Highways consist of major road infrastructure that gives priority to cars. They usually also serve light, medium- and heavy-duty trucks and other forms of transport, and they may also incorporate special lanes for buses. They seek to minimize delays and therefore typically rely on underpasses and overpasses, rather than the traditional intersection, and design speeds are usually well above local or main road speeds, tending more to the 80–100 km/h range.

Highways, however, remain an essential component to be considered in any integrated or cycling-inclusive transport plan. This is partly, because in many places they constitute major barriers to human-powered transport modes, and particularly bicycles. Note, however, that they can also offer significant opportunities to improve bicycle conditions. New highways, for example, that include segregated lanes for cyclists within the new infrastructure (bridges, accesses, intersections and so on) or add or improve existing cycleways as part of mitigating measures can bring the same long-distance higher speed perspective to cycling as they bring to driving, offering quick, clear routes to people travelling relatively long distances by bicycle every day.

See Chapter 8 for a detailed discussion of designing for both district main roads, trunk roads and highways.

7.2 Determining the right road section for each set of conditions

Before contemplating the design of any specific road section, planners should determine the current and/or sought after mix of activities. What groups (in terms of age, experience, vehicle and direction) will use the road and for what purposes (such as traffic, transport, trade, social life or parking)? What limits are necessary to ensure enough space for each of the envisaged activities?

On a metropolitan highway, priority goes to the smooth flow of motorized traffic. This means not only limitations in terms of requirements of drivers and vehicles, but also homogenizing the flow of motor vehicles in direction and speed. On residential streets, however, priority must go to social life. Motorized traffic can be allowed, as long as it plays a subordinate role. For intermediate roads, we often need to mix different uses and purposes. Relatively fast-flowing traffic may occupy two or three lanes in each direction, with a segregated bus lane next to especially wide sidewalks, and a wide, treed median with or without an "express" cycle lane may provide additional room for cyclists, pedestrians, civic and social life. Each purpose requires quite a different set of conditions. Different instruments may be used to change conditions.

The first involves information (such as, 'drive with care and courtesy'). When used on its own, this instrument is relatively cheap and doesn't require a lot of preparation, but its impact may be limited. Moreover, to remain effective it often requires considerable repetition.

The second instrument is regulation in the form of general traffic rules (nationally) and/or specific traffic signs (locally). The effectiveness of this tool should be estimated realistically. Old habits are hard to change, making it necessary to accompany any new regulation with information, education and enforcement.

Often, however, changing road design is (also) necessary.

The essence of road design is bringing the use (that is, the actual behaviour of different groups of road users) into line with the function (that is, the mix of activities, within the envisaged set of conditions) by way of the shape (that is, the design of the road and its environment), in combination with other instruments.

7.3 Uniformity versus variety

Uniformity in road design and traffic signs offers the advantage of making these readily recognized and understood. Users require less time to respond to changes in conditions. This

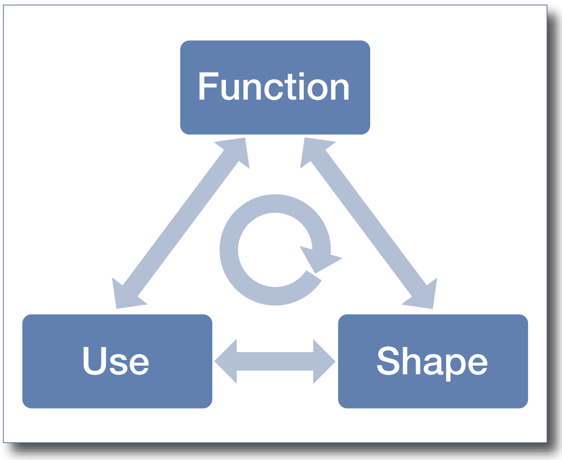


Figure 73
Function, shape (form) and use.
Source: Draft Provisions for Cycling National Manual for Urban Areas, 1st edition

is especially important in situations where there is little time to react, because of high traffic volumes, but also when a collision may have a relatively severe impact, because of large differences in speed, direction, mass, and vulnerability, making it especially important to protect different kinds of vehicles and road users.

A varied streetscape attracts attention, by reinforcing the sense that something may pop up anytime, anywhere. Moreover, it offers extra possibilities to adapt public space to local needs and create an attractive environment. This is especially important in residential areas, where social life, walking and cycling should take priority.

Altogether, these considerations make uniformity desirable on metropolitan highways, while residential streets are better designed as a series of individual 'rooms', each with its own character, avoiding the design elements typically used on main roads. In residential areas, uniformity is a problem: it encourages drivers to pay less attention and speed up, under the impression that they know what to expect.

7.4 Integration or segregation

One major decision involves the question of how integrated or segregated the different modes — human-powered or motorized – should be: to what extent will specific space on the road and at intersections be assigned to each group or will they be sharing lanes and mingling at crossroads?

In many situations, the speeds and volumes of motorized traffic are incompatible with walking and cycling. This incompatibility increases the risks to cyclists and pedestrians, since safety correlates directly with the number of encounters and the complexity of traffic conditions. Large numbers of fast-moving cars also affect the quality of the ride for cyclists or walking conditions for pedestrians. Freedom of movement (to make the manoeuvres you want to make) declines. Busy traffic requires constant alertness. Usually, cycling on roads with heavy traffic is not very attractive either.

Even in other circumstances cyclists may feel very uncomfortable. Parking manoeuvres create (fear of) problems. In narrow streets, cyclists may feel they are being used as living speed reducers, or they may find themselves driven into a corner by a car when it is overtaking.

Two approaches are typically used to overcome this incompatibility: integration or segregation. Each has its advantages and disadvantages.

7.5 Segregation: different road profiles

Segregation deals with the problem of major differences in volumes and speeds by giving each incompatible mode its own space. On road sections, this may be a good solution, but it may require redistributing space among the different kinds of road users. Segregated facilities usually require more space than integrated facilities.

Advantages are that road sections with segregated facilities protect cyclists better, drivers' overtaking manoeuvres are easier, and cyclists are less affected by congestion. Moreover, cycling becomes more comfortable as the need for alertness is decreased. These advantages may be lost, however, if good, cycling-friendly solutions cannot be included in intersections. Most cycle trips are short. Detours can therefore make cycling unattractive. This makes it very important to offer cyclists safe crossings at most side streets.

Methods for segregating at intersections include an overpass/underpass (spatial segregation) or traffic lights (time segregation). A roundabout offers a solution without complete segregation. The best, most cycling-friendly option depends on the local circumstances.

Segregation's disadvantages include some loss of freedom to cyclists, while drivers may speed more and be less aware of cyclists. As there is

Figure 74

Cycling on heavy used roads is not attractive, Santiago, Chile.

Photo by Bas Braakman

▲ Figure 75

Cycling on heavily used roads is not attractive, despite the apparent "safety in numbers" for cyclists (Pune).

Photo by I-CE, Tom Godefrooij

often no (real) segregation of crossing flows at intersections, building segregated bike ways may reduce accidents on road sections, but increase accidents at intersections.

The degree of segregation ranges from very little to a lot, depending on road conditions, particularly volumes of motorized and HPT, speeds, and the direction of flows.

Methods for physical segregation typically include: making or using a strip of grass, pavement, or gravel between the car lane and the cycle track; setting car and bike lanes at different levels; putting a line of trees, posts or other elements[49]. For design details, please consult the CROW design manual. In this chapter, we are focusing mainly on the criteria for choosing between integration, visual segregation and physical segregation.

49 A fence may be used in an attempt to prevent pedestrians and cyclists from crossing the road. But this is usually unsatisfactory, a resource that basically says their needs are low priority.

▼ Figure 77

A stand alone bicycle track in Bolzano, Italy following its own route. These solutions are particularly popular for recreational trails but they may require unappealing detours when it comes to commuter cycling. Moreover, without proper lighting and natural supervision by people visiting local shops or in the area, after dark these routes can be unattractive to those most vulnerable, particularly women and children.

Photo by Hans de Jong

Figure 76

One-way street allowing contra-flow cycling.

Photo by I-CE, Tom Godefrooij

Overview of cycling infrastructure by degree of segregation

No segregation

Different modes are seamlessly integrated, and there may be restrictions on speeds and/or volumes of motorized traffic.

Streets, or parallel roads:

- with two-way traffic;
- with one-way traffic for all;
- with one-way car traffic, and two-way cycle traffic.

Visual segregation

Different modes visually separated by road paint, logos and possibly signage

Cycle lanes for one-way cycling, on both sides of the road

Note: Some countries differentiate between legally recognized cycle lanes, marked by lines and a bicycle logo on the pavement, and generic space available to cyclists.

Figure 78

An example of a bicycle lane in the Netherlands.

Photo by I-CE, Tom Godefrooij

Physical segregation

Different modes are physically separated by a difference in level, and/or a strip of grass, pavement, curb, gravel, tree line, or other physical barrier.

Cycle paths alongside roads for motorized traffic:

1. two-way, allowing cycling in two directions:
   - on both sides of the road,
   - on one side of the road;
2. one-way, allowing cycling in one direction
   - on both sides of the road,
   - on one side of the road;

Figure 79

One way cycle tracks at each side of the road in Eindhoven, the Netherlands.

Photo by Bas Braakman

Note: When using a one-way cycle lane, it is best to combine it with a similar lane on the other side of the road, to prevent misunderstanding among cyclists. Experiences where single cycle lanes go in one direction on one road, and the opposite direction on another parallel road, have found that cyclists simply get confused and tend to end up using one-way lanes to travel in either direction, seriously reducing their usefulness and creating hazards.

Complete segregation

Cyclists have their own independently traced route with no parallel lanes for motorized traffic

Stand-alone cycle paths following their own route

Figure 80

Stand alone cycle track through residential area in Quito, Ecuador.

Photo by Bas Braakman

Note: These are normally for human-powered traffic only and cover often long distances or link into routes that include streets with mixed traffic.

7.6 Integration

Integration seeks to resolve incompatibility by adapting drivers' behaviour to the circumstances. It underlines the equality of all road users. All groups have the same freedom of movement. Moreover, no extra space is needed for traffic purposes.

The main source of risk arises from the number of motor vehicles and their speed. A solution can therefore involve reducing the number of cars on the road and/or their speed. Integration requires a higher level of attentiveness as traffic volumes and speeds increase, making it hard to apply effectively on road sections or in areas where the number of motor vehicles cannot be limited or speeds cannot be reduced.

This is also related to expected conditions. Some through roads are meant for large volumes of traffic or heavy vehicles (buses and/or trucks). Physical speed reducers designed for heavy vehicles are less effective when applied to ordinary cars and they are uncomfortable on routes with frequent bus transport.

Figure 81

Two way cycle track, one way car traffic, Eindhoven, The Netherlands.

Photo by Bas Braakman

7.7 Balancing a range of interests and needs

When a segregation-based approach is used, there is no equality of modes. So a balance of interests must be achieved. Often, planners must distribute the limited space available among different road user groups. Clearly, any group considered less important ends up at a disadvantage, especially when the available space is not enough to meet all demands. When ample space is available, segregation may lead to large-scale solutions that increase the barrier effect of roads.

Integration and segregation, however, complement each other:

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

Reaching agreement on these complementary approaches may be easy in principle. But in practice, segregation may excessively restrict the free movement of cyclists. All too often segregation seems to aim at guaranteeing the free flow of motorized traffic, rather than achieving a safe, fair balance between modes. Cyclists are relegated to the road side or, in many countries, even the sidewalk, generating conflicts with pedestrians. Intersections may be even worse, offering poor or non-existent solutions that confuse all users, creating unnecessary hazards for all, particularly those most vulnerable (pedestrians, differently abled individuals,

Figure 82

An example of a recognizable bicycle route network in Florianopolis The bicycle route is combined with pedestrian facilities. Because it is a facility in the median of the road special attention has to be paid to reach this facility in a safe way.

Photo by I-CE, Jeroen Buis

cyclists. For this reason, in many countries cyclists' organisations oppose the obligatory use of segregated cycle facilities.

Generally speaking, experienced cyclists often prefer an integrated approach, particularly where a cycling-friendly balance has not been achieved. Less self-confident cyclists, however, tend to prefer segregated facilities. A well-designed cycle path offers them safer and more comfortable cycling. Cycle paths can contribute to a coherent and recognizable network of cycle routes, offering design continuity throughout. If segregated facilities are designed well enough, many objections to segregation will disappear. Alignment and width of segregated facilities at road sections and intersections are crucial in this respect.

7.7.1 Cycling in car free zones

The question of cycling in pedestrianised streets, squares and malls requires special attention to local conditions. Once the decision is made to designate pedestrian areas, the question of whether or not to allow cycling can lead to heated debate. Some people expect cyclists to disrupt the planned situation in which pedestrians have total freedom of movement. Experience, however, shows that in many places pedestrians and cyclists mix well. Only when pedestrianised (or rather 'car free') streets are very crowded (narrow shopping streets at peak shopping hours and entrances to central train stations at peak commuting hours) problems may become inevitable. At that point, pedestrians' freedom of movement will be limited by congestion anyhow, as will cyclists', who may find it necessary to dismount and walk.

Depending on local conditions, then, one of two measures can therefore be useful, to facilitate cycling in pedestrian (or rather 'car free') areas without creating undesirable conflicts or hazards:

- Give pedestrians and cyclists more room by making a large car free area where cycling is allowed (Figure 82);
- Create separate cycle tracks (Figure 83).

When intervening or creating medians or parks that integrate cycle facilities into general landscaping, pedestrians must have their own space. Otherwise, planners will create bitter and endless conflicts, as cyclists attempt to move at their normal cruising speeds, while pedestrians, often family with children out for a breath of fresh air, block path ways, creating serious hazards.

Whatever measure you ultimately use, avoid creating lengthy detours for cyclists. These can be very annoying. Some cyclists will simply ignore the rules. Others will refuse to cycle.

Remember that even in pedestrian areas, some motor vehicles (deliveries, public services, emergency services, movers, doctors, construction/repair people, etc.) must be allowed. Their number has to be restricted, leading to access controls at entrances and/or throughout the whole area. Street layout must nonetheless allow fairly large vehicles to manoeuvre, creating space that can often be used by both cyclists and the occasional motorized vehicle.

Box 16: Road safety audits

A Road Safety Audit (RSA) is a handy tool to use at different points in a project, from planning through preliminary engineering, design and construction. It can also shed light on impacts, real, potential or necessary, for any sized project, from minor intersection and roadway retrofits to mega-projects.

Five benefits

RSAs:

1. Help produce designs that reduce the number and severity of crashes;
2. May reduce costs by identifying safety issues and correcting them before projects are built;
3. Promote awareness of safe design practices;
4. Integrate multi-modal safety concerns;
5. Consider human factors in all facets of design.

Normally, they are carried out at four different stages of a project:

Stage I	Feasibility and preliminary design, *i.e.* conceptual;
Stage II	Detailed design;
Stage III	Upon completion (and preferably before being opened to traffic);
Stage IV	After the project has been in operation for a period of time.

Sources: http://www.roadwaysafetyaudits.org, http://www.cambridgeshire.gov.uk/transport/safety/methodologies/safety_audit.htm. See Chapter 7 for more information on audits and checklists.

Figure 83

An entrance to the pedestrian heart of the city centre of Delft (The Netherlands). The sign specifies 'Cycling allowed'. A removable bollard (about 1 metre high) restricts entry by motor vehicles.

Photo by Steven Schepel

Figure 84

A street in Amsterdam's city centre, reserved for people on foot and on their bicycles. The chosen layout involves a gentle compromise consisting of a rather narrow, but clearly marked cycle lane and two rather narrow sidewalks. Note: The sidewalk continues across the intersection: according to traffic rules in the Netherlands, this means that anyone coming from the side street has to give way to all road users.

Photo by Steven Schepe

8. Designing for cycling makes residential and central business district streets better — for all

Steven Schepel

For related subjects

For Key Terms used in this chapter, see Box Chapter 5.

See ***Chapter 3*** for ideas on urban form and how they shape activities.

See ***Chapters 5 and 6***, for more information on specific road types leading into or connecting these areas.

See ***Chapter 10***, on ***cycle parking***.

See ***Glossary***, especially the section on ***traffic calming***.

Trips for cars, bicycles and pedestrians start and end on residential streets. Furthermore, residential streets also form part of public spaces where people meet, children play, hawkers sell their goods and residents and visitors park vehicles: in short, they are the site of a large number of different and sometimes conflicting uses. The design process for residential streets and areas should take every type of road use and motive into account.

The goal of this chapter is to make the reader aware of the importance of good residential street design: the environment directly surrounding their homes is essential to people's wellbeing. The first section introduces the subject. The next deals with target groups and types of road use, identifying some of the conflicts that can arise when designing this kind of street. The third and last section discusses design aspects.

8.1 Residential streets as public space

In urban areas, residential streets not only serve short trips. They also serve as public space. Residential streets may be located in city centres, residential areas and around schools: the "habitat" areas referred to elsewhere in this Handbook, where road use in bicycles or walking receives priority. All these 'local' streets are called residential streets in this chapter.

The vast majority of trips begins and ends on residential streets. People will base their decision about whether to walk, cycle, take a bus or drive largely on the conditions they face as they walk out the door of their home or office. Residential streets therefore require careful design. All trips start on foot or on a bicycle, and then continue by the same mode, or switch to public transport or cars.

8.2 Types of road use versus target groups

Table 6 compares types of road use with target groups. It shows that residential streets not only deal with traffic, but also with 'stationary' road use, in the form of social and commercial activities: for example playing, meeting and exchanging goods. In some cities from developing countries, there is also a significant amount

Figure 85
A square in Bogotá, where children can play. Giving priority to access by pedestrians and cyclists is often the key to improving both quality of life and the local economy.
Photo by I-CE, Andrew Wheeldon

Table 6: Road uses and target groups

Target group \ Road use	Pedestrian	Bicycle	Moped	Car	Public Transport	Social Activities
Children	X	X				X
Parents	X	X	X	X	X	X
Adults	X	X	X	X	X	X
Elderly people	X	X	X	X	X	X
Disabled people	X	X	X	X	X	X
Residents	X	X	X	X	X	X
Shopkeepers	X	X	X	X	X	X

of paratransit (depending on the place, both motorized and human-powered, as occurs with rickshaws and other similar vehicles used in much of Asia and Latin America).

Almost all thinkable types of road-use and target groups can be found on residential streets and thus need to be considered within the planning and designing process. The matrix illustrates this clearly, with the 'x' marking a 'relevant' combination of type of road use and target group.

Although it might look like a simple task to some planners and designers, residential street or area design is the most challenging, because of the large number of relevant 'road use — target group' combinations. Within the design process, it is important to search for the right location for traffic calming measures. Most obvious is re-arrangement of a street with shops, or a school environment, and marking spots where pedestrians and/or cyclists cross the road. Thus, drivers better understand the reasons for speed reduction measures and are more wiling to adapt to local circumstances.

Adding to design complexity is the fact that residential streets should be designed not only to accommodate different types of traffic and target groups, but also to function as attractive, safe public spaces for playing, relaxing and socializing. The poorer the population served, the more important the design of residential streets becomes, in terms of enhancing quality of life.

Users of bicycles and people walking should have priority on residential streets. Motorized traffic should be treated as less important, although cars should still be able to access homes, shops and other origins and destinations. Even in fully pedestrian zones, some vehicles (emergency services, maintenance, garbage collection, deliveries, transport of disabled people, etc.) are inevitable.

8.3 Design aspects

Within the design process, the following aspects should be considered:

1. Protection

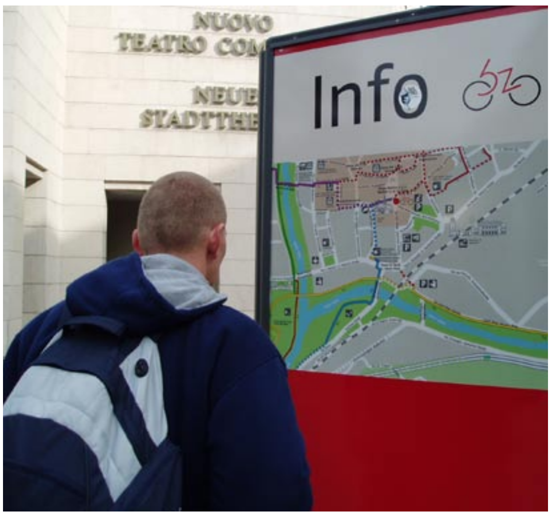
- General safety (preventing assault, robbery, etc. and diminishing fear);
- Traffic safety (preventing traffic accidents, and diminishing fear);
- Traffic calming (keeping traffic volumes low), and
- Limiting speed.

Figure 86

Reducing speed at a raised platform/intersection in Bogotá; for car drivers this design enhances the attention of the side streets. They become more aware that other traffic — such as cyclists and pedestrians — could suddenly appear from a side street. The speed reduction effect enhances road safety.

Photo by I-CE, Andre Pettinga

Figure 87
Sign posts show the cyclists the way in Quito, Ecuador.
Photo by Bas Braakman



Figures 88 and 89
(Houten, The Netherlands) Signposting and information maps (Bolzano, Italy) make inhabitants, including car drivers, more aware of cycling facilities and therefore the opportunities for using a bicycle more frequently. These facilities are also most useful for visitors and tourists.
Photos by Hans de Jong

2. Walkability
- Room for walking;
- Street crossing.

3. Cyclability
- Amenities for cycling;
- Cycle parking;
- Street crossing;
- Signposting.

4. Criss-crossability (possibilities to use the full width of the street for walking, cycling, and social activities)
- Encourages more communication from one side of the street to another, reducing hindrances, usually by (re) arranging car- and bicycle parking;
- Enforcement of parking and other rules.

5. Attractiveness (enjoyability)
- Streetscape (enjoyable design, shade trees and sidewalk gardens, other green space, materials, relationship to buildings, furnishings such as benches, good lighting, etc.);
- Variety;
- Possibilities for private initiatives on public, semi-public and private property.

6. Usability for social activities
- Offers ample opportunities for playing and other social activities;
- Empowers local residents and shopkeepers to make full of use of available space.

Each of these six aspects will be explained and illustrated below. But do not try and concentrate your efforts on one aspect separately, because most measures will influence several aspects at once.

8.3.1 Protection

Protection, in terms of personal security and traffic safety, is the very first precondition to create a thriving public area that attracts road-users of bicycles and walking and invites people to meet each other. If they don't feel reasonably safe (from both aggression and traffic accidents), people, especially women and parents with children, will spend as little time on the street as possible, and go by car whenever they can. Nor will parents let their children play independently on the street and in public areas, partake in social activities, go to school, or visit family and friends on their own.

General safety depends largely on the presence and visibility of human-powered adults, particularly women, 'common' road-users such as pedestrians and cyclists, but also street-vendors, and crafts people. It also helps when houses, stores, restaurants, offices and workshops have windows that open onto the street, creating natural vigilance and allowing parents to supervise their children and keep an eye on what's happening in general. Benches, sidewalk gardens and other street furniture that encourages passers-by, especially the elderly, to relax for a while, also enhance the safety of streets and other related public spaces, as well as making them more welcoming and comfortable.

To foster a continuous stream of 'common' road-users, the street should be part of an uninterrupted network of public space that is attractive to pedestrians and cyclists. Public lighting is essential not only to find the way and avoid obstacles, but also to feel comfortable after dark. One common error is for streetlights to focus only on drivers' needs for seeing on the street and neglect pedestrians and cyclists. Lighting should fit the residential habitat (not too high, at suitable intervals, illuminating sidewalks as well as roads, etc.).

Traffic calming measures can significantly reduce vehicle volumes and speeds. Depending on the country, the most traditional method is known as the "speed bump", "slow bump" or "sleeping policeman". Keep in mind that a rough road surface or a very sudden change in the gradient is rather uncomfortable for cyclists. Design should therefore meet high cycling standards, usually a cross-section in the form of a wave, and should come with good maintenance. Another well-known measure to slow traffic is to place elements on the roadway that force drivers to deviate from a straight line. These kinds of measures can be effective, but also bring a lot of irritation if they are not integrated in an attractive and comprehensive layout that shows why traffic calming is necessary.

Designers should use their designs and, if necessary, signage to highlight places where extra care is needed, especially where pedestrians and cyclists are likely to pop up (not only paths and side roads, but also entrances to buildings and playgrounds). Make sure that drivers and children can see one another quite clearly (no obstacles or parked vehicles blocking the view).

Figure 90
Public lightning of bicycle tracks and footpaths is essential to feel comfortable and safe after dark. Notice that in this situation the sidewalk has been combined with a cycle path. This is an effective way to enhance both cycling and walking, without creating an unnecessary conflict between cyclists and pedestrians.
Photo by I-CE, Daniëlle Wijnen

Well-tested traffic calming concepts (see Box 17 for a more complete list, and the relevant section in the glossary) include:

- 20 mph ("Twenty is Plenty") or 30 km/h zones;
- Woonerf or Home-zones;
- 'Shared Space'.

Box 17: 20 mph ("Twenty is Plenty") or 30 km/h zones

Local authorities in most European countries have introduced these **zones with limited speeds** as a simple method of reducing speeds (traffic calming) and saving lives. Usually the road has a traditional profile, which is not changed. Whether this concept is effective or not depends on drivers' willingness to respect traffic rules (attitudes vary considerably from country to country) and on the streetscape (does the driver really feel the need to slow down?). When introducing 30 km/h zones, authorities should at least be willing to apply an occasional speed bump and clearly identify the boundaries, by putting up a raised sidewalk, for instance, across the street at every entrance/exit to the 30 km/h zone.

Figure 91 ▲

One of two main entrances, highlighted using a raised intersection, to the 30 km/h zone in Bolsward (The Netherlands). Buses and freight vehicles also use them. In 30 km/h zones all traffic, including cyclists, coming from the right enjoy priority. The whole area, including the historical city centre with its shopping streets and 10,000 residents, is a 30 km/h zone. Road safety meets high standards in 30 km/h zones.

Photo by Hans de Jong

▼ **Figure 92**

In this 30 km/h zone, a major feature is how side streets are clearly marked. Cars and other vehicles advance more slowly. This is crucial, since a car's braking distance at a speed of 50 km/h is 25 metres compared to 13.5 metres at 30 km/h. This difference in speed saves lives and reduces injury significantly in the case of an accident.

Photo by Hans de Jong

Box 18: Traffic calming: winning the road back for children, walkers, and cyclists

Traffic Calming A combination of measures (mostly changes to the road environment) aimed at altering driver behaviour, primarily by reducing speeds and improving conditions for pedestrians and cyclists. The objective is to create an environment favourable to the peaceful coexistence of different transport modes, primarily in residential, recreational and commercial areas. Traffic calming is based on the fact that traffic speeds of under 20 mph or 30 km/h substantially reduce fatal or serious accidents and injuries. They may aim to improve public space, social equality, safety or security, social relationships, quality of life. Traffic calming techniques developed worldwide include:

Auto-free Zones: (Italy) Florence and Milan have instituted (following citizen referenda) a permit process that limited all but essential traffic. Traffic volumes were reduced by 50%. Bologna tightened access restriction to streets in the historic central district while improving bus, trolley, and metro services;

Bicycle Boulevards: Barriers are used to restrict or prohibit through motor vehicle traffic, but allow through bicycle traffic. Stop signs are often removed to make this route more attractive to cyclists. A local street parallel to an arterial street is best for this application. Bryant Street is a two mile example in Palo Alto, California; Traffic Diverters: Traffic diverters, curb extensions, cul-de-sacs, and neckdowns are used to discourage cut-through traffic in residential areas.

Central Refuges (medians): Islands situated in the middle of the road to reduce lane widths and provide a refuge for pedestrians and bicyclists crossing major roads;

Channelization Changes: Changing the lane configuration of a street to create more space for bicycle traffic. For example, Seattle, Washington has converted several streets from 4-lanes to 2-lanes with a centre turn lane (some of which have later been changed to planted medians); Slow Streets: Various efforts have been made to slow sections of specific streets. For example, Berkeley, California has used a combination of speed humps, shifting travel lanes, and channelization to achieve a six block long slow street;

Chicanes: Physical obstacles or parking bays, staggered on alternate sides of the highway so that the route for vehicles is tortuous; Traffic Throttles (pinch points): The narrowing of a two-way road over a short distance to a single lane. Sometimes these are used in conjunction with a speed table and coincident with a pedestrian crossing;

Community Street: (Japan, 1980) Similar to Woonerven;

Corner Radii Treatments: Normal curb radii (6– 7.2 m) have been designed to facilitate turning movements by trucks and larger vehicles, allowing faster automobile movements as a side-effect. Reducing the size of the radii (2.0–4.5 m) can significantly slow traffic and increase pedestrian safety; (Source: *Traffic Calming, Auto-Restricted Zones and Other Traffic Management Techniques*, A. Clarke and M. Dornfeld, http://www.ite.org/traffic/documents/tcir0006.htm).

Curb Extensions (sidewalk widening): The sidewalk on one or both sides of the road is extended to reduce the highway to a single lane or minimum width for two-lane traffic. This reduces crossing distances and discourages parking close to intersections and crosswalks;

Curb extensions (which change the end of a two-way street to a one-way street) and neckdowns (provide "pinch points", but allow two-way traffic) are used at entrances to neighbourhoods to discourage/slow motor vehicle traffic from entering. Traffic diverters and cul-de-sacs are placed to prevent through traffic. Traffic diverters may be diagonal (allowing only a single 90 degree turn from all approaches) or truncated (allows a right turn movement around one end of the diverter);

Entry Treatments Across Intersections/Continuous Sidewalks: Surface alterations at side road intersections, generally using brickwork or other textured surface materials. The level of the road may be raised to the level of the sidewalk;

Environmental Road Closures: Road closures, generally in residential streets, designed to remove through traffic or prevent undesirable turns; No entry: with "cycle slip": Access to a road is barred in one direction by a No-entry sign. The rest of the road remains two-way, and bicyclists and pedestrians can pass the No-entry sign;

Mini-Roundabouts (traffic circles): Small roundabouts situated at an intersection. Some have raised centres, others are just painted circles on the road;

Pedestrianization: (Europe, 1960s) Short stretches of streets (90–300 m) reserved for the exclusive use of pedestrians, usually located in central city/shopping areas (*i.e.* the Ithaca Commons);

Raised Intersections: The highway is raised at an intersection, usually by brickwork or a plateau with a ramp on each approach. The platform is at curb level and may well have distinctive surfacing;
Road Humps and Speed Tables: Raising the surface of the road over a short distance, generally to the height of the adjacent curb. Humps can be round or flat-topped. The latter being known as speed tables, which can extend over many feet;
Road-Pia: (Japan, 1984) Area-wide traffic calming resulted in reduced vehicular traffic volumes/ increased bicycle and pedestrian traffic, reduction in accidents and average vehicle speeds;
Rumble Strips: Lines of cobbles or other raised surfacing designed to warn drivers of excessive speed or of the proximity of a hazard area where lower speeds are desirable; Transverse Bands: Painted lines oriented as transverse bands across the highway at decreasing intervals. They are intended to give drivers the impression they are travelling with increasing speed, so they will react and slow down;
Signing Techniques: Informational signs, such as "residential street", "local access only", "no through traffic" are in common use. Stop signs placed frequently throughout a residential area can significantly slow traffic. The City of Saint Paul, Minnesota employs a "basket weave" pattern whereby stop signs are placed in such a way that the only unimpeded path is quite circuitous;
Textured Surface: The use of non-asphalt surface, such as brickwork, paving or cobbles to reinforce the concept of a traffic restricted area; Shared Surfaces: The traditional distinction between sidewalk and pavement is removed, leaving pedestrians, bicyclists and motor vehicles to share a common space;
Tortuous Roads: Roads that are designed to meander, occasionally quite sharply, reducing the view of any stretch of "open road" and thereby encouraging lower vehicle speeds;
Traffic Cells: (Sweden, 1969) City of Gothenburg divided itself into five cells. Auto traffic was prevented from crossing the boundaries between cells except at specific ring-roads. Transit, bicycles, and pedestrians were allowed to cross. Parking was reduced and public information efforts increased;
Transit Street and Pedestrian Zones: Motor vehicle traffic is limited to commercial deliveries while transit "circulators" act as "horizontal elevators". This concept has worked well in Madison, Wisconsin and Denver, Colorado (note: bicycles are prohibited in the Denver example);
Verkehrsberuhigung: (Germany, 1980s) Similar to Woonerven. Traffic speeds controlled at 18 miles per hour (30 km/h); Safe Routes to School: (Denmark, 1980s) City of Odense has a ten-year program to implement "slow speed areas" of 13–30 mph (20–25 km/h), along with various other calming techniques, in areas close to schools or on popular school routes;
Woonerven: (The Netherlands, 1970's) Woonerf literally means "living yard". No segregation between motorized and human-powered traffic (*i.e.* no sidewalks), but pedestrians have priority. Playing is also permitted. Drivers may not drive faster than a walking pace. Parking allowed only at specified locations, which is screened by plantings and often alternates from side to side creating a nonlinear travel line. Informational signs tell drivers they are entering a Woonerf.
With thanks to http://www.co.tompkins.ny.us/planning/vct/tool/trafficcalmingtechniques.html for many of the definitions in this list. We recommend this useful toolbox for anyone interested in more information on this and other related subjects.

Figure 93
Intersection where a separate bicycle track crosses the 30 km/h street with mixed traffic. The road surface of this raised intersection is marked by using a different pavement.Intersection of a 30 km/h street with mixed traffic and a separate bicycle track.
Photo by Hans de Jong

Box 19: Woonerf (Home-Zone)

In the early 1970s, Dutch planners became increasingly sensitive to the idea that the street was too important to be left to motorized traffic and parked cars. They introduced the *Woonerf* concept in Delft, defining it as "a street for children, where car-traffic is allowed, but only at limited speed." In the UK, this concept is called a "Home-zone".

These concepts require a completely different arrangement of the streetscape. No continuous curb separates the street into a roadway and sidewalks, to show that the whole width of the street is primarily meant for walking, cycling and playing. Cars cannot drive in a straight line, because the space for vehicular traffic is shifted and limited by trees, lampposts and all kinds of street furniture. Parking is only allowed in specially designated places. The speed limit is "walking pace" (for horses) or maximum 15 km/h.

Figure 94

In a home zone, everyone shares the available space, including both traffic and children playing.

Photo by Hans de Jong

Shared Space

Recent work, inspired by Hans Monderman and others in the Netherlands and Denmark, has gone a step further than traditional traffic calming measures. According to Monderman, motorists will make eye contact with other road users and slow down when the streetscape tells you that this is a special place not primarily meant for the flow of motorized traffic and when the layout does not clearly demarcate pedestrian and roadway facilities through painted lines, signage, curbs or traffic lights. For roads with traffic volumes under 5,000 vehicles per day, Monderman recommends removing traffic lights and all street markings that differentiate pedestrian and cycle space from motor vehicle space. This approach assumes that there is no problem with parking (or commercial activities) occupying every empty spot. Parking regulations must be effectively enforced whenever necessary.

Figure 95

Shared space in the city centre of Eindhoven, The Netherlands.

Photo by Bas Braakman

8.3.2 Walkability

Sometimes designers argue that in some neighbourhoods, most people do not need sidewalks (or rather, segregated areas for pedestrians) as long as traffic speeds remain very slow or volumes are minimal. But even in such conditions a completely car-free strip may be wanted for some groups, for instance (elderly) people who are less mobile or parents with toddlers venturing out into the world for the first time. And in developing countries, ensuring sidewalks can substantially improve walking and therefore freedom of movement for the vast majority of people. Where pedestrians' needs aren't properly taken care of, quality cycle lanes may be invaded by walkers, creating enormous friction between the two groups.

In most circumstances, therefore, a well-paved and properly maintained sidewalk is necessary. At the very least, it should be wide enough (excluding obstacles such as parked vehicles, lamp posts, trees, etc.) for people with a wheelchair, stroller, walker or carrying cart.

Note that bicycles can also block the sidewalk. Make enough room to park bicycles by providing for sturdy stands that are suited to attaching locks at waist height (see Chapter 9, on cycle parking).

Amenities to make crossing the street safe and easy are even more important, even more so if no traffic calming measures have been taken (When traffic is sufficiently slow, crossing can be done everywhere, which — for residential streets — is the ideal situation). They should occur at the very least at side roads, paths, and

Figure 96
Bulb-out (bubble corner) as traffic calming measure.
Photo by Dan Burden, http://www.pedbikeimages.org

Box 20:
Walkability Checklist (US DoT)

http://www.walkableamerica.org/checklist-walkability.pdf

- Did you have room to walk?
- Was it easy to cross streets?
- Did drivers behave well?
- Was it easy to follow safety rules?
- Was your walk pleasant?
- How does your neighbourhood stack up? Add up your ratings and decide.

Based on six simple questions, with clear answer choices, the US Department of Transport's Walkability Checklist turns any interested person into an "auditor", offering a clear score, and pointers on how to achieve immediate and more complex improvements. Other cities, such as Toronto, countries, such as Australia, or institutions, such as the Active Living Centre (US), offer charters and a wide range of tools for enlisting the help of residents' when it comes to evaluating and improving residential streets.

Participatory evaluations

User-friendly graphics and easy- to-use audit and checklist tools can make evaluations participatory, thereby greatly extending their usefulness without increasing costs. The Australian TravelSmart website has a useful set of tools in line with Dutch principles for cyclability, which local governments around the world can adapt for their own use. See http://www.travelsmart.gov.au, also the source of the graphic accompanying this box.

Box 21: An example of a cyclability checklist from Australia

http://www.travelsmart.gov.au/bikeability/pubs/routebasedchecklist.pdf

This instrument is suitable for application by local planners on their own or — best option — in cooperation with cyclists, and includes a rating system. It is particularly useful to work with a panel, selected to represent beginners, average and advanced cyclists, those with special needs or abilities, different age groups, and so on.

Coherence

1. Can cyclist speed be maintained for the majority of the route?
2. Is parking banned in on-road bike lanes?
3. Are bicycle lanes or left traffic lane widths adequate to accommodate cyclists?
4. If the route is in a rural area, are wide paved shoulders on roadway provided?
5. Is the route supported by co-ordinated systems such as signs and markings that are clear and easy to follow?
6. Are necessary pavement markings clearly visible and effective for likely conditions?
7. Are necessary regulatory, warning and direction signs located appropriately?
8. Is route free from redundant/unnecessary signs?
9. Are there signs and line marking on shared paths to encourage users to share the path, *e.g.* 'keep left'?

Directness

10. Is the route as direct as practicable given hills and major intersections?
11. Does the route link with other parts of the network?
12. Does the route provide direct/continuous links to activity centres and recreational facilities?
13. Does the route provide continuous and convenient links to adjacent streets?
14. Are steep climbs & descents minimized?
15. Is the number of stops required along the route acceptable?
16. Are there suitable alternative routes to choose from?
17. Is an alternative route indicated when earthworks disrupt the main route?

Comfort & Convenience

18. Is the riding surface smooth and free of defects that could affect the stability of cyclists or cause wheel damage?
19. Are sealed shoulders at least as smooth as traffic lanes?
20. Are paths wide enough for the pedestrian and cyclist volume?
21. Are paths usable by cyclists on wider or larger bicycles such as tandems or cyclists towing trailers?
22. Is a centre line marked on the pathway to reduce conflict between cyclists and pedestrians?
23. Are smooth and fl at gutters/channels provided at storm water drain inlets?
24. Are kerb crossing ramps ('pram ramps') provided where the route includes transitions from roads to paths?
25. Does the riding surface have adequate skid resistance, particularly at curves, intersections, bridges and railway crossings?
26. If rumble strips are installed along the roadway, is the shoulder beyond the rumble strip smooth and sealed?
27. Is there adequate lighting along the bike route?
28. Does the route allow for less confident/less experienced cyclists to use low traffic streets, off-roads paths or footpaths?
29. Is the riding surface generally free of areas where ponding or flow of water may occur?
30. Is the route free of weeds and tree roots?
31. Is the route free of construction or maintenance equipment?
32. If holding rails or bollards are provided, are they positioned so they don't unduly interfere with access for cyclists and other users?

Safety

33. Where paths are located adjacent to roads, is there sufficient separation and/or protection from the roadway?
34. Are special provisions for cyclists provided along curving roads?

entrances to major buildings and playgrounds. It is essential to minimize the distance to be crossed in one go by squaring (rather than rounding) street corners, using "bulb-out" or "bubble" corners in combination with local parking, extending sidewalks across streets or providing a traffic island in the middle.

These measures make it safer for pedestrians to cross, ensure that pedestrians (especially the young who are still learning, and the old, who may have more limited mobility) do not have to pay attention to traffic coming from more than one direction, and make the crossing more conspicuous. Parking should be distanced from crossings, since it blocks drivers' visibility, particularly of (small) pedestrians, wheelchair users and cyclists.

8.3.3 Cyclability

Most residential streets are suitable for cycling, particularly when:

- Motorized traffic volumes are (kept) low;
- Speeds are limited;
- Crossing the street is no problem;
- The road surface is reasonably smooth and properly maintained. If humps are necessary, they should be carefully designed to avoid creating problems for walkers and cyclists;
- Streets are two-way, at least for bicycle use.

In such conditions, separate bicycle facilities are not necessary. However a special streetscape may be useful if the road forms part of a main bicycle route. Separate bicycle paths are possible, but the same definition may be achieved simply by a conspicuous pavement colour, special lampposts, locating a line or trees or shrubs in a key position, or other features.

Where more important bicycle routes follow residential streets or cross habitat areas, simple sign posting of these routes may be necessary, for two reasons. Coded cycle routes, combined with bike maps, can help cyclists identify other bicycle- or human-powered-vehicle-friendly routes. Moreover, this communicates to all road users that roads, intersections, and traffic signals give priority to cycling and other human-powered transport modes. Thus, suitable signage can enhance walkability, cyclability and the attractiveness of human-powered use.

8.3.4 Criss-crossability

On many residential streets, parked cars predominate. Cars need huge amounts of space, sometimes in private, but most often in public spaces. Many streets become traffic "gutters" and sidewalks are blocked by long rows of standing steel, even where traffic volumes are relatively low. Crossing becomes impossible, except at corners.

In The Environmental Quality of City Streets (see Chapter 3), Appleyard and Lintell have shown quite clearly how sociability declines when people cannot easily cross the street wherever they want to. Shops and other commercial enterprises get fewer visitors, people have fewer friends and acquaintances, and children's worlds become strictly curtailed. Play may become impossible, because neither children nor adults can use the full width of the street anymore.

This makes ensuring that the full length of the street can be crossed essential to creating a thriving, attractive public space. Parking should not only be regulated and in many situations restricted, but also effectively controlled.

Restricting parking and/or driving can also be tied to specific hours. This is a well known regime applied to shopping streets. The same rationale can apply to streets around parks or schools, so they can be used as playgrounds, extension of the green area, and safe routes.

Usually cars are allowed on residential streets. Sometimes, however, breaking up some thoroughfares and turning them into car-free streets can be very effective to calm the traffic in large habitat areas. This can make it possible to create a continuous and more or less car-free route connecting important places for local residents. The 'Kid-grid' concept developed by Ineke Spapé is an example of this method (see http://www.soab.nl). The idea is that safe and attractive routes will not only connect the schools and playgrounds, but also shops, libraries and other facilities in an area that are frequently used by children.

Restrictions on cars typically offer some advantageous "side-effects". They may influence the choice of transport mode, as every trip begins and ends by walking or cycling. More people will walk or cycle all the way if the trip is short, or take public transport for longer distances, particularly if the walking- and cycling environment en route is pleasant and safe, if sidewalks or roads are free of parked cars, and if they must walk as far to reach their parked car as they have to walk to reach the nearest public transport. On the other hand, if people can walk out their front door into their private car, and the sidewalk is obstructed by vehicles parked in public space, if the streets have not been designed for safe and pleasant cycling and walking, or if people have to walk a long way to reach the nearest bus, they will use their car or motorcycle even for short trips, needlessly congesting roads, consuming public space and increasing air pollution.

8.3.5 Attractiveness

For an attractive environment, the street should not only be laid out as a route, but also as a space for living and a front yard to adjacent buildings.

Good layout can turn an ordinary street into an enjoyable place, simply through suitably arranging trees, seating, sculpture, and play elements, choosing appropriate materials, and achieving a good design. Moreover, layout can enhance the enjoyment of extraordinary elements, such as sculpture, heritage buildings or views.

Residents, shopkeepers and other parties can add their own flavour to the streetscape and contribute to its suitability for a range of activities, by artful use of shop windows, external displays, mini-gardens, seating, or play elements.

Variety makes each single element more enjoyable, strengthening the notion that one is moving through a space alive with possibilities. Therefore, each street segment should be separately designed.

8.3.6 Usability for social and civic activities

The residential street should offer room for all sorts of social and civic activities, not only specific to children playing, but also for people of all ages to mix, to see, and be seen. They should offer attractive sidewalks and small squares for neighbours to gather and exchange the latest news, comment, criticise and initiate collective actions to better their street and their neighbourhood. In developing countries, and especially poor neighbourhoods, the street may be the only public space available. Where housing

Figure 97

Buenos Aires (Argentina) a flower shop on the Florida street pedestrian mall contributes to area aesthetics.

Photo by Carlosfelipe Pardo

is overcrowded, it may also, offer the only place where residents can get away for awhile, clear their heads, read a book, daydream, meet up with friends.

How friendly a street is to children is a good general measure for how well it works for everyone. Children play all day. Play is their most significant activity. They learn while playing; they play while learning. They may play in a group, or on their own, with other children, with family, or by copying adults. Their play may be quiet or restless. Play enjoys infinite variety, making it impossible to fully describe all play activities and suitable conditions. To reach full development of all their faculties, children need a wide range of situations, the more the better. Denied the ability and spaces to play freely, children's social, emotional, intellectual and physical development becomes extremely limited.

As a rule, public space as a whole must be attractive to all age groups. Mixing age groups is important, not only because children want to spend part of their time in the world of adults, but also to enhance social safety.

Separate play facilities can be very attractive for a little while. They can complement the possibilities at home and in the street, as long as they are within reach along safe and attractive routes. Play facilities on the other side of an unsafe road are worthless, in fact, extremely hazardous. Play facilities isolated from natural vigilance from parents and other responsible adults make playing a special activity that is only possible when an adult is available to accompany the child or children to the playground.

Box 22: Child-friendly checklist

Looking at special play facilities is not enough, if you want to judge the usefulness of a street layout. It is better to use a checklist of possible activities of adults and children:

- ☑ Are there sheltered places to play with dolls and toys or to make a drawing on the pavement?
- ☑ Are there suitable places to sit comfortably, to chat, and watch children informally?
- ☑ Is the street inviting to climb and balance, to build a hut?
- ☑ Is there room for moving around, jumping or playing hopscotch, using a scooter or skating, skipping rope, learning to cycle?
- ☑ Is there room for activities with a number of people, such as playing ball or sitting together?

9. Designing for cycling along main roads and highways

Steven Schepel and Bas Braakman

9.1 Balancing demands

The design of a district main road is probably the most difficult task for a traffic engineer. It must handle all sorts of road users, coming from all directions, and the possibilities for segregation may be very limited. This poses the challenge of achieving a balance between the many demands of all, in the context of the set of conditions chosen for the road. The choice of what kind of cycle facility to implement (bicycle path or bicycle lane, for example) also depends on traffic characteristics, particularly:

- Traffic volumes;
- The number of traffic lanes;
- Presence and volumes of heavy traffic (trucks and buses);
- Traffic speeds;
- Crossings facilities for pedestrians and other vulnerable users.

9.2 Making the most of major infrastructure

As was seen in a previous chapter, main roads and highways are meant to collect and distribute motorized traffic travelling from one habitat area to another or to other destinations. They may also take the form of a circular road surrounding a habitat area with different segments, each with its own entryway.

Intersections in these roads should be designed for the exchange of motorized and non-motorized traffic leaving or entering residential roads, while motorized traffic should flow relatively easily between intersections, keeping total travel time on the route the same or less than travel time on alternative routes inside habitat areas. Otherwise, district main roads will fail to fulfil their function.

This chapter examines the advantages and disadvantages of different types of cycling facilities along main roads and highways, to help planners make well-considered choices.

9.3 Types of cycling facilities along main roads and highways

We can distinguish between visually segregated (cycle lanes)and physically segregated cycling facilities (cycle paths or cycle tracks) (Figure 98).

9.4 Advantages and disadvantages

It is important to compare the advantages and disadvantages inherent in the different solutions, to make the best choices. Planners and designers, particularly those who do not habitually cycle, should always consult the opinions of a range of current and potential users, to have access to all the necessary information for making an optimal decision. The kind of cycle way that works just fine for an expert cyclist on a racing bike may be a disaster for a father or mother who typically carries groceries or a child on the back of a bike.

9.4.1 Do different kinds of cyclists feel comfortable and safe? Specific hazards

Most cyclists, especially beginners, small children, the elderly and women, prefer segregated cycle ways to cycle lanes. The physical separation between a major road and a cycle path makes them feel more comfortable. The same separation, however, may impair their safety, especially if a row of parked cars stands in

For related subjects

For Key Terms used in this chapter and an extensive further readings list, see Chapter 5.

See ***Chapter 6*** on matching design to road conditions.

See ***Chapter 7*** on designing residential streets and traffic calming.

See ***Glossary*** on habitat areas, traffic calming, cycle routes, cycle paths, and lanes, etc.

Figure 98

Cycle lanes in Eindhoven, The Netherlands.

Photo by Bas Braakman

Figure 99
Parallel road with one way traffic and two way cycle traffic in Geldrop, The Netherlands.
Photo by Bas Braakman

between, causing drivers to lose sight of them. This can lead to unexpected and potentially hazardous encounters, particularly when cars turning into side streets run into cyclists continuing straight through an intersection. This often makes it necessary to prohibit parking at some distance before an intersection or a side street and signage and/or markings to make drivers more attentive, with clear warnings to highlight how the cycle path crosses the side street.

Cars unloading, turning into and emerging from private property, or opening their doors into any bicycle route can be extremely hazardous to cyclists. This means that any combination of parking and cycling requires extra margins and attention to details.

A roundabout is a very efficient layout for an intersection and it can favour general road safety, compared to other types of intersections (with or without traffic lights), provided that its geometric design is aimed at slowing down the approaching traffic (Figure 102). However, trucks turning into a side road may overlook cyclists or moped riders. The traditional solution is to force cyclists to cross side streets at some distance from the roundabout and give way at all times. This may simplify conditions for motor vehicles, but it is very annoying for cyclists. Moreover, it demands extra width from the side street. Some experts advocate ending the cycle path before reaching the roundabout, thus mixing cyclists with motorized traffic. Others keep the cycle path close to the roundabout, while using signage to highlight potential conflicts for cyclists and drivers alike.

Cyclists will probably feel more comfortable on a cycling facility at some distance from any highway (see also comments in Chapter 2 on air

Figure 100
When bike lanes or segregated bike paths are located alongside parking, a buffer space must be included to prevent cyclists from getting hit by an opening door. "Dooring" as it is called causes some of the most serious, in fact often fatal, accidents.
Photo by Fundación Ciudad Humana

pollution and cyclists). At the very least, facilities for them should be separated from high-speed traffic by a wide strip of grass, pavement, or gravel, preferably with trees to provide shade. A simple barrier is not enough to ensure cyclists are (and feel) comfortable and safe.

Designers should pay special attention to places where cycling facilities meet highway exits. It is very important to prevent sudden encounters between fast motorized vehicles and cyclists. A cycle path on the median offers some advantages in this respect, but only as long as motorized traffic cannot, and does not, cross the median. Cyclists following a cycle path on the median will not feel comfortable and safe, however, if they are supposed to leave the median at every crossing. In that case many of them will prefer to ride on the main motorway (or not cycle at all).

Cycling in two directions on a cycling facility along a main road requires that cyclists are physically separated from oncoming motorized traffic. Therefore cycle lanes (by definition without physical segregation) are for one-way cycling only, and must be on both sides of the road.

Allowing cycling in two directions on cycle paths (by definition with physical separation) requires extra width. At intersections it may also surprise other road users, who are not aware of traffic going in the 'other' (unusual) direction. When asked, drivers may indicate that they know cyclists may come from either direction, but they may not pay enough attention in their everyday practice. Extra risks may arise, unless the design clarifies the unusual situation very well.

On the other hand, allowing cycling in two directions can be advantageous (and safer) for many cyclists when it reduces the number of

Figure 101
It's the job of traffic engineers and designers to design a clear and safe road layout. For motorized traffic that is turning left or right it must be clear that through cyclists on the separate bicycle track have priority.
Photo by I-CE, Hans de Jong

Figure 102
A roundabout mixes cyclists with other traffic. A good design effectively reduces speed. When done like this, mixing different road users is a sensible, practical solution for all.
Photo by Hans de Jong

Figure 103

This road, an important connection between a national highway and the city of s-Hertogenbosch (The Netherlands), has separate cycle tracks on both sides. On the left, the track has been designed for two-way cycle traffic. The advantage is that fewer cyclists have to cross the road to reach their destinations.

Photo by I-CE, Tom Godefrooij

intersections on their routes or facilitates their use of better (safer and more comfortable) crossings (Figure 103).

9.4.2 Connecting a cycling facility to side streets and crossing main roads

Because most cycling trips are relatively short, a cycle facility that creates many detours will lose much of its attractiveness. The facility should therefore be connected at suitable intervals to the network of smaller streets on either side of the main road or highway (Figure 104).

Main roads and highways, whose purpose is to collect and distribute traffic leaving and entering residential streets, require intersections suitable for traffic exchanges. Fitting in cycling facilities should therefore be no problem, provided that the layout clearly indicates cyclists' presence. Moreover cyclists should receive preferred treatment at traffic lights (if any).

A zebra crossing without traffic lights is the simplest measure for crossing a road. But this solution (zebra) is only safe when motor traffic is approaching at low speeds and is sufficiently alert to possible pedestrians and other users. Distances to be crossed in one go, in combination with the number of 'gaps' in the traffic flow, determine whether such a crossing is suitable or not. Are pedestrians and cyclists tempted to take too many risks, for instance, because they find it too difficult to judge the situation, or because they grow tired of waiting? Traffic lights at adjacent intersections may create sufficient gaps in traffic flows, while islands between lanes may reduce distances.

Traffic islands should be large enough to protect cyclists and their bicycles (2.00 m) fully. Beware that small children, people with packages and the elderly (all of whom need more time) will also use the crossing. So will a lunch-time or holiday crowd, so think about the whole day and seasonal cycles, as well as specific moments and conditions.

In many situations, particularly with a busy road, a separation in terms of time (traffic lights) or space (underpass or overpass) is essential to guarantee the safety of 'common' road users.

Figure 104

Convenient cycle infrastructure with car traffic passing over in Eindhoven, the Netherlands.

Photo by Bas Braakman

Figure 105
This bicycle track in the Netherlands crosses a street near an intersection. There is not only a raised platform to reduce car speed, but there is also an "traffic island" to give pedestrians and cyclists the opportunity to cross in two phases. This could be useful when car traffic is too busy to cross the street in one go. This photo illustrates how design can support the coherence of the bicycle network, where it is not obvious in the first place.
Photo by I-CE, Tom Godefrooij

Sometimes a junction with a side street may be blocked (by a temporary or permanent barrier, or some other element), to facilitate steady traffic along the main road. The resulting detour may not be difficult for motorized traffic, but will be less acceptable to cyclists and pedestrians. Many will disobey the rules, even if it means taking a risk. It is important to design and build safe, comfortable crossings serving side streets, wherever possible. Typically, the use of fences, which simply block cyclists and pedestrians, are a sign of failure to create decent amenities.

For a long time, advisors came up with special overpasses and underpasses as the only proper solution for pedestrians (and cyclists) to cross major roads. These facilities, however, force them to struggle up and down height differences of three to five metres or more. Cycling up and down requires long ramps, taking up valuable public space, hindering free movement in side streets and forcing pedestrians and cyclists to make detours. Barriers of this nature severely limit the mobility and the access of a wide range of people — children, parents, shoppers, others with heavy equipment or other burdens. This

Figure 106
Cycle bridge to cross a highway in Quito, Ecuador.
Photo by Bas Braakman

Figure 107
A convenient cycle under pass in Eindhoven, The Netherlands.
Photo by Bas Braakman

means they discriminate against those whom social policy is most intended to help.

From cyclists' perspective, an underpass has advantages compared to an overpass. It requires less effort, because they can take advantage of the speed they generate on the way down for the upward climb on the other side. Differences in height (up and down) are smaller. Subsequently slopes will be shorter. Many pedestrians and cyclists don't like underpasses, however, because they feel vulnerable or fear assault, especially after dark. It is a challenge for designers of underpasses to minimize the (feeling of) insecurity associated with underpasses (Figure 107).

Pedestrian overpasses are inappropriate, particularly for the elderly, people carrying packages and small children when they must overcome height differences by stairs or slopes. This often leads to their not being used. It is common to hear of pedestrians being killed directly under pedestrian overpasses. If used, overpasses should be as low as possible given the necessary clearance for the highest vehicle allowed on the road. This can be done by lowering the level of the road underneath the overpass.

Figure 108
A convenient underpass in Houten (The Netherlands). The cycle track passes the circular road, with car traffic two metres up and bicycle traffic one down'. The underpass has been combined with a bus stop and bicycle parking facilities. This cycle track connects cycle tracks in the built up area with the tracks in the rural area. So cycling for daily (commuter) traffic is combined with cycling for leisure.
Photo by Hans de Jong

Given a choice, it is best to keep pedestrians and cyclists on ground level, while raising or lowering the metropolitan highway, not only because slopes and detours are less bothersome to motorized traffic, but also to enhance safety. Building this sort of highway is more expensive, but the additional cost of pedestrian/cycle facilities will be marginal.

9.4.3 Some additional design questions

Where cycle paths merge with motorized traffic, does design make all road users aware of this change?

Sometimes, it may become necessary to end a cycle path in the middle of a road section (for example, when the road narrows), thus forcing cyclists to mix with motorized traffic. In these situations, designers should create a transition zone, for example by narrowing lanes before the merge, providing a cycle lane as an intermediate measure for some distance. Consistent signage throughout the city (or, preferably, the country) alerts all users and contribute to smooth integration.

A compromise in design may be necessary at a severe bottleneck (for instance a narrow bridge). In such an exceptional situation, designers may have to narrow lanes and reduce the speed limit. This could make combining pedestrians and cyclists (no mopeds) on one path necessary as well.

How can cycling facilities encourage cycling among drivers?

A conspicuous cycling facility next to a main road can act as a beacon showing car drivers the benefits of cycling, even if most cyclists would prefer a facility at more distance, shielded from the noise, fumes and sight of motorized traffic. Turning lanes previously dedicated to car use or parking over to cyclists also helps to redistribute road space more fairly, safely and sustainably.

How can cycling facilities encourage occasional cyclists to ride their bikes more often?

Other ways to encourage facility use include special signposting, preferred treatment at traffic lights, and a conspicuous design, including special colouring of the cycle paths at each crossing, signage, and special lamp posts. Road design should warmly welcome cyclists.

Does the design offer suitable solutions for mopeds and other light vehicles?

Mopeds and other light motorized vehicles (such as tuk-tuks, motorized rickshaws, and agricultural transporters) can be a nuisance to cyclists. The decision on whether to allow them on a cycle path should be made on grounds of compatibility. How well do these vehicles fit into the general flow on the main road, and to what extent do they hinder or pose a hazard to bicycle traffic?

Cyclists will certainly prefer a cycle path without these vehicles. Admission to the cycle path may be inevitable, however, if they are excluded from the main road. Then the condition is that speeds are more or less within the same range as those cycling. Upon that the path should be extra wide, in fact, as wide as a standard parallel road. When mixing these other vehicles with cycle traffic, slopes, underpasses and traffic lights should also be tailored to both types of traffic.

9.5 When a central median is the best place for cycle infrastructure

The decision on where to put cycle infrastructure should result from careful analysis using the multiple perspectives described elsewhere in this handbook. In most cases, one-way or two-way cycle paths on both sides of the metropolitan highway are most appropriate. However, some times the central median is the best choice. Using an existing median for a cycle way works well when:

- The route is designed for covering long distances rapidly (similar to a highway used by cars);
- The number of conflict points (side streets or intersections) can be minimized, but connections to routes leading to intermediate destinations are feasible and safe;
- Ingress and egress points are an integral part of design;
- The median is wide enough to afford comfortable (preferably shaded and protected from extreme weather), safe and separate facilities for cyclists and pedestrians (leaving

Figures 109 and 110
Cycle track in the median in Santiago (Chile) and Bogotá (Colombia).
Photos by Bas Braakman, Carlos-felipe Pardo

pedestrians out of the design is a recipe for endless conflict);

- Other local considerations are present.

9.5.1 Origins and destinations

If cyclists' points of origin and destination vary greatly, the central median will tend to be problematic. A wide range of origins requires a corresponding large number of entry points, generating problems as the number of crossings to a central median tends to be limited and creating new crossings is very expensive (this is even more the case when destinations are directly along the concerned roads). This ceases to be an issue, however, when cyclists come from concentrated origins in high-density districts and are headed for a few destinations.

9.5.2 Cycle trip lengths

When cycle trip lengths are relatively long, and origins and destinations are situated close to the highway, using the central median can offer some advantages. The directness of the cycle route is very good, because a metropolitan highway usually takes the shortest path. Moreover, cyclists have to enter and leave the cycle route on the central median only once. They can use the central median to cover a long distance, without being bothered by other traffic and obstacles. However, when most cycle trips are short or very short (under a couple of kilometres), the use of the central median will be less attractive.

9.5.3 Trip purposes

Using the central median will mean having to cross a very busy metropolitan highway and having to accept the presence of large volumes of motorized traffic nearby. This is not very comfortable for cyclists, especially when good alternative routes through residential areas are available, with less traffic and more pleasant surroundings. Commuter cyclists tend to accept this discomfort if the cycle path in the median is direct, quick and without lots of traffic lights and other delays. Other cyclists, such as those with recreational or shopping purposes, tend to switch to less direct, but also less car-dominated routes, having more time and less rush.

9.5.4 Number of conflict points

Cycling on tracks at one or both sides of the highway can be problematic when cyclists have to cross many side streets. These create conflicts when cyclists have to wait more and deal with more traffic. The central median is advantageous if there are fewer intersections than side streets or intersections can be designed less complicated. Cyclists must wait less, making the route a lot quicker.

Notwithstanding, cyclists along a metropolitan highway will have to obey traffic lights at full intersections. Usually green phases for the main flow of motorized traffic will be much longer than for traffic from the side streets. Cyclists using the cycle track in the median will have the advantage of using this long green phasing, together with the main traffic flow and the time spent waiting for traffic lights to change can therefore be minimized.

9.5.5 Suitability of the median

Of course the median should be suitable for a two-way cycle path. This means it must be wide enough (at least 5–6 m) and provide enough obstacle-free space for a two-way cycle path at least three metres wide. Larger medians offer more comfort (cyclists feel less 'threatened' by traffic close to them) and can be used as green spaces. In countries with hot, sunny days for much of the year, shade trees are necessary to attract cyclists. Including extra facilities, such as resting places, with benches, washrooms, drinking fountains, and so on is a good idea. It is important to include pedestrian facilities in the overall plan. Otherwise there may be constant conflicts.

All these factors should be considered before deciding where to position cycling infrastructure along a highway or main road.

Figure 111

Cycle track in the median protected by a fence in Santiago (Chile).

Photo by Bas Braakman

9.6 Further reading

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Figure 112

Cycle track in the median with benches in Santiago (Chile).

Photo by Bas Braakman

10. Bicycle parking: tools for success

Ineke Spapé (SOAB consultants)
and Tom Godefrooij (I-CE)

For related subjects

(For Key Cycle-facility design terms, see box Chapter 5)

See ***Chapter 4*** on How to organize the policy making process.

See ***Chapter 11*** on intermodal trip chains.

See ***Chapter 13*** on Social marketing and Citizens' participation.

See ***Chapter 14*** on collecting key information necessary to make optimum decisions.

10.1 Chapter summary

This chapter presents key components of the theory and practice of successful bicycle parking initiatives. Together they offer a sound foundation for a structural and integral approach to bicycle parking. It starts by describing the fundamentals, goes on to describe the DCQ-scan, then outlines how to develop an effective Bicycle Parking Plan. The last section offers advice on promoting bicycle parking.

10.2 Introduction

The use of the bicycle as a transportation mode requires suitable parking measures. These in turn call for improving cycle networks and promotional activities to encourage more cycling. A lot of cities invest in upgrading the quality of these networks. If bicycle use is significant, the need for bicycle parking will be significant as well: at the end of every cycle trip, women, children and men must all park their bikes!

There are many reasons for offering quality bicycle parking facilities. Without effective parking facilities, fear of theft may keep people from cycling, undermining the impact of other measures to encourage cycling. Conditions at home and at destination deeply influence cycling habits.

Providing parking facilities contributes to public welfare in several ways:

- Good services attract more people to cycling;
- Good policies provide facilities where they will be used (unused facilities are a waste of money);
- Well-designed facilities contribute to the quality of the public domain, benefitting all users;
- Prevention of theft and hooliganism improves the position of cyclists.

Several European cities have introduced bicycle rental systems, such as Call-a-Car in Berlin, Velov in Lyon and Velib in Paris. These rental systems are directly linked to parking facilities: rental bicycles need to be parked too. For an international overview of existing systems, see Chapter 10 of this handbook.

10.3 Three key components of successful bicycle parking

The three key components in successful bicycle parking are:

- Policy goals;
- Responding to consumers' demands;
- Types of facilities.

Combining these components reduces the risks of failure and optimises the likelihood of success in the implementation of a consumer-

Figure 113

A nice and quite original parking facility for bicycles at a cinema in Bogotá (Colombia). One drawback is that the bicycle must be lifted to park it.

Photo by I-CE, Roelof Wittink

Figure 114

The successful rental or "public bicycle" system Velov in Lyon (France), run by advertisers JC Decaux. This is the automatic rental unit near a major theatre. System members can take a bicycle from this unit, travel to their destination and drop it off at one of hundreds of units distributed around the city.

Photo by Hans de Jong

Figure 115

The lack of suitable parking facilities generates serious problems in public spaces, as this overcrowded square in Goes (The Netherlands) illustrates. Bicycles locked haphazardly around trees or other improvised facilities are clear signs of where to locate bike parking racks.

Photo by Gerda Katsma, Fietsersbond

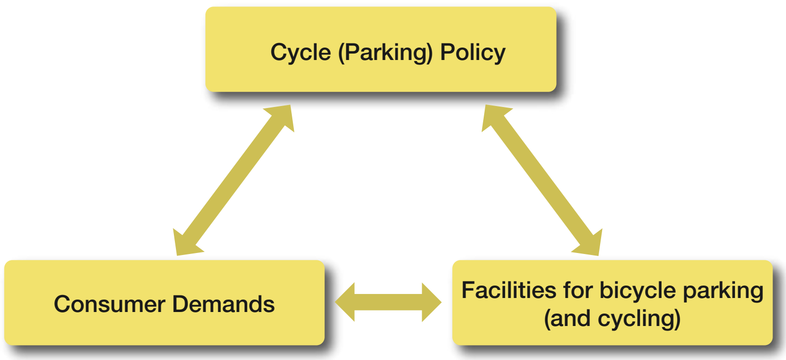


Figure 116

The three main components of successful bicycle parking.

Source: SOAB CONSULTANTS

Figure 117

Cycle parking problems in Beijing (or, as Japanese have termed it, bicycle pollution).

Photo by Carlosfelipe Pardo

oriented bicycle parking strategy, offering the right facilities in the right places.

10.3.1 Component 1: Policy considerations for a better bicycle parking policy

Effective bicycle parking policies can contribute to many goals. Here we explore the five basics.

Reason 1: Better facilities serve cyclists (and other road users) better

Taking cycling seriously means offering the right facilities: both the location and the quality are very important. What kind of rack (with or without extra locking possibilities) will be most useful? How user-friendly is the facility? All too often, bicycle parking facilities don't match users' needs. These 'Bicycle killers' don't stimulate bicycle use. In 1999, the Dutch Cyclists' Union and manufacturers jointly defined key characteristics, represented by the *FietsParKeur*, a seal of approval. Both users and producers therefore defined the hallmark qualities required. Many Dutch cities are now shifting to facilities with the FietsParKeur seal of approval. Better quality facilities also contribute to better quality urban spaces, thereby benefiting cities in general.

Possible criteria for a Bicycle Parking Facility seal of quality:

- How easy it is to position the bicycle (particularly if it has additional accessories such as child seats, baskets, panniers, etc.);
- How easy it is to lock the bicycle using a strong metal lock and not weaker chains, easily cut by thieves armed with metal cutters (one lock or two, integration of accessories, etc.);
- Minimal risk of personal injury (to cyclists and passers-by);
- Minimal risk of damage to the bicycle itself;
- Resistance to theft and vandalism;
- Durability of materials.

Reason 2: The right facility in the right spot

Location is an essential factor when cyclists, or potential cyclists, choose where to park their bicycles. They will often prefer a spot that is close to their destination and that provides good visibility, particularly for short-term parking. But all too often, the location of bicycle parking facilities does not match users' needs: racks are positioned in the wrong location (places with poor lighting, difficult access, in the middle of a median with no direct access to subway or bus transit, or out of the way).

Figure 118
Bicycle racks in the city centre of Bolzano, Italy.
Photo by Hans de Jong

The location, details and quality of facilities matter greatly. It is essential to test both locations and designs on a wide range of cyclists. A panel, including children, men and women of different ages and with different trip purposes (school, shopping, commuting), can be a relatively simple and useful method for this.

Where indoor storage facilities are being developed (for example in the city centre or at railway stations), planners should give priority to including quality lighting, safety, and accessibility. Locating parking adjacent to cycle routes to ensure easy access and egress is also very important.

It is better to reread 'wrongly parked' bicycles as a sign that existing facilities are insufficient.

Reason 3:
Quality bicycle parking contributes to public spaces

(Too) many parked bicycles can contribute to a chaotic streetscape and less attractive public spaces, exacerbating risks, hazards and decreased accessibility for pedestrians, because wrongly parked bicycles block their way. However, not every so-called 'wrong' place (against houses, buildings, etc.) is genuinely problematic, so the wisdom of a restrictive approach is highly debatable. In fact, it is better to reread these 'wrongly parked' bicycles as a sign that existing facilities are insufficient. Good bicycle parking facilities do not just bring more order to the street's image. They should serve as an integral part of urban design. In most cases, "cycling-friendly" is "people-friendly" design and should be perceived as such by cyclists and other users of public space, when properly done.

Good bicycle parking facilities can also contribute to the living environment's safety and accessibility. Large numbers of randomly parked bicycles can be a hazard to all sidewalk users. Disabled people, the elderly, rescue and fire services all frequently have problems when poorly parked bicycles block their way. Attractive and well located bicycle parking facilities can prevent or minimize such problems.

Reason 4:
Quality bicycle parking prevents theft and vandalism

Every year in urban areas, a lot of bicycles are stolen. This is a problem from the perspective of the legal system and general public security. Moreover, the theft or destruction of parked bicycles also discourages cycling. Many studies have shown that fear of theft and vandalism are important barriers to people cycling, as are the wobbly old bicycles that they may resort to, to avoid the theft of a more valuable bicycle. Altogether this points to specific security requirements for any bike parking facilities. Secure bicycle parking facilities (with extra locking options or supervision) have been proven to dramatically reduce theft. As a result, more people feel safe to use their bicycles on a regular basis in the city.

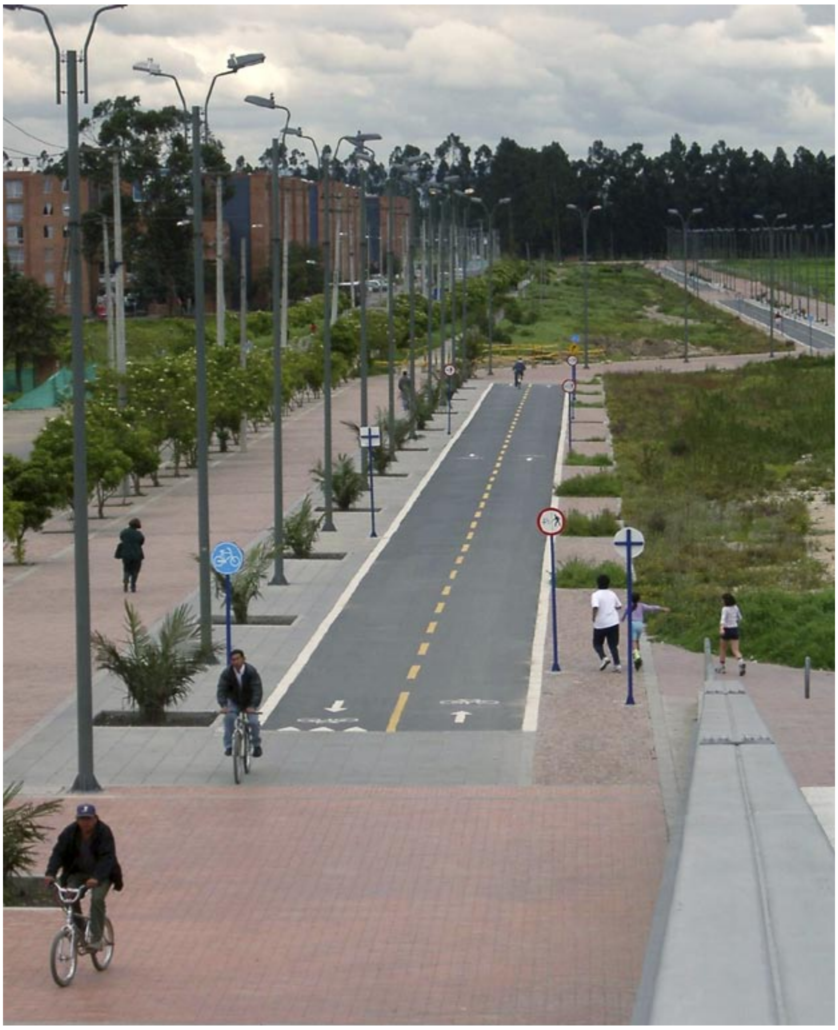


Figure 119

A good example of how good designs for pedestrians and cyclists improve the quality of public spaces, benefitting everyone.

Photo by I-CE, Roelof Wittink

Reason 5: Quality bicycle parking encourages positive modal shifts

Social trends such as an increase in wealth, more reliance on information and communications technologies, two-income families, the 24-hour-a-day economy, and the shift toward an older population, combined with fewer younger people, bring with them the need to push mobility management higher on the public agenda and, within that, the promotion of bicycle use. It takes special measures to get potential cyclists into the saddle and keep them there, quality bicycle parking being one of them.

In this context, it is important to treat bicycle-parking policy as an integral part of mobility policies, vital to achieving the right combination of pull- (honey or carrot) measures and push- (vinegar or stick) measures. Good parking for bicycles in the right locations stimulate bicycle use and boost its modal share. Creating quality cycle parking is a 'pull policy' (offering a carrot). The relationship to social and spatial trends is evident. This calls for good bicycle parking facilities at destinations, but also at home, where cyclists should be able to park bicycles easily and accessibly. The cycling network as a whole has to be of the best quality. In short, when taking the bicycle, the whole chain of transport should strive for optimum sufficient quality, from the point of origin (residential areas) to destinations, and of course the route in between.

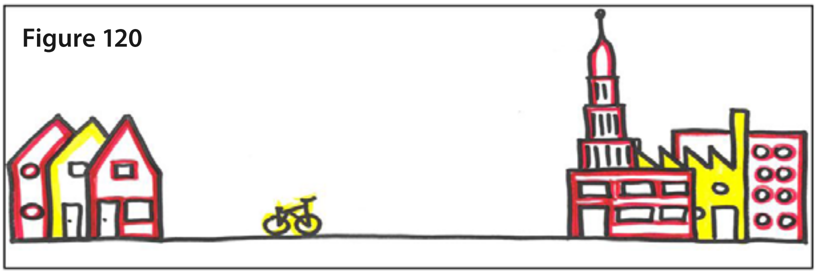
These considerations imply specific quality requirements for bicycle parking facilities. Any plan should be tested against how well it achieves these objectives. Most problems occur at places that serve as multiple destinations, particularly city centres, shopping centres, stations (metro/train), bus stops, residential areas, employment areas, company premises, public buildings and public areas, schools and locations hosting occasional or tourist-oriented events (pubs, restaurants, boulevards, etc.).

10.3.2 Component 2: Quality bicycle parking responds well to consumers' demands

The Bicycle Trip 'Chain'

Cyclists normally start from home, follow a regular or occasional route through the city, and then reach their destinations. This means that quality parking facilities for bicycles are needed at the point of origin, destination (whether this be short-, medium- or long-term) and at possible stops en route.

Figure 120



Bicycle (parking) policy therefore needs to address these needs at the origin, the destination and along the whole trip chain. It should also facilitate switching to other transport modes (buses, subways, trains). This is discussed in greater detail in Chapter 10.

It is important to keep this trip chain approach in mind. The quality of good bicycle policy is not determined by good facilities at an individual point in the transport chain but by the lack of facilities along any part of the chain: its quality is determined by its weakest link.

People will cycle more often if they:

- Can park their bicycles easily at home;
- Can ride along safe, comfortable, attractive and direct routes through a coherent network;
- And can park their bicycles safely, close to their destinations.

Generally speaking, cyclists want and need parking that is:

- Close to the destination (short walking distances, preferably shorter than the distance between car parking and destinations);
- Safe and secure (offering good visibility, prevention of and protection from theft and vandalism);

Figure 121

Photo: Importance of facilities on the whole trip chain. Main station Enschede (NL).

Photo by SOAB consultants

- Protected from inclement weather;
- Inexpensive;
- Easy to use.

In addition, local governments or specific providers (bus companies, employers or rail companies) often require that facilities be:

- Vandalism-proof;
- Easy to maintain;
- Easy to manage;
- Of high spatial quality;
- Inexpensive to provide; and
- Of high technical quality.

The importance of each requirement to consumers may vary according to the specific user group, the length of time and the time of day that parking is required, the type of location, and so on. In practise, it is not always possible to meet all user requirements to the maximum and some compromises must be made. The next section offers some advice on how to reach an acceptable balance in any given context.

Different User Groups

There are many different kinds of cyclists and they usually require a specific mix and type of facilities.

Often these users have different wishes for different locations and destinations. All cyclists makes their own personal choices in terms of time, conflicts, children or luggage; in terms of trip purpose, acceptable sacrifices versus preferred benefits or quality. A basic principle is to analyse the duration for which parking is required: short- (0–2 hours), medium- (6–8 hours, as commuters do) or long-term parking (overnight, mostly at home, at railway stations or other transport hubs). For each need, users prefer different solutions. A short-term parking facility is typically just a rack of some kind outside a shop or house; commuters and other medium-term parkers usually prefer more secure and protected facilities. Overnight parking requires quality solutions inside or near homes or relevant destinations/hubs (see 10.2.3). Major destinations attracting a wide range of cyclists should offer parking facilities that respond to these different needs.

Consumers and life styles

___ Students
___ Commuters
___ Experienced vs inexperienced cyclists
___ Elder people
___ Young families
___ Families with elder children
___ ……

Institutions

___ Housing corporations
___ Office owners
___ Shop owners
___ Station Managers
___ …….

Figures 122 and 123
Family cycling, "transport" of children.
Photos by I-CE, Andrew Wheeldon and Roelof Wittink

Combining the ideal form of facility with user groups leads to a strong user oriented and therefore better used supply of parking facilities.

The time of day also brings different users — and uses. A large, well-supervised storage facility in a commercial city centre can, for example, be very well used during the day, because it attracts a lot of shoppers and visitors. But at night the same storage facility may be virtually empty, while many bicycles are parked randomly outside, against buildings. The much younger public that goes to pubs and bars in the evening or on weekends behaves quite differently from families with children or elderly people that come in during the day.

10.3.3 Component 3: Types of facilities

Bicycle parking facilities and the cycle trip chain

The main types of bicycle parking facilities include:

- **Cycle stands:** mostly units for 1 or 2 bicycles.
- **Cycle racks:** mostly units for 6 or more bicycles.
- **Cycle lockers or boxes:** for individual or collective use. They can be opened by a conventional or an electronic key. An organisation is responsible for key distribution and administration. Requires a managed, operating system.
- **Automatic cycle parking (mostly paid):** the cyclist hands in the bicycle at the entrance. The system registers and stores the bicycle. Upon return the cyclist has to use an electronic key to recover the bicycle. An organisation is responsible for key distribution and administration. Requires a managed, operating system.
- **Guarded cycle parking (mostly paid):** collective cycle storage with supervision during most of the day and evening. These bicycle storage facilities or bicycle stations can be more profitable if they offer additional services, such as maintenance and repair, selling of accessories and bicycle rentals.

Offering facilities for bicycle parking and/or offering free parking in storage units can be potent instruments for local and regional governments in their urban transport planning and mobility management.

To optimise use along the whole cycle trip chain, for modal integration, planners should also consider:

- A balance between short-, medium- and long-term parking facilities;
- Security and accessibility;
- A prime, highly visible location for racks;
- High quality facilities.

The Netherlands has introduced a seal of quality (see http://www.FietsParKeur.nl) to guarantee that these requirements have been met and to support local authorities' efforts in this sense. Cities in Canada, the US and Australia offer excellent guides to local institutions and businesses, and city policies include providing cycle parking tips, or infrastructure. Every city has its own needs, so must carefully analyse initiatives elsewhere before adapting them to local needs. Good places to start include an outstanding design guide prepared by the American Association of Bicycle and Pedestrian Professionals, available at: http://www.apbp.org/pdfsanddocs/Resources/Bicycle%20Parking%20Guidelines.pdf.

A growing number of cities have increasingly comprehensive bike parking policies. Not only do they define design standards but they also offer information to businesses, institutions and other interested parties on how to implement quality parking. Note that most now ban the "toaster" design, commonly used around the world, because they damage bicycles and should be avoided.

You can see a wide range of examples of how cities have applied these policies (on location, design, provision) in the further reading section at the end of this chapter.

10.3.4 Differentiation among users and uses

Because bike users have so many different needs, there cannot be a single, ideal bicycle-parking facility. SOAB consultants developed the Mini-Midi-Maxi-Mega© package for situations in which cyclists are unable to park their bicycles in or near their homes or other destinations (best case). Many housing, shops, offices and other commercial buildings in existence today were built without considering bicycle parking, making renovations necessary to provide this adequately.

The SOAB approach offers guidelines for choosing bicycle-parking facilities in different circumstances. Any bicycle parking plan should offer a carefully balanced mix of user group- and length-of-stay-oriented measures. Cyclists deserve a well considered supply of racks (Minis), small street storage or box/drums (Midis) at transfer points for public transport, and substantial storage in neighbourhoods and city centres (Maxis and Megas). Cyclists should be able to choose between different kinds of facilities, depending on their motives and the length of their stay.

Table 7 provides an overview of the facility scales and their place in the bicycle trip chain (location: origin – route – destination). The cells show the specific recommended facilities related to scale and location in the bicycle trip chain. Source: SOAB consultants.

In addition to the scale of facilities the exact type and location should be evaluated from the users' point of view.

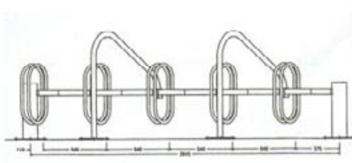
Sometimes, this package may be too demanding. In that case, it's important to realise that some type of facility should be offered at key points along the trip-chain with a certain minimum in terms of numbers and quality. The

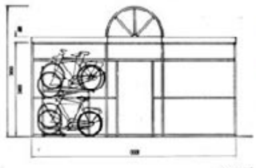
Table 7: How to determine user group-oriented cycle parking facilities?

Approach	Characteristics	Distance from O-D	Length of Stay	Typical User
Mini	Stands, racks, free and in the open, close to origin or destination points.	1–50 m	0–2 hours	Drop-in shoppers, café/coffee shop patrons, library users, short parking for visitors in neighbourhoods, etc.
Midi	Small-scale, locked and covered facilities that can be rented, may be located slightly further from destination (boxes or drums).	50–100 m	6–8 hours or overnight	Residents, medium term parking for visitors, shops employees outside city centre
Maxi	Internal or constructed parking for neighbourhoods of specific user groups (employees), accessible by key, pass or chip-system, supervised by camera. Small scale. Paid. Limited number of bicycles (50–60).	50–250 m	overnight	Residents
Mega	Internal or constructed city centre parking or parking at main stations, guarded by personnel, locked, possibly connected to other public services (eg. shopping mall). The number of bicycles is far larger (100 or more). A service organisation may be necessary, or the facility may form part of normal security arrangements. A fashionable mall in Santiago, Parque Arauco, has hanging racks for bicycles in its main security booth and a handy bike store and repair workshop just around the corner in the same underground parking facility.	250–500 m	3–4 hours 6–8 hours overnight	Shoppers in city centres, tourists, employees, residents city centres, etc.

Original source: MINI-MIDI-MAXI-MEGA© table SOAB consultants

Table 8: Mini - Midi - Maxi - Mega






	Mini (free)	Midi (paid)	Maxi (paid)	Mega (paid)
Origin	Rack at front-door	Box or drum, locked, at 30 metres	Residential storage, locked, build-in or covered, not public	Central storage, not public, with service, for inhabitants
Route	Rack at bus-stop or station	Box or drum at transferpoint	Station-storage, covered, not public	Biketransferpoint, with service, public
Destination	Rack at shops, work, sports, school	Box or drum, locked, not-public, at sport, school, centres…	Emplaye-storage or for evenements, locked, built-in, not public	Citycentre storage, evenement-storage, public

Figures 124 a, b, c, d

Different facilities for bicycle parking all over the world.

Photos a) India, Delhi Sept 2003 by Jaap Rijnsburger; b) NL, Utrecht by Giselle Xavier, c) Netherlands Railways I-CE Gerlo Beernink; d) Bogotá by Daniëlle Wijnen

requirements for cycle parking arise from how the facility will be used. Preferably, they should be free. To raise funds for free bicycle parking (at higher quality levels) cities could introduce Mobility Funds based on paid car parking. One must consider that the costs of bicycle parking facilities are marginal compared to those for cars. And that's not only because of more efficient space use.

10.4 The Distance-Cost-Quality (DCQ) scan

10.4.1 What it is

As mentioned above, bicycle parking choice and behaviour is determined by a complex set of interrelated factors. This makes it essential for planners to keep in mind that users will look for a balance between distances, costs and quality.

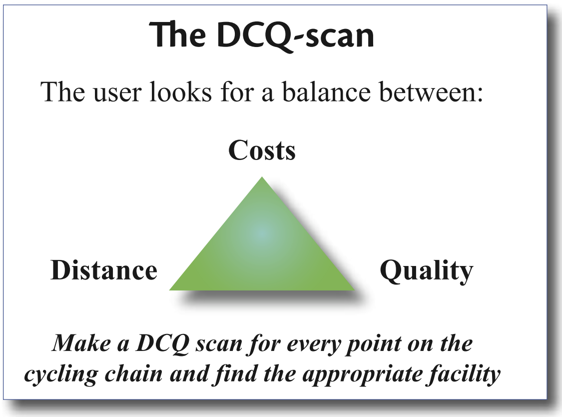


Figure 126
DCQ triangle
Source: SOAB CONSULTANTS

To find optimum solutions, the Distance – Cost – Quality Scan or DCQ-scan© can help to analyse possible facilities, the point on the bicycle trip chain, and the bicycle parker's preferences. It is based on knowledge about consumer-oriented supply of facilities, many cities' experiences, and an analysis of cyclists and their bicycle parking behaviour.

10.4.2 How does the DCQ-scan work?

Distance analysis

In principle, cyclists would like to park their bicycles as close to their destination as possible. There is a correlation between the length of time parked and the acceptable walking distance: cyclists are unlikely to walk five minutes to leave their bicycles for five minutes. This makes the following elements important:

- Locate short-term parking facilities near important destinations;
- Locate long-term parking facilities (guarded, covered) at a maximum 150–500 metres from important attractions (depending on the quality offered).

Cost-benefit analysis

Users look for the best quality at the lowest price:

- **Free:** greater walking distances, lower cost to cyclists;
- **Paid:** higher cost for qualities such as shorter distances, better protection from the weather, better service, more security.

Therefore, wherever possible, try to identify cyclists' wishes and try experiment with free parking for cyclists (as many Dutch local authorities do) or low-cost facilities.

Quality analysis

Quality requirements with regards to space, weather protection and security usually have to be adjusted to local restrictions. Among the choices:

- Outdoor racks versus guarded, indoor facilities;
- Covered versus open-air parking facilities;
- Guarded versus unguarded;
- Stand-alone parking service versus parking combined with bicycle-repair, rental and other services;

Figure 125
Up to twelve bicycles need fit in the space of one car.
Photo by Carlosfelipe Pardo

- One user group versus different user groups with different demands on quality;
- Functional quality versus aesthetic or urban quality.

In determining the right parking facility at the right place, the DCQ-scan can help find the best balance between needs and possibilities (demand and supply). The DCQ-scan helps evaluate potential use. If scores on elements such as distance, location, or quality are low (or there is an unsatisfactory price: quality ratio) then cyclists are unlikely to use the facility. Bicycle parking policy should be more than just implementation of infrastructure. The DCQ-scan can help go beyond this, and it is important to note that one should do a DCQ-scan for Every Point on the Cycle Trip Chain and Identify the Appropriate Facility.

DCQ-scan and problem locations

___ City centres
___ Shopping centres
___ Stations (metro/train) and bus stops
___ Residential areas
___ Working areas, company premises, buildings
___ Public buildings and areas
___ Schools
___ Special events
___ Tourist areas, pubs, restaurants, boulevards
___ …….

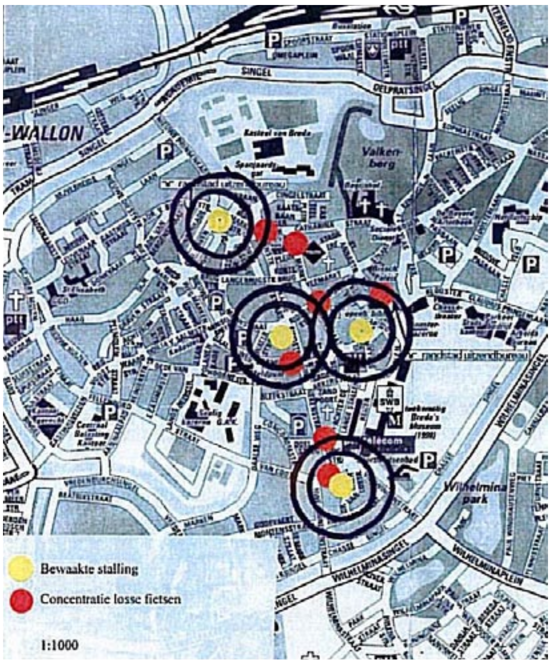


Figure 127
Illustration: example of a DCQ-scan applied to the city centre of Breda (NL). The orange dots identify concentrations of parked bicycles in streets. Yellow: suggested guarded cycle parking facilities to serve the area of influence (black circles).
Source: SOAB consultants

Cyclists have a lot of different destinations: city centres, shopping centres in the neighbourhood, transfer points such as metro or train stations, bus stops. They also have more utility-related destinations, such as employment areas, companies, public buildings, hospitals and schools. And they also attend special events, theatres, tourist areas, sports places, pubs, restaurants and boulevards. A lot of destinations are inside residential or downtown areas. All possible locations can be scanned with the DCQ-scan.

10.5 A bicycle parking plan: steps to success

10.5.1 The ideal bicycle parking plan

Creating an 'Ideal Bicycle Parking Plan' involves not only offering facilities, but also requires cooperation among planners, industrial designers, manufacturers and users, in an ongoing effort to improve the position of bicycle parking through the following steps. For each step, we offer suggestions about how to proceed.

Step 1: Start collecting data: get a clear focus on the problem

Take into account:

Quantitative demands:

- Gather facts and figures! Count (bicycles and racks, usage on different times of the day and week). Counts are usually reliable near centres and this information creates a solid baseline for monitoring;
- Check for general problems and make sure all possible problem fields or goals (modal shift, preferred locations and quality of facilities, public space and theft and vandalism: see Section 10.1.3) have been taken into account;
- Check for problems related to bicycle trip chain location (origin-route-destination);
- Check for problems related to user groups;
- Check guidelines (function-related and area-related);
- Observe.

Qualitative demands

- Opinions, experiences and wishes concerning types, diversity, locations, tariffs;

- Present and future demand: ask people, using questionnaires and, interviews;
- Include participatory processes to involve relevant stakeholders (companies, residents) and identify consumer-oriented solutions;
- Hold workshops with local traffic officers to determine priorities;
- Hit the road with politicians or staff responsible for traffic;
- Compare the data to the norms or standards:
  - recommended distances are based on Dutch norms and experiences and should be translated into local or regional standards for measurements, distances, and so on;
  - standards (*e.g.* for individual facilities or for use of facilities by more user groups) can help trace the problem and can provide a basis for estimating quantities that are needed;
- Allow an extra 20–30% in additional facilities, depending on ambitions and prognoses. If over 80% of parking spots are in use, cyclists will find it hard to find a free place.

Step 2: Spatial analysis

- Analyse functional-spatial aspects to choose a facility;
- Analyse the spatial possibilities of facilities;
- Investigate local possibilities;
- Investigate types of facilities;
- Contact bicycle-parking experts and local specialists (professionals and users in the area) and have them participate in the functional-spatial analysis;
- Meet with representatives of local interest groups, such as shopkeepers, cyclists and residents;
- Provide information;
- Use good examples as a basis from catalogues, design manuals from elsewhere, etc.
- Use tailor-made master plans as an example;
- Offer workshops, bicycle and bus tours to civil servants;
- Compare all of these with the results from counts and questionnaires.

Step 3: DCQ-scan in facility implementation plan

- Apply the DCQ-scan for each main point in the bicycle chain;
- Make a 'bill of requirements';
- Define where should there be guarded facilities (Maxi and Mega);
- If Megas: define which combination is thinkable (public restroom, bicycle repair shop, bicycle rental, etc.);
- Where Minis should go;
- Where Midis for employee bicycle parking (if there is a need);
- Develop an implementation plan;
- Define priorities for short-term and long-term implementation.

Step 4: Public participation and ongoing dialogue

- Provide for ongoing communication throughout the whole planning process, including diagnosis, evaluation and choice of alternatives, pilot programs, evaluation, readjustment, etc.;
- Communicate and invite input on targets and policy;
- Ensure quality communication within and between different levels of government, target groups and partners;
- Use a good organisational and participatory model;
- Involve relevant target groups (process!);
- Make somebody (or an organisation) responsible!!;
- Many parties are involved! Determine the most relevant;
- Who can contribute what to the solution? Consult as widely as possible;
- What is the best implementation strategy for the measures? Consult as widely as possible;
- Look for opportunities.

Step 5: Implementation

- Take care to provide for operational management of bicycle lockers, guarded storage and wherever else this is a key component, taking into consideration local possibilities;
- Arrange project management and control, taking into consideration the need for facility maintenance, possibly through local initiatives;
- Arrange project management and control.

Step 6: Evaluation and monitoring

- Reserve and plan activities to measure and report the effects;
- Organise monitoring of use of facilities;
- Evaluate satisfaction;

Figure 128
Bicycle parking plan for Zaanstad (NL)

- Be sure to incorporate the views of planners, politicians, pedestrians, wheel chair users, cyclists, store keepers, and others whose space may be affected.

10.5.2 Where possibilities are limited

When possibilities are limited, the best thing to do is to observe cyclists' parking behaviour and offer the best possible facilities at well-frequented locations. Providing paid vigilance (guards) may solve problems of theft and vandalism. Some cities in developing countries provide supervised bicycle parking as part of job creation initiatives associated with poverty reduction. Surveys, ongoing monitoring and consultations with user groups help to reduce risks and optimise results.

Figure 129
Engineers in Sao Paulo (Brazil) discuss the best location for a new bicycle parking facility.
Photo by GTZ SUTP

10.6 Bicycle parking policies as part of travel demand management

Taking bicycle parking seriously means introducing a bicycle parking policy both in response to demand from existing consumers and to stimulate bicycle use, offering quality facilities as identified by surveying and monitoring the bicycle parker! Providing bicycle parking facilities is an important yet insufficient measure for optimizing results.

As discussed elsewhere in this handbook, it is crucial to combine honey (or 'carrot' or 'pull') measures' with 'vinegar (or 'stick' or 'push') measures'. Carrots are meant to attract cyclists: bicycle lanes, more effective spatial planning, safe road crossings, differentiated bicycle park facilities closer to destinations, high quality of public transport (Bicycles-on-Buses and trams) and promotion activities. Sticks make car use less attractive: car-restraint zones in city centres, road pricing and paying for car parking in inner cities and residential areas.

Providing bicycle parking facilities is an important but not the only necessary measure for achieving real impact. Only a combination of push measures (discouraging car traffic) and pull measures (supporting bicycle traffic) will boost cycling. Bicycle parking should be a structural part of urban mobility management and master planning of urban and regional accessibility, for both local and regional authorities and for private organisations.

10.7 Key points

- Observe where people park their bicycles and offer facilities there;
- Discuss possible locations with employers, housing firms, companies and local businesses;
- Offer only good quality facilities. There's a lot of information available already: use it instead of trial and error or reinventing the wheel. Therefore locate short-term bicycle parking as close to destinations as possible (to offer convenience and to prevent theft and vandalism). Provide cover and lighting in bicycle parking areas and install bike racks that support the frame of the bicycle, not just the wheel. Offer good quality, but

simple facilities, that accept a variety of locks. Keep bicycle parking areas clean.
- Don't put up signs that say "No Bike Parking". If you must provide signage, place a sign indicating the location of bicycle parking and don't locate bicycle parking facilities close to pedestrian areas, wheel chair accesses or locations where they could be hazardous to pedestrians. Source: http://www.cycle-safe.com.
- Organise a local 'cycle parking facility show' for different types of cycle parking facilities and ensure they are tested by your residents, employees, and potential users.
- Work together!

10.8 Tips for cyclists using facilities

- Wherever possible, leave your bicycle in guarded parking facilities or lock your bicycle to racks or stands;
- Provide your bicycle with two locks: that's one more than the bicycle beside yours. A thief would think in the same way;
- Discuss possible locations for bicycle parking facilities with your local or regional government or with shop owners, employers, neighbours and so on.

Providing bicycle parking facilities is an important but not the only necessary measure for achieving real impact. Only a combination of push measures (discouraging car traffic) and pull measures (supporting bicycle traffic) will boost cycling.

10.9 Further reading

To take a look at cities with interesting cycle parking policies, see:

Toronto, http://www.toronto.ca/bug/bp_choosingrack.htm;

Vancouver, http://www.cityofvancouver.us/bike.asp?menuid=10466&submenuID=23027&itemID=23513;

Portland, http://www.portlandonline.com/TRANSPORTATION/index.cfm?c=34813&a=58409;

San Francisco (integrated into its rapid transit, BART, system) http://www.bart.gov/guide/bikes/bikeoverview.asp;

Western Australia, http://www.multiline.com.au/~bta/parkguid/parkguid.htm;

Queensland, http://www.transport.qld.gov.au/resources/file/eb56270c9373aac/pdf_c3_bicycle_parking_facilities.pdf;

Sydney, http://www.cityofsydney.nsw.gov.au/AboutSydney/ParkingAndTransport/Cycling/CycleFriendlyWorkPlaces.asp;

Japan (Australian-made YouTube film), http://www.gizmodo.com.au/2008/04/japanese_multi-level_bicycle_parking-2.html;

Germany (example of a cycle-rack producer), http://www.igvelo.ch/agm2007/Dokumente/Double-deck%20bicycle-parker.pdf;

Bicycle Parking Guidelines, http://www.cycle-safe.com;

CROW, Publication 158 Leidraad fietsparkeren;

CROW, Publication 98;

FietsParKeur, visit http://www.FietsParKeur.nl;

I-CE, Cycle Manual Dublin;

SOAB consultants, Outline Assessment of Bicycle Rental Systems (January 2006). http://www.optimum2.org/measures/bicycle schemes/outline;

SOAB consultants, Several Cycle Parking Studies (Amsterdam, Utrecht, Enschede, etc.).

11. Building a multi-modal transport system: integrating cycling and public transportation

Carlosfelipe Pardo and Lake Sagaris

For related subjects

See ***Chapter 4***, on How to organize the policy making process.

See ***Chapter 10*** on bicycle parking,

See ***Chapter 13*** on Education, advocacy and citizens' participation.

See ***Chapter 11*** on Regulations.

Chapter summary

This chapter discusses different ways of integrating bicycles into public transport, outlining the benefits and describing the different types of integration that are possible in an urban setting. We also briefly discuss financial aspects. The types of integration described include those that directly involve transport operators with bicycles, but also other initiatives that improve connectivity with public transport by enhancing its accessibility. The main message here is that integrating bicycles and public transport is a crucial (but sometimes neglected or underestimated) component of a comprehensive, efficient and sustainable transport system.

Integrating cycling into the system makes for better distribution of passengers across the different transport modes.

11.1 Introduction

Successful integration of cycling and public transport requires a well-planned bicycle network that complements the public transport system, to ensure that bicycle users can safely and comfortably travel to public transport access points.

A combination of walking (short distances), cycling (intermediate distances) and public transport (longer distances) is the most sustainable transport option in urban, economic and environmental terms. Each complements the other in terms of strengths and weaknesses. Like driving your own car, cycling offers door-to-door service. It has high 'penetration ability' (that is, it provides access to almost every individual address), can be used at any time, and is fast and efficient on short distances. Its radius of action, however, is rather limited: cycling is less suitable for long distance travelling.

Public transport, on the other hand, is very strong in transporting large numbers of people over longer distances. Its penetration ability, however, is limited, and people have to adapt their travel patterns to a timetable. Especially for short distances, public transport door-to-door travel times are relatively long. This inefficiency on short distances reflects the fact that public transport rides require trips to and from the public transport stop to the origin and destination addresses.

Taken individually, cycling and public transport are poor replacements for the travel possibilities offered by the private car. When treated as an intermodal transport system, however, the intelligent combination of both offers complete mobility options to individuals and a really attractive alternative to private car use for daily commutes, not only in term of costs, but also time.

Moreover, a truly successful public transportation system integrates all transport modes and makes the most of their complementary characteristics. This incorporates other modes, such as cars, taxis, bicycle taxis, pedestrians and, obviously, bicycles and pedestrians.

11.1.1 Door-to-door travel: a "chain of trips"

Virtually all trips can be analysed as a "chain of trips". The simplest chain has three links: a walking trip to a vehicle, a vehicle ride (finding a parking place if the vehicle is a private car) and a walking trip to one's final destination. The concept 'chain of trips' is of utmost importance when thinking about public transport. All public transport users have to travel from their origin to the public transport stop, and at the end of the trip from the public transport stop to their destination. This means that "access" and "egress" trips are an inevitable part of public transport travel. These "feed" the public transport system, and are referred to as feeder trips. Given its complementary characteristics, cycling is an excellent feeder mode.

An integrated transport system should allow users to ride their bicycles from their home to the nearest public transport station, then take public transport to their final destination (by leaving their bicycle at the station or taking it with them on the public transport vehicle). When well implemented, travel times become similar to or better than those of a private car, especially in big cities with congestion and less provision for parked cars, above all when public transport enjoys segregated express routes (*e.g.* in bus rapid transit, BRT, or rail systems), and can therefore travel congestion-free.

Cycling's advantage over walking is that it increases the catchment area, that is, the area served by a particular public transport access point. It does this, because people can cover longer distances as part of the first stage of their trip. A transport policy that includes as wide a range of multimodal (or intermodal) trips as possible can increase public transport ridership, while increasing access for all transport users. It also improves the likelihood of people using the most efficient transport modes for each trip. Further, this integration also encourages people to use public transport for recreational purposes to travel to the city outskirts, for example, during off-peak hours. Finally, the combination of bicycle and public transport is in many cases faster and much cheaper than taking a car to work (due to traffic jams, time to find a parking space, paying for it, etc.). Companies that encourage bicycling-public transport use for employee commutes have been quite successful. And they save money, because fewer parking spaces are needed for cars.

Key initiatives to improve cycling-public transport integration include:

- Providing better bicycle route connections to (main) public transport stops;
- Offering smooth, safe transfers between bicycles and public transport, and/or including parking facilities for bicycles at public transport stations;
- Making bicycles available for egress trips, through bike rentals or public bicycle services;
- Integrating bicycle taxis as a feeder service.

An alternative is to actually improve public transport operations by adding bicycles: one proposal developed in the Netherlands was to create a bus service that did not use all stops, while others were upgraded and bicycle parking was included. As a result of the service having fewer stops, more passengers would come by bicycle to the remaining bus stops and the total travel time, from door to door, decreased.

Figure 130

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.

Diagram by Tom Godefrooij

Specific measures in terms of infrastructure and operations must be developed to achieve multimodality. While this chapter focuses on measures to integrate cycling into public transport, these are often applicable to other transport modes, such as cars and taxis, with initiatives such as "park and ride" stations (where automobile users park their cars in the terminal stations and take public transport) and parking spaces for taxis in specific stations (where there is a low-density network of public transport). The lack of such measures can result in informally established taxi-stations or similar problems.

Integration does not always mean bringing more people into the public transport system. It can also mean a better distribution of users and more efficient use of infrastructure. In the case of experiences such as that of TranSantiago, in

Figure 131

Bicycles are complementary to public transport.

Photo by smchevrettte

Figure 132
An informal location where taxi drivers stop to take public transport passengers.
Photo by Carlosfelipe Pardo

Santiago (Chile), where buses and the metro have such high level of crowding, integrating cycling can help ease the pressure on the system or supplement service where on-the-ground facilities are weak.

The key point here is that integrating cycling into the system makes for better distribution of passengers across the different transport modes, optimizing bus, car, cycling, walking, road infrastructure and other transport- and traffic-related systems and investment. This is a more productive point of view than perceiving cycling as just a feeder to a public transport system.

11.1.2 Cycling — public transport integration today

In developing countries, urban transport policies have started to shift their focus away from automobile traffic and over to public transport, and in some cases non-motorized transport. This is the trend in cities such as Bogotá, Jakarta and elsewhere, in every continent. However, there is still some confusion as to the importance of integrating these two modes.

Some of the problems that arise from neglecting or underestimating cycling's usefulness within a public (and urban) transport agenda include the creation of parallel networks of bikeways and public transport, which miss opportunities to interconnect, by parking a bicycle at a bus station, for example, or riding the bus with a bicycle. Another, problem occurs when bicycle users share public transport trunk lines without clear regulations related to such practice, thus reducing road safety for both modes. This reflects poor traffic management and road design, and lack of an "integration" policy of these modes. Paris, London and other cities have successfully promoted the shared use of bus lanes, through clarity as to such use. Elsewhere, rules are not clear and cities have been less successful in applying this policy.

Some concerns raised by public transport operators with regard to integration include their perception that bicycles may compete with public transport for users, or involve

Figures 133 and 134
A bicycle user rides along a segregated bus/PT/NMT lane in Paris and London.
Photos by Carlosfelipe Pardo and Hans de Jong

Box 23: Forces driving modal integration

Urban and social planning considerations

Local, regional and national authorities have sought to better integrate bike-bus-subway-train systems for multiple reasons. Integration may form part of:

- **"Active" transport policies**, to counteract obesity-related illnesses and reduce the burden on health programs;
- **Energy efficiency** programs, to reduce dependency on fossil fuels;
- **Air quality** programs, to reduce the emissions associated with cars' holding large modal shares;
- Programs to reduce emissions that contribute to **global warming**;
- Improvements to **quality of life, social equity, and public spaces**;
- Responses to **demands from cyclists**;
- Concerted efforts to **retain or expand transit's modal share**.

In countries with ageing populations, planners are increasingly taking a life-cycle approach to public transport, seeking ways to integrate the widely varying needs of children, women, families, daily commuters, the differently abled, the elderly, and so on. Often, meeting the needs of one group enhances conditions for others. This approach can create cities that are more competitive globally, because more people want to live there.

Public transport-related considerations

Transit agencies have their own reasons for trying bike-transit integration, among them:

- Bicycling extends the catchment area for transit services and provides greater mobility to customers at the beginning and end of their transit trips. "Bike-on-bus programs can attract new riders to the bus system, thereby boosting revenues."[1)]
- Bicycle-on-transit services give cyclists backup when it gets too dark, weather changes, illness strikes, a major highway or hill blocks daily commutes, bringing them onto transit.
- Bicycle and transit integration usually forms part of plans to decrease automobile traffic congestion, reduce air pollution (by reducing motor vehicle trips), and improve the public image of transit. It is particularly effective for reducing air pollution, since the worst pollution occurs during the first 11 km driven, when the motor is just warming up.
- It offers more commute options for workers, giving firms more flexibility on where to locate.
- These benefits help communities reduce their reliance on single-occupant vehicle travel and make their transportation systems work more efficiently.[2)] Although some policymakers mistakenly assume that bikes compete with public transport, evidence points to well-planned bike-transit integration improving public approval, while studies from Vancouver, Toronto and the US suggest they can also convince some car users to switch.

In the Netherlands, about 40% of all train passengers arrive by bicycle at the railway station. Approximately 10% of all passengers are also using the bicycle from the egress trip to their final destination.

A survey by Denver Regional Transit District, for example, found that of the 2,300 daily bike-on bus users, half had not used transit previously; 27% said they would have been driving alone without bike access.[3)] A Vancouver study found that 30% of bike locker users had never used public transport before. A 1999 Toronto found that almost half (48%) of recreational cyclists said that distance was the main reason they did not bike to work, with 84% saying that if parking were available they would use transit.[4)]

A Return on Investment Study of Bikes-on-Bus (BOB) programs found that one of four BOB users was new to transit, and over 80% of these reported that they switched, because they could access transit by bicycle. About 72% used BOB to commute to work, 83% of these four or more days per week. Eighty percent travelled less than 1.6 km after getting off the bus.[5)]

1 RBA Group. "Long Island Non-Motorized Transportation Study Bike on Bus Final Report," prepared for the New York State Department of Transportation and the New York Metropolitan Transportation Council, July 2004, p. 17.

2 TCRP, 2005, p. 1.

3 http://www.echosvelo.net/article.php3?id_article=545, 17 August 2003.

4 http://biketoronto.ca/topic/show/430.htm (August 2005).

5 Hagelen, p. 43. This study even suggested handing out BOB information to drivers whose licenses are suspended, providing a package that includes bus schedules, a one-month bus pass, or even a bicycle and helmet. "Bicycles that are abandoned on racks and unclaimed could provide a good source of bicycles for such a program. Hagelin (2005), p. xiv.

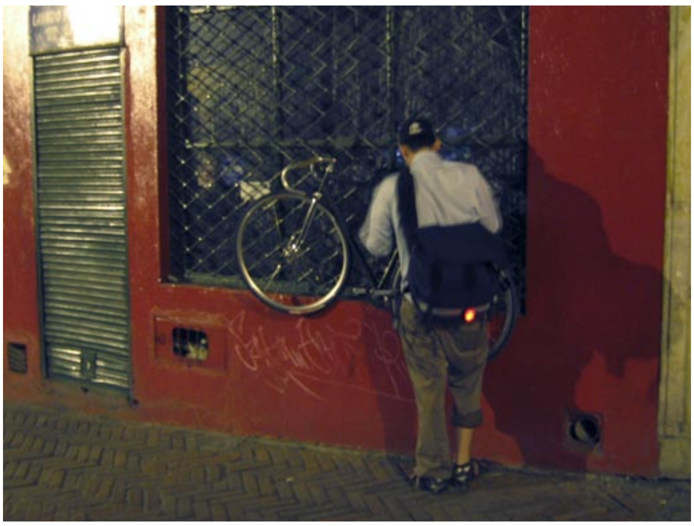
Figures 135 and 136
Bogotá: free bicycle parking station inside a TransMilenio terminal station (left) and an informally integrated bicycle on bus system (right).
Photos by Carlosfelipe Pardo

delays in service, operating speed, reliability, safety, security, maintainability. Although there is some competition in certain distance categories, bicycles have different optimal trip lengths than public transport. Including options for integrating both modes can clearly increase ridership of public transport, while improving conditions for people using bicycles. Thus, the general public's needs are best met through an "integrated" approach.

Studies by the Transport Research Board (US) and elsewhere have found that making bicycles welcome on trains and bicycles-on-bus programs has become popular and well evaluated in the United States and Canada. In fact, one in five transit agencies in North America now have these systems and are steadily expanding the percentage of their bus fleet with the racks for carrying bikes. Initial concerns about safety, turning ratios, and so on were quickly allayed by practical experience. In Europe, where most regional public transport systems are train- rather than bus-based, these allow or promote cycling and public transport integration, sometimes at no additional cost.

Depending on the city, integration may be planned (for example, most of Bogotá's TransMilenio terminals provide bike parking at no cost to users), or emerge spontaneously (as is seen in various cases of intermodal transport), because public transport users have discovered the practicality of combining bicycle and public transport. In cases where the bicycle is used "spontaneously" in combination with public transport, users may have to pay a higher fare, because they use more space inside the vehicle. In TransMilenio's case, bicycle users can leave their bicycles in a roofed and guarded bicycle parking facility at no additional cost. However, they must pay for their ticket upon

Figures 137 and 138
Examples of informally parked bicycles in Frankfurt and Bogotá.
Photos by Carlosfelipe Pardo



entering the bike parking station. The sections below address the different options to integrate bicycles and public transport and provides recommendations as to their advantages and disadvantages.

In some cases where no bicycle parking exists but there is substantial bicycle use, cyclists may simply lock their bicycles to any available post or surface. In these cases, it is easier to promote bicycle parking for public transport, thereby reducing the risk of theft. Thus, the optimum response to "bicycle overparking" outside public transport stations is not banning bicycle parking, but rather installing proper infrastructure or developing strategies to promote the use of intermodal trips with bicycles and regulating their use.

11.1.3 The benefits of integration (bicycles-public transport)

The benefits of modal integration include:

- Door-to-door service, competitive with or even better than that offered by private vehicles, particularly where there is a rapid train or segregated bus service (BRT);
- Greater access for users, who can travel farther at the same cost;
- Increased ridership for public transport: when cycling is integrated into a public transport system, catchment areas of the system is greatly increased due to the greater distances travelled by cyclists. For example, a typical catchment area of a public transport system will be defined by the travel time for feeder trips, which in most of the cases will not exceed 15 minutes. As cycling is three to four times faster than walking, the catchments area can increase 9 to 16 times by introducing cycling as a feeder mode (the increase of the radius squared: πr^2.). This will result in greater income for public transport operators as well when the system is properly planned and adapted to cycling integration;
- Better distribution of commuters across the different modes — where roads, buses and subway systems are overwhelmed, transferring users to bicycles for shorter journeys can help relieve extreme pressure; where public transport systems are under-utilised, enlarging the catchment area can also increase ridership;
- The bicycle becomes a low-cost feeder system for public transport: some mass transit systems may have feeder routes that are included in the normal fare of the system. That is, users who have paid their ticket end their trip on a feeder service out of a terminal. This normally entails significant operating costs. When cycling is integrated into public transport planning, bike parking is included and bicycle use is promoted, operating costs fall, reflecting the fixed costs of security and the initial investment in parking facilities. Both feeder routes and cycling integration should become an integral part of the system (for example, by reducing frequencies along bus feeder routes). In the Netherlands, for example, about 40% of all train passengers bike to the railway station, and in rush hours this percentage is even higher. This has saved a lot of money on peak bus services, which would otherwise have been very costly.

11.2 Types of integration

Integration can take many forms. Some require leadership from public transport operators themselves, while others involve current or potential stakeholders. To organise the different options of integration, the Figure 139 will be used as a guide.

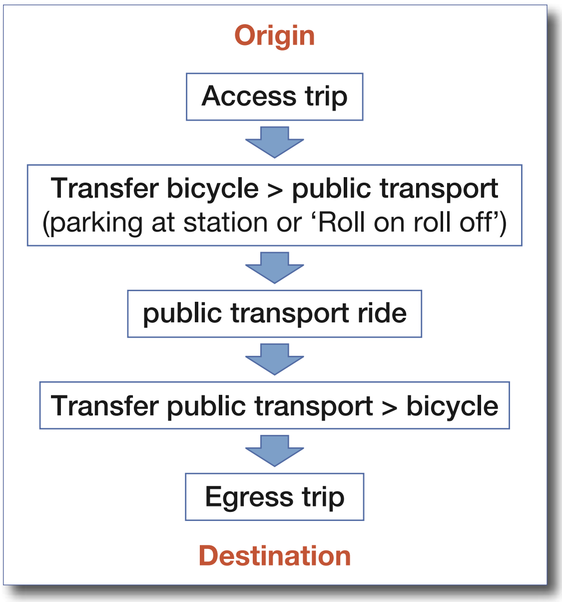


Figure 139

The main components of a trip chain when discussing bicycle and public transport integration.

Concept by Tom Godefrooij

Based on the stages shown above, the following different options of implementation must be taken into account:

For the access trip: In order to allow a safe ride to a public transport system, the network must be optimised, as discussed throughout this handbook. This essentially involves making access to transfer modes easier for those using bicycles. This is briefly described in Section 11.2.1.

For the transfer bicycle > public transport: In this transfer, the following components are useful:

- Bike parking: the provision of bicycle parking facilities near or in public transport stations (Section 11.2.2);
- Bike stations: enhanced bicycle facilities in key locations with various services, used as a multi-modal transfer station (Section 11.2.3).

During the public transport ride: In some cases, bicycle users will be allowed to take their bicycles during the trip on the public transport vehicle. Options include:

- Bikes on buses (within and between cities): provision of bicycle racks on buses, where public transport relies mostly on bus-based systems (Section 11.2.4);

Figure 140
A bicycle user leaving this bicycle parking facility can ride to his final destination safely, since there is an extensive bicycle route network that he can join as soon as he walks out the door of this facility.
Photo by Carlosfelipe Pardo

- Bikes on rail systems (within and between cities): provision of space and permission to enter rail vehicles in specific times and locations, for large cities with rail based systems (Section 11.2.5).

Transferring to and from Public Transport (Access/Egress): Bicycles should be provided to serve people whose point of origin or final destination is too far from the public transport station for them to complete their trip on foot. In some cities, users keep a second bicycle parked at the egress station, but this is not normally the case, particularly in developing cities. Three services to meet this need include:

- Rental bicycles: bicycles which are managed by a specific company and are rented and returned to the same location, mostly for touristic purposes;
- Public bicycles: More or less similar to rental bicycles, but organised on a larger scale, as a public service. This is an innovative approach that has rapidly gained popularity in recent years (see Section 11.2.6);
- Bicycle taxis: three-wheeled human-powered vehicles that operate as feeders to public transport (see Section 11.2.7).

Public bicycles and bicycle taxis also serve for access trips to public transport stations. Clearly, as discussed in the previous chapter, bicycle parking at public transport access points is crucial.

Throughout Access and Egress Trips: Being able to get to and from bus stops and transfer stations is vital, of course, so the kinds of network optimisation, discussed in the rest of this handbook are very important, with a clear focus on the routes between main public transport stops and important destinations (see Section 11.2.1).

Finally, it must be note that, as this is a chain of trips, one must remember that "a chain is as strong as its weakest link." The next sections provide more detailed descriptions of how these ideas have been applied in specific cities in the developed and developing world.

11.2.1 Access via bike routes to transfer nodes

One component that is often forgotten when developing bicycle-public transport integration is the provision of bicycle routes and ramps that provide easy access to public transport stations or other transfer nodes. Without these facilities, integration will be hard to achieve. In turn, bicycle route and facility planning should always consider its potential integration and closeness to public transport as a success factor. Special intersections, access ramps or other facilities are often key to providing safe, attractive and comfortable links between public transport and road infrastructure.

This handbook provides a full discussion of bicycle route planning and design in its many chapters. In this section we will focus on effective measures to deal with these issues as they relate to connectivity, specifically connecting origin (= living) and destination (= work places, schools, shops) areas with public transport stops.

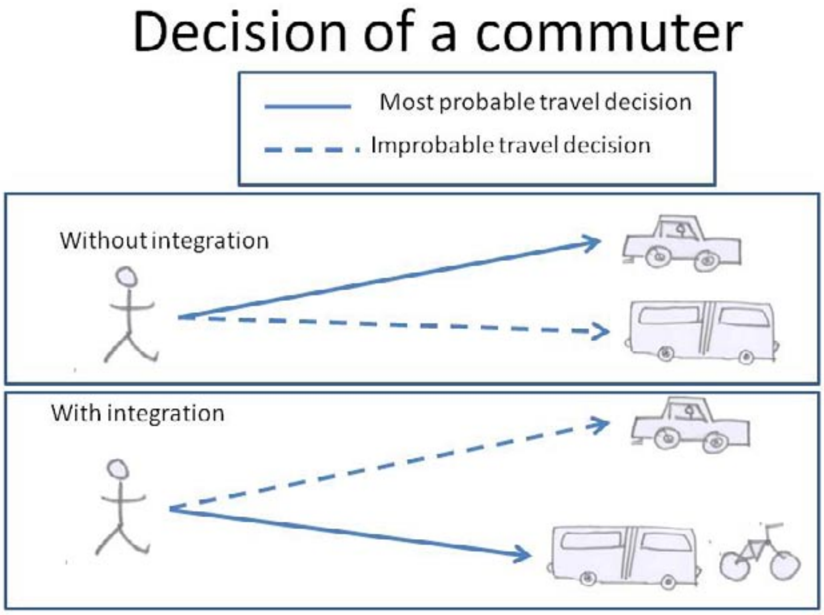


Figure 141
Travel decisions of a commuter depending on integration.
Drawing by Carlosfelipe Pardo

11.2.2 Bicycle parking facilities

Proper bicycle parking facilities are key to any proposal for modal integration. Chapter 10 provides more details on the design and typology of bicycle parking facilities, while this chapter looks more closely at their benefits and role with regard to integration within public transport.

This ***option is recommended*** when origins (or destinations) are located at relatively long distances from bus or train access stations (*e.g.* 3–5 km), when bicycles cannot fit into vehicles, or when topography or other urban features create barriers and bottlenecks to cycling in specific parts of the city. Facilities of this nature have been created to help cyclists cross San Francisco's main bridges, for example, to climb steep hills in Toronto, or to provide alternatives in the event of sudden illness or bad weather.

Quality, secure bicycle parking encourages people to cycle to transit stops and stations and thus complete their trip on public transport. Sometimes, especially during low-peak periods, carrying the bicycle inside the public transport bus or train may be a good option. Often though, especially during peak periods, this may result in chaos for all users due to overcrowding. Measures such as parking and external racks, combined with the bike-taxis, rentals and public bike systems described above, offer relately inexpensive and highly efficient solutions. In many cities, parking in stations is strongly encouraged and provides a long-term solution for a city with a high percentage of bicycle use. Where security is adequate, many users with a secure parking option will keep a bike at each end of their daily commute.

In Houten (see Figure 142), 90% of all train passengers ride their bicycle to the railway station. This high percentage is due to the extremely well developed cycling infrastructure there. People in Houten use public transport facilities more than in other similar Dutch cities.

Concerns about personal safety (particularly for women, the elderly, children) and theft are particularly strong when bike parking is

Figure 142
Lockers and bike parking infrastructure in Houten, The Netherlands.
Photo by Carlosfelipe Pardo

combined with modal integration, since bicycles are typically parked for six to eight hours or longer, every day, in the same place. Sufficient lighting is important to prevent scary urban places rife with perceived or real hazards that are particularly discouraging to women. Being able to see is also essential to unlock bikes and navigate safely.

People will only leave their bicycles at train, subway or bus stations when they are sure that nothing will happen to them during the day. Sometimes this means they will be willing to pay a fee for greater security, or that the public transport operator must provide security as part of the service. The latter is preferable since, inevitably, fees become barriers and given a choice, fewer people will use this option if there is an additional cost involved. Many prefer to travel their whole route by bicycle rather than pay a fare plus parking costs.

Providing secure bicycle parking for free can still be a good investment, thanks to the greater ridership gained by integration, and /or the possibility of distributing journeys more evenly throughout the system, thereby relieving pressure on overloaded segments and adding more passengers on under-used stretches.

The Bus Rapid Transit (BRT) system, TransMilenio, in Bogotá, offers an interesting case study of bicycle parking. When the system was originally planned, bicycle integration was actually seen as a separate system from the BRT and was therefore not included. However, by the time the Avenida Americas terminal was built, cycling integration was clearly on the agenda. A covered, guarded, 800-space bicycle parking facility was built at the terminal and bicycle users can now leave their bicycle at no additional cost. This boosted ridership by 4%. To date, no bicycle has been stolen. This has also reduced the need for feeder buses to the terminal.

Figure 143

Commuters' entrance to an 800-bike capacity parking facility in the Americas Terminal, Bogotá.

Photo by Carlosfelipe Pardo

Box 24: Australia: A national policy to encourage bike parking in major cities

Australia has taken another approach, studying bike-bus interactions on the road network in depth, examining safety, health, user behaviour and other issues. One result was the national Cycle Connect program, run by its Department of the Environment and Heritage, which encourages the installation of bicycle lockers and cages.

The original two-year grant initiative offered Aus$1.2 million in 2004–2005 and the same amount in 2005–2006. It required matching or in-kind contributions comprising sites, concrete plinths, access ramps, supplementary active transport infrastructure and ongoing administration.

Cycle Connect focused on improving bike facilities in major cities, providing more protection from bad weather and theft. It required participation from local bike user groups (BUGs) and careful positioning of lockers or parking facilities. Lockers should be outfitted with "quality pick-proof locks" or electronic systems and allow storage of helmets and other cycling gear. "Most lockers have a door at the wider end of a tapered box and the bicycle is wheeled in backwards. Others are tall and the bicycle is hooked by the front wheel and hangs inside or is held on a curved ramp. The most common design is back-to-back lockers that form rectangular boxes that can be set in rows and occasionally stacked as a two-tier arrangement." (Cycle Connect, http://www.nt.gov.au/transport/ntroads/cycling/cycleconnect.shtml.)

Cages may also be used, typically at no extra or very limited costs, "since an objective of this initiative is to substitute cycling for short car trips." ***Lockers are often portable***, so they can be moved around according to demand.

Bicycle parking in TransMilenio was then replicated in most terminal stations, increasing ridership overall. It has not yet been included in intermediate stations, however, although there are plans in this regard.

11.2.3 Bike stations

A broader arrangement, often referred to under the "new mobility" label, because of its sweeping possibilities and integrative effects, are bicycle or intermodal stations. At the very least, these are systems where bicycle parking includes a multi-service approach, often combined with a multi-modal transfer point that can include not only public transit, but public cars (rentals or carshare systems, such as that of Bremen in Germany). The bike station, which may be a concession, publicly operated or run by pro-cycling civil society groups, offers additional services, such as repairs, rentals, showers, sales of accessories, maps, guided tours, and so on. This approach may help to offset bicycle parking costs (security, maintenance and even minor repairs).

Figure 144

A recently reinaugurated bicycle station in Maua, Sao Paulo, Brazil, where users not only have guarded bicycle parking but also workshop, bathrooms, water and even legal advice.

Photo by Carlosfelipe Pardo

11.2.4 Bicycles on Buses (BOB)

Most inter-city bus companies allow bikes to be carried in their luggage compartments, although some require payment of an additional fee. For bus-based urban public transport systems, bicycles may be allowed inside the bus at non-peak times. This is a partial solution, however, that often leaves more dissatisfaction that contentment among commuters.

Increasingly, front-mounted bike racks have become the solution of choice in the United States and Canada, where bikes are often allowed on buses during non-peak periods. Rack-based service is seen as an important complement. Initial concerns about turning ratios, potential hazards, accidents and delays have been allayed by experience.

Bike-on-bus systems work well in cities where bicycle mode share (and integration to public transport) is relatively low, and thus regular service by buses carrying the standard two-bike rack is sufficient. Increasingly, the issue of rising demand is being dealt with successfully by expanding bike racks to all buses within specific transport systems, and some cities are even experimenting with larger racks for carrying three or more bicycles.

Figure 145

A bike on bus system, in United States, uses a bicycle rack in front of the bus.

Photo by Richard Masoner http://www.cyclelicio.us

11.2.5 Bikes on rail systems (Integration inside vehicles)

One form of integration, very popular in Europe given its intensive network of trains, is to allow bicycles on surface or underground trains. Despite initial concerns, in practice this has proven relatively easy to resolve through sound planning. It must be noted however, that the market for this service (bicycles on trains) is mainly recreational: when cyclists want to make longer cycle tours in other areas. The German railways discovered that this recreational market was very profitable for them as it attracted a new category of clients. However, the relevance of this service for daily commuters is limited as commuter trains are often too crowded during peak hours to take many bicycles. The only exception is the carrying of folding bicycles, typically a niche market.

When implementing this option, it must also be ensured that the actual "trip" from the station entrance to the actual platform is adapted for bicycles. Mainly this refers to special ramps provided for bicycles on staircases and an adequate option in the platform to access the vehicle (at level boarding). Below are some measures that have also proven effective:

- Special bicycle cars: One option for including bicycles on surface or underground train systems is to include a specific wagon for them, which is a typical German solution for the recreational market. A vehicle offering this option may have specific frequencies (*e.g.* every 30 minutes) and stop at

Box 25: How Toronto got a bike-on-buses (bob) program up and running

Toronto provides an excellent example of how a pilot program can be implemented relatively quickly. Its metropolitan transit authority, the Toronto Transit Commission, was just completing the first year of ***a pilot bike-on-bus program*** in March 2006. Bikes have been allowed on Toronto's extensive subway network during non-peak periods since it was built in the 1960's. However, demand from cyclists has grown.

The Toronto Transit Commission is headed by and includes elected city councillors, including some bike enthusiasts. When it decided to go for a bike-on-bus program, TTC authorities ***looked to other transit systems*** in the US and in Ontario for examples of how to go about it. A ***Project Initiation Meeting*** brought together all internal TTC stakeholders. Project manager Tim Lawson considers this was crucial to the pilot program's success. It addressed internal issues, particularly concerns about additional work time, delays, safety, loading, disputes with customers.

Meetings were also held with city staff, particularly those involved in ***promoting bike use***, and the transportation engineering department. In conjunction with the purchasing department, the project team ***studied two rack providers***, Sportworks, which supplies some 75% of bike-on-bus racks in the US, and BykRak, recommended by Chicago. The TTC tested both racks on buses and both firms bid to supply the pilot program. The 110 stainless steel racks, initially quoted at CAD$1,200 each, ultimately cost $450 apiece. Delivery of the first racks took four to six weeks.

Operating rules were defined and promotional materials developed to reflect them. Installation, with no specific budget for staff time, took longer, but the first bus was ready for Bike Week in June 2007 and all buses were functioning by late June, to applause in the media.

The ***criteria involved in choosing routes*** included length, high frequency bus service, speed (had to be competitive with cycling), crossing barriers such as the 401 highway and a major hill, and routes providing connections with bike paths on the waterfront or in other areas. One limitation was the requirement that all buses work out of a single one of the city's six garages and that the buses chosen be either low-floor or lift-equipped. Two routes (14 km and 12 km) running north-south were chosen. During the first year of the program, 30,000 brochures were distributed and website information includes user surveys and a brief video illustrating how to use the racks. Operator ***training typically took 60–90 minutes*** and was completed within a month.

Cyclists are asked to ***remain at the front of the bus*** and keep an eye on their bike, both to avoid theft and to avoid their forgetting their bike, which has been a problem. The ***cost of the initial program was CAD$155,000***, with about one-third of this going to the racks, one-half to training operators, and the rest to installation and marketing. Consideration of the program began in November 2004, it was approved in April 2005 and up and running by late June, to take advantage of summer weather. Tim Lawson, the project director, recommends getting most of the groundwork (such as rack testing and bidding) done early, so the program can move ahead quickly once approved. It is also important to choose new buses that will not be rotating out of the system, since switching racks from one bus to another requires time and resources. Also vital is including racks on every bus on the pilot route, so they are freely available to users.

For an excellent ***information film*** and ***example of BOB implementation*** and a great example of citizen-government cooperation, see the ***San Francisco Bicycle Coalition's*** website, http://www.sfbike.org/?transit.

Figure 146
Bicycles inside vehicles are an option where space is available, usually during off-peak periods.
Photo by Frank Roche

Figure 147
Exclusive train car for bicycles.
Photo by Richard Masoner, http://www.cyclelicio.us

every station en route, or be "seatless". In some cases, these vehicles may have built-in racks for vertical placement of bicycles. This option is also recommended where most bicycles are large (26 or 28-inch wheels). Another option is to provide a special section within each bus or wagon (for example, at the front or rear) adapted for bicycles (that is, with no seats or with racks). This makes entering and leaving the vehicle faster, since bicycle users are spread among all vehicles rather than concentrated in a specific car.

- Dedicated space inside ordinary cars or in baggage compartments: It is also feasible to allow bicycles in the corner of each car, as occurs with Denver Light Rail, on Dutch intercity trains, or in specific cars as occurs on Amtrak in the US (baggage compartment) and other systems around the world. These efforts often require no special cars, relying on signage and web information to manage this kind of traffic. For a handy summary of policies on British trains, for example, see http://www.atob.org.uk/Bike_Rail.html. Some systems charge a small additional fee, while others do not. The choice of using a fee or not is difficult in developing countries where many users are of low income. However, when there is a high integration of bicycles and public transport, it may be feasible to charge an additional fee for the service as it may be used for maintenance, system optimisation or other costs.
- Time restrictions: Many systems worldwide allow bikes on trains (and sometimes buses)

Figure 148
Train car for bicycles.
Photo by Joao Guillerme

Figure 149
The minimal space required by a folding bicycle inside a public transport vehicle.
Photo by anabananasplit

during non-peak hours, limiting integration during peak periods when it could potentially be most useful.

- Folding bicycles: Folding bicycles, which can be carried onto vehicles and stored against a wall or under seats, are another option, although they are not available everywhere, and can be prohibitively expensive for some users.

When the main public transport mode is bus-based and there is no special vehicle (or space inside a vehicle) for bicycles, there may be problems with allowing bicycles inside the vehicle. In this case, transit systems in Canada and the United States have had successful experiences with bicycles on buses (BOB) programs as described above.

11.2.6 Public bicycles

Another option that has contributed substantially to bike-transit integration in cities such as Paris, Barcelona and elsewhere, is a public bicycle system. This is especially useful when people have short trips that would otherwise be taken in another mode of transport, or when distances to public transport stations are longer than walkable. These systems of free or rented bicycles also increase bicycle ridership and access. Logistical arrangements differ according to context.

In many cases, bicycle rental stations are located at public transport stations. These systems have been developed in cities in the Netherlands, Germany, Spain and more recently as Velov in Lyon and Velib in Paris. In 2007, Paris introduced 15,000 Velib bicycles distributed at 1,200 stations within the city ring road where three million people live. As of November 2007, more than 11 million trips had been made on these bikes. This system has been managed by an advertising company which has provided the vehicles, operation and maintenance. In Frankfurt, the public transport authority manages a similar system. Plenty of information is now available on these systems, particularly the Paris Velib (see http://www.velib.paris.fr).

Figure 150

Implemented since 2007, the Paris public bicycle system "Velib" has been a great success, earning the city the Sustainable Transport Award for 2008.

Photo by Carlosfelipe Pardo

Figure 151

The Frankfurt public bicycle scheme is managed by the public transport operator Die Bahn.

Photo by Carlosfelipe Pardo

Figure 152

Beijing has developed a low- cost public bicycle scheme as well.

Photo by Carlosfelipe Pardo

Figure 153
A trial public bicycle scheme in Barcelona in 2003, later transformed into the current "Bicing" initiative.
Photo by Carlosfelipe Pardo

There are many approaches to public bicycles, ranging from very simple to complex systems, which include GPS tracking and unlocking systems via SMS and subscription services on the Internet (for a lively informative blog on what is happening around the world, please see http://bike-sharing.blogspot.com), However, simpler systems are also feasible and less expensive, making them a good choice for developing cities. In 2008, Montreal (Canada), the Providencia municipality of Santiago (Chile) and Buenos Aires (Argentina) began to adapt experience abroad, particularly in Barcelona and Paris, to their needs as Latin America cities. Keys to success include:

- Bicycle location: Bicycles are most needed in specific locations (*e.g.* near the city trip origins) during morning rush hours and will be left elsewhere by day's end. Moving them back to where they are needed requires careful, systemic planning, based on suitable studies.
- Tracking systems and storage: When funding is available, these systems should have a proper tracking system (for example, a Global Positioning System or GPS) so the operator can pick them up at night and place them in strategic locations around the city (or take them in for servicing). This can also enhance customer service (for example, an operator can use an SMS message to cell phones to report on the nearest location for available bicycles). If this kind of system is not available, bicycles should be stored in strategic locations, and users must return them to the same point, once they've finished using them.
- Users and locking/unlocking rental bicycles: Bicycle rental systems may have a user-registration system, requiring that users register (and possibly pay a fee). If the investment is sufficient, users can "unlock" bicycles assigned to them using a code sent to them by SMS.
- Bicycle design: The risk of theft can be reduced by giving the bicycles a distinctive design and applying a specific security system (such as a GPS-tracking device or other). Accessories and parts can be

Figure 154
Locking system of Paris's Velib.
Photo by Carlosfelipe Pardo

Figure 155
Design details of Paris's Velib.
Photo by Carlosfelipe Pardo

Figures 156, 157, and 158
Some traditional bicycle rickshaws in India and Thailand.
Photos by Carlosfelipe Pardo

Figure 159
A modernised bicycle rickshaw (becak) in Indonesia, developed by ITDP.
Photo courtesy of Shreya Gadepalli

designed to make them hard to disassemble (for example, with wheels screwed to the axel). Typically, these systems use especially designed bicycles that stand out wherever they are found. Colombia's National University, for example, provides free bicycles with an exclusive design only seen on campus.

- Bicycle maintenance: Though it may seem trivial, maintenance must be carefully planned and generously budgeted for. Typically, it is required on a weekly basis, requiring sufficient mechanics to service the entire fleet. Lack of maintenance increases the risk of injuries and reduces service quality. Users should also be able to fix a bicycle at certain points in their journeys, should this become necessary. The best option is to have on-site bicycle repair and maintenance, through service vans, such as those used in Paris.

11.2.7 Bicycle taxis as feeder systems

Bicycle taxis are another option for integration. Rickshaws, becaks and other vehicles can become part of a successful multimodal strategy in any city. However, there is a tendency to ban these vehicles in many developing cities, because they are perceived as "backward". In contrast, in many developed countries bicycle taxis are being reintroduced with greater frequency every day, and are increasingly seen as a crucial component of transport policy. Some projects (such as ITDP's rickshaw improvement activities in India and Surabaya) have started to re-establish the image of bicycle taxis as a clean and sustainable option for many transport trips.

Figure 160
A European example of bicycle taxis in Barcelona, Spain.
Photo by Carlosfelipe Pardo

The benefits of bicycle-taxi and public transport integration include the fact that bicycle taxis:

- Are a zero-emission transport option;
- Can be less expensive than taxi trips;
- Operate at lower speeds and with lower risk of accidents than other transport modes;
- Are a good option for medium-length trips of people arriving at their work or study (*i.e.* up to 5 km);
- Occupy less space than other transport modes. Their capacity to deal with hills can be boosted using electric rather than polluting diesel motors. They take up less space, offering better service in crowded shopping and other urban spaces;
- Are a source of income for low-income people.

Despite these benefits, in many developing countries, the main problems with rickshaw use are twofold: vehicles are unsafe and badly run, and there are no clear regulations as to how these should be used (*e.g.* number of vehicles allowed, specific routes, driver-related and contractual regulations, among others). This has led to their being banned in some places (for more information, see Chapter 13, on Regulations).

Some car-taxi drivers also perceive bicycle taxis as a threat to their business: another misconception, since car-taxi customers normally require longer trips than those covered by bicycle taxis, so only a portion of their trips will be lost to bicycle taxis. Good planning and proper integration should generate increased ridership and distribute it according to trip length between bicycle and car taxis.

11.3 Financial aspects

All cycling-public transport integration strategies must take into consideration financial needs, prior to implementation. Failing to recognize and foresee these issues may result in serious difficulties and conflicts if implementation is perceived as clumsy. One useful rule is that bicycle parking at transit stations should preferably be free or as low-cost as possible: Since cycling-public transport integration can improve distribution of ridership throughout the city transport system, ideally there should be no charge to users. Costs can be covered through a variety of different strategies, including direct subsidies, complementary businesses (tourist information, bike repairs, etc.), inclusion in the public transport fare, advertising, cross-subsidies from gasoline taxes, as described further below.

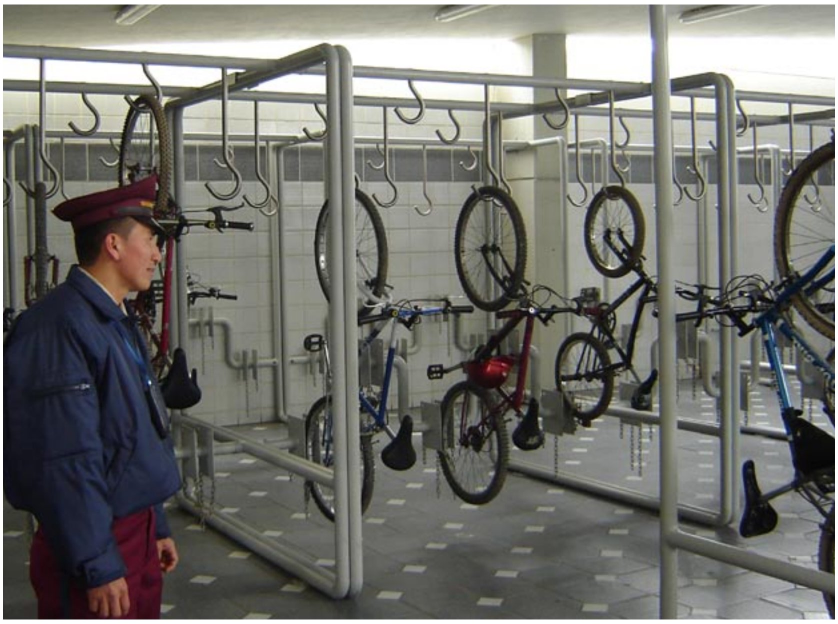


Figure 161
Guarding infrastructure for bicycles has a significant cost.
Photo by Carlosfelipe Pardo

Costs that should be taken into account include:

- Building costs: for bicycle parking facilities and rental/free bicycles. These costs are normally marginal compared to full station development or bus procurement.
- Maintenance costs: Costs for maintaining parking infrastructure (and bicycles).
- Signage: Wherever possible, a uniform system of signage denoting where bicycle parking facilities are located should be used throughout the city (or the country). This makes quick identification possible and facilitates both awareness of the availability of these services and users' ability to access them quickly and easily.
- Surveillance/security costs: for bicycle parking facilities, surveillance cameras and security guards or make use of "natural" surveillance systems, such as local home-owners, small businesses or kiosks that can integrate bicycle parking into their regular spaces and routines.
- Additional staff: Though there is normally not a great increase in staff needs for integration strategies, some cases may need more than one additional staff member to implement these activities.
- Informational products: Posters, brochures and other publications are necessary to inform the public about the availability and

Figure 162
Information and signage of Paris's Velib system.
Photo by Carlosfelipe Pardo

logistics of these strategies. These may also need to be distributed outside of stations.

- Vehicle (bus-train) adaptation costs: for bicycle-special-vehicles.

Some strategies to reduce or cover these costs (other than the public transport fare itself) may include:

- Publicity: at public transport stations, in buses or elsewhere.
- Cross-subsidies: car parking fees or other transport-related fees such as congestion charging, fuel taxes or others can be used to cover costs for integration strategies.
- Integrating the cost: Including the bicycle parking facilities as part of public transport operation is coherent, since the provision of such facilities increases the catchment area of the system and thus generating greater revenue.
- Retail services associated with bicycle parking facilities/bicycle stations: As explained above, adding multiple services to a bike parking facility can greatly simplify its implementation, even where substantial costs, such as ongoing vigilance by security, are involved. Bicycle shops and repair services gain direct access to a key part of their market, bicycle users, when integrated into medium- to long-term parking facilities. But other kinds of service can also help. Just think of the kinds of services provided by convenience stores associated with train stations or gas stations, for example. Bakeries, coffee shops, quick-and-easy provision of basic goods, are all interesting possibilities for ensuring the financial viability of an integrated service, particularly if special needs — of women and children — for example, are provided for, both in terms of safe parking and quick-and-handy services (baby food, diapers, milk, something for dinner…).

11.4 Further reading

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12. Cycling-friendly regulations for sustainable cities[50)]

Carlosfelipe Pardo

For related subjects

See ***Chapter 4***, on How to organize the policy making process.

See ***Chapter 9***, on Bicycle parking.

See ***Chapter 10***, on Integration within the transport system.

See ***Glossary*** on traffic calming, cycle ways and other information

Figure 163
Heavy bicycle use of bikeway in Jinan, China.
Photo by Carlosfelipe Pardo

12.1 Chapter summary

This chapter provides some guidelines on how legal and regulatory measures can promote bicycle use. It discusses the main issues, provides recommendations and some examples of good and poor practices, and discusses regulations in terms of general policies, circulation, users and commercial cycle use.

12.2 Overview

It is difficult to address the topic of cycling regulations in developing cities. Reasons include the lack of appropriate examples in cities from the Southern hemisphere and indeed the reality that few positive examples exist in countries or cities of the developed world. It is also worthy to note that, in many cases, regulations are mostly restrictive in nature, which makes it more difficult to present positive examples. This chapter will focus on the positive aspects of such regulations and recommendations of how to arrive at regulations that promote (rather than deter) bicycle use, while keeping it safe.

Some regulations covered bicycles and their use in cities in the 19th and early 20th centuries, but these were primarily related to the physical areas where bicycles could circulate freely. Some restrictions dealt with riders' age or dexterity. When the car came along, these regulations were either forgotten or never updated. An interesting example is Peru, where people are legally required to apply for a bicycle driver's license. However (thankfully), no one actually remembers or enforces this law. In other cities, some basic test (*e.g.* doing a "figure eight" with a bicycle) used to be necessary for a circulation permit, while children were not allowed to cycle at all in many areas.

Today, however, it is difficult to find specific regulations in this sense, except in the Netherlands (and other Nordic countries), China and a few other places. This may reflect the priority enjoyed by motorized vehicles and the

[50] This chapter is based on previous chapters on regulations by Walter Hook from the *Non-motorized transport training document* developed by GTZ.

assumption that human-powered modes would slowly become obsolete. Even Bogotá, often described as "bicycle heaven", does not have appropriate or sufficient regulations concerning the use of these vehicles. Note, however, that lack of regulation can be better than bad regulations.

In most countries, traffic codes regulate vehicles' use of roads. Treatment of human-powered vehicles (HPVs) depends on definitions in the traffic code. In the opinion of some experts and cycling advocates, HPVs should receive the same legal treatment as other vehicles. They argue that specific regulations for HPVs are inherently discriminatory. This approach, however, could also be used to argue that restrictions on motorized vehicles are similarly discriminatory.

Any specific HPV regulations should reflect their particular operating characteristics. One crucial aspect is that HPV users are much more vulnerable than motorized vehicle users. The Vienna Convention on Road Traffic (1968) establishes the principle that drivers should be most careful of the most vulnerable road users, such as pedestrians and cyclists, particularly with respect to children, elderly people and disabled people. The term vulnerable is often used to underline the fact that pedestrians and cyclists are much more vulnerable to speed and volumes of motorized vehicles than drivers. Differences in vehicle weight, size, operating speeds, noise and emissions justify different regulations pertaining to their use.

Although allowing for specific treatment of vehicles with different operating characteristics under the law does tend to invite some discrimination, this can be minimized as long as vehicles with similar operating characteristics receive similar treatment.

Additionally, the environmental impacts (in the broadest sense) of the different vehicles/modes can justify different legal treatments. Indeed, in many cities this is already the basis for restrictions on car use, an approach that could be extended to include giving priority to modes that don't create road dangers, don't pollute and don't decrease the liveability of cities and villages.

12.3 Different categories of laws and regulations

In fact, we can identify several types of legislation that affect cycling, walking and other sustainable transport modes. These include:

- Legislation governing traffic and transport/urban *planning*. This type of legislation describes which level of government is responsible for each type of planning. In some countries there is a hierarchy of plans that guides municipal governments in this area.
- Legislation governing *road authorities*. This type of legislation describes the jurisdiction and responsibilities of road authorities and procedures they have to follow when they change the road layout, signage and markings.

Figure 164

Regulations in China require every major road to have at least one cycle lane.

Photo by Carlosfelipe Pardo

- *Vehicle* legislation. This type of legislation defines the requirements that vehicles (and accessories, including for example, lights and helmets) must meet to use the road. Laws typically distinguish between sales requirements (for which the manufacturer is responsible, which make it illegal to sell non-compliant vehicles) and user requirements (for which the user is responsible and can usually be fined or otherwise sanctioned for non-compliance). For human-powered vehicles in most countries, only user requirements apply, placing all responsibility on the user. Consumers have no protection against sub-standard products, beyond general consumer legislation. Technical standards applied by the industry can also be seen as a less formal kind of vehicle regulation. In some countries these standards have a legal status.
- Highway or traffic code. These regulations define road users have to *behave* in traffic and how to react to traffic signs and markings.

In most developed countries, traffic codes define bicycles and cycle rickshaws as 'vehicles', and their drivers are subject to the same rights and responsibilities as drivers of other vehicles, unless otherwise specified. These countries often have special provisions in national, provincial, and local traffic codes to reflect their different operating characteristics. In developing countries, bicycles typically exist in a legal grey area. In Delhi, India, for example, cycle rickshaws are classified as agricultural vehicles, and in Yogyakarta, cycle rickshaws were not defined at all until a new law declared them vehicles. Often, bicycles are not clearly defined in the traffic code, and their rights and responsibilities are not clear. Some times this means they are more likely to be harassed or victimized by traffic police. Clarification of their status as vehicles can therefore be an important first step. Some other general examples of regulations are provided below:

In the Netherlands, the planning law for traffic and transport says that traffic and transport plans should properly deal with cycling and walking. At urban and regional level there should be a network for road connections that can safely be used by cyclists. Amongst traffic professionals and users, there is a shared understanding that this typically involves some combination of bicycle tracks and lanes, and sometimes traffic calming measures. This is based more on professional consensus than on legislation. Of course, there are some regulations defining signage, minimum widths and road markings. Normally bicycles and low-speed mopeds (maximum 25 km/h) may circulate on these roads, and in some cases there are specific facilities which prevent vehicles from going at high speeds.

Figure 165
Helmet use is mandatory in Colombia.
Photo by Carlosfelipe Pardo

In China, the national transport code requires that all large avenues must have one full lane (3.5 m) dedicated to bicycle use. Different cities allow or ban motorcycles and electric bikes from these facilities.

The Colombian National Transport Code applies the same regulations to bicycles and motorcycles and they are discussed in the same

Figure 166
Bicycle users in Chile will benefit from its upcoming Bicycle Law.
Photo by Carlosfelipe Pardo

section of the Code. However, bicycles are the only vehicles allowed on bikeways and their use, where provided, is mandatory. Helmets are mandatory across the country, and reflective vests and lights are required from 6pm to 6am. Failure to obey these rules will result in bicycle confiscation and a fine (sometimes many times higher than the value of the bicycle itself).

In legally inclined Chile, there has long been discussion of creating a single bicycle law (*Ley de la bicicleta*), with growing interest among parliamentarians, transport ministry officials and Ciclistas Unidos de Chile (CUCH), a federation of active pro-cycling organisations. In 2008, the Minister-Secretary to the Presidency and CUCH created a special commission to work on a draft law for encouraging cycling-inclusive policies and the necessary funding at every level of government. One interesting side effect of this process has been growing awareness among decisionmakers of the multiple beneficial facets of bicycle use, a change that has helped move cycling-friendly policies up the priority list on health, cultural and other agendas, as well as transport. Previously, however, changes tended to be restrictive or even dangerous. Urban road maximum speeds were raised from 50 km/h to 60 km/h some years ago (see discussion of speed and fatalities in Chapter 2), at the same time as pro-cycling measures were under discussion, so it is important to keep very much in mind the context in which a pro-cycling law, policy or regulation is under discussion. Perú is also debating a possible bicycle law.

12.4 Key issues

12.4.1 Traffic measures affecting cycling within urban design

The design of a city and its related laws can do a lot to increase the probability of greater bicycle use. Since segregated cycle paths are not always present and are never the sole route used by cyclists, citywide regulations can contribute to substantial improvements. The best include:

30 km/h zones: 30 km/h has been established as an appropriate speed for most streets in a city. Studies have demonstrated that this speed limit reduces accidents and the seriousness of injuries. It also improves the street from the perspective of other users, particularly residents, reducing noise, excessive traffic and congestion, and other negative impacts. Risk of death plunges, by 2–3% for every km/h drop in speed. This kind of blanket measure is highly beneficial, therefore, to cyclists and most other users of roads, sidewalks and adjacent properties.

Free access: Bicycles should be allowed two-way access to one-way streets, thus enhancing their connectivity. This has been a highly successful measure for keeping traffic orderly and predictable in many European cities. It also helps keep cyclists off sidewalks, since often it is finding themselves trapped amidst one-way streets that force them into pedestrian territory. Keeping cyclists off sidewalks also requires proper counter-flow facilities on busier roads.

Blanket rules for bikeway provision: In their national or local transport regulations, cities can require provision of bicycle-specific infrastructure in specific locations, at modal transfer points, in public and private buildings, associated with library or public recreational facilities, within malls and other major trip destinations. As described above, China has specific regulations for its cities. Also, the construction of the BRT system infrastructure in Bogotá requires bikeways along the same trunk line when being built.

A suitable assignment of jurisdictions is crucial for proper road design. Contradictory jurisdictions can lead to substandard facilities. In Santiago (Chile), for example, municipalities, which have jurisdiction over sidewalks but not roads, have resorted to creating a category of "recreational bikeways", usually squeezed into limited sidewalk space, often next to wide roads that would be more appropriate for cycling solutions. In Bangkok (Thailand), traffic police have jurisdiction over roads, while municipalities control sidewalks. This, combined with the high priority set on motorized traffic flows, has led to cycleways being restricted to sidewalks (in fact, sometimes just painted over them) or in city outskirts, where demand is very low (thus generating no bicycle use, and "proving" that cycleways are not needed and are a "waste of space"). Again, in Santiago, some mayors complain that they can't establish 30 km/h zones in suitable neighbourhoods, because they have no jurisdiction over the roads in their territory.

Legislation empowering municipalities to make key decisions on road-median-sidewalk use permits better, more balanced solutions for all. Many cities whose authorities have the necessary powers have used them to create gracious, attractive, tree-lined boulevards and other solutions that respond to much broader needs. In an integral design for all uses of public space, it is important to have jurisdiction of the complete section.

12.4.2 Regulations on financing bicycle infrastructure

Financing of bicycle friendly infrastructure should in principle not be a problem. Any city or road authority has a budget for road management, and the main question is how to spend this budget. Cycling inclusive planning should entail a reallocation of (mostly existing) budgets in favour of more cycling-friendly road and network designs. It is especially relevant to note that any bicycle-related infrastructure will have a lower cost than infrastructure for motorized modes (compared in terms of kilometres built, space per trip, space per person-trip and many other parameters). Thus, including cycling as part of an overall infrastructure (or transport) budget would reduce costs rather than increase them.

However, this requires a paradigm shift, which can be facilitated by providing specific funding opportunities for specific bicycle infrastructure. These allow cities to experience the usefulness of investments in cycling without having to make difficult decisions regarding reallocating existing budgets right away.

Financing cycling infrastructure and its promotion is a crucial issue among cities interested in encouraging more bicycle use and building the appropriate infrastructure. Although countries where cycling is welcomed have specific funds for such investments, many cities face a situation where funds for cycling infrastructure and measures are not part of their current budgets and there may be no division or institution in charge of cycling within the municipality. This can result in the view that large-scale cycling infrastructure is “too expensive” (despite the much lower costs when comparing to infrastructure for other transport modes). Practical solutions to this kind of impasse include:

Figure 167
Bangkok traffic police have not allowed bikeways on major arterials, a policy that has produced poor quality bikeways on sidewalks.
Photo by Carlosfelipe Pardo

Cross subsidies: In some cases, revenue from one project can be directed towards another specific project such as cycling infrastructure. In the case of London’s congestion charging system, 6% of revenue goes to improving cycling and walking conditions. Elsewhere, fuel surcharges pay for infrastructure development, with a portion of this going to cycling infrastructure.

Earmarked funds: Sometimes specific funds within a municipal, provincial or national budget must go specifically to walking and cycling improvements. The US highway law, for example, establishes a percentage that goes to fund a wide-range of initiatives, many organized by civil society groups, to encourage integration of these transport modes within local habits and planning.

Other measures used in other sectors that could be applied to cycling projects include:

Carbon funding: A recent approach to funding transport improvements is that of carbon funding. The most well-known example is the Clean Development Mechanism, where a transport improvement project from a developing country can “sell” the CO_2 emissions saved thanks to specific measures to a developed city. Though this works well in some sectors, it has proven difficult to demonstrate carbon emission reductions in the transport sector and thus few projects have been approved by the regulating agency (UNFCCC). Moreover, cycling is not yet included within the options to develop a carbon fund in transport so this is not yet a feasible option unless the revenue from another CDM project were used as a cross-subsidy to bicycle infrastructure (for details on CDM and transport, see module 5d, GTZ sourcebook CDM in the Transport Sector). It would be a challenge to change the calculation methods for carbon emission reductions in order to capitalize on the potential contribution of (the promotion of) cycling to this Issue.

Taxes: Though taxes often have a bad name with the general population and may be regressive in nature, cycling infrastructure taxes could be implemented. This, however, may not be the best way to generate revenues for worthy social and urban projects. The costs in terms of cycling's image among the general population may be far too high for this strategy to work. Using revenues from existing or future gasoline taxes to help fund more cycling-friendly infrastructure could be an appropriate way to do this.

Land value taxes and other measures: These have normally been used to effectively finance transport improvements large and small, among them the Hong Kong Metro, where the land owner paid a significant portion of the increase in land value along the metro trunk lines to the city. These taxes or charges could also be used similarly to fund cycling infrastructure, either by means of a cross subsidy or direct payments from higher land prices near where bicycle infrastructure has been built. Note that in many city planning systems, local planners have the power to demand and negotiate substantial improvements to surrounding land development, when a large industry goes in for example, or more commonly, within new residential developments, malls, business and other real estate projects. Typically this funding or tax goes to access improvements such as traffic lights, new intersection designs and the like, all areas where it would be highly favourable to integrate other users, particularly cyclists and walkers.

12.5 Traffic laws and best practices

Most regulations affect cycling directly or indirectly, particularly those governing vehicle circulation. As mentioned earlier, today many tend to restrict rather than encourage the circulation of bicycles.

In this sense, it is important for regulations to look beyond existing designs and assumptions about speeds and throughput. In today's world, with cities competing for top notch professionals and the resources they need to thrive, regulations (and designs) increasingly give priority to people's needs rather than vehicles, favouring more people- and environmentally-friendly modes, particularly those most equitable for society as a whole. Thus, many short journeys inefficiently served by cars are excellent candidates for improvements that favour walking, cycling and other human-powered vehicles, particularly cycle taxis, which can lighten the load of people doing their shopping, with small children or other special needs. This new approach can lead to new regulations on crossings, right of way, turning priorities, and designs for roads and public spaces.

- Cyclists may make right turns (or left turns, for countries applying the UK system) when traffic lights are red, provided they give priority to oncoming traffic: this measure significantly improves bicycle ease of use and access over other modes. It makes cyclists more visible to car users and allows them to turn when it is safest, a condition that often depends on a more context-dependent analysis of intersection flows than can be allowed for by traffic planners and computer programs running lights. Conversely, right turns on red for cars should not be allowed, since this decreases safety for cyclists and pedestrians.
- Cycling streets (streets where bicycles have priority over cars, see Figures 166, 167) may allow cars, provided they travel at speeds compatible with pedestrians and bicycle users. An excellent and highly successful example of this measure is Houten, where most roads treat cars as "guests", giving cyclists priority. See Chapter 7 on residential streets for more detail on this issue.
- In many intersections, bicycles should have priority over motorized modes. This applies also to regular crossings and situations where cars turn and encounter a bicycle on the crossing: the car must yield to both cyclists and pedestrians.
- Roads defined as one-way for cars should allow cyclists to circulate in both directions and be duly labelled: as described in a previous section, this is a critical measure for improving cycling connectivity, and is

Figures 168 and 169

In Houten (The Netherlands), a car is defined as a "guest" in spaces that give priority to bicycles and walkers. The so called "cycling street" in the right photo looks like a cycle path, because of the red surface which has been used for all cycle pavements in the Netherlands; but cars can use this part of the main cycle route to reach their parking places. This type of "cycle street" is one of the latest developments in the Netherlands.

Photos by Carlosfelipe Pardo & Hans de Jong

applicable wherever bidirectional cycling can be made safe.

- Generally speaking, an urban road network based largely on one-way streets discriminates against the safety and efficiency of cycling. These systems tend to encourage higher speeds and make intersections particularly complex, forcing road users to make detours to reach their destinations. This particularly discourages cyclists, as distance is a major factor in choosing how to travel. One-way systems typically reflect the dominance of the car in the thinking of planners and authorities, thus conflicting with the concept 'cities for people, not for vehicles'.
- In most cases, cycling is not allowed in segregated bus lanes, although Paris, London, and Edinburgh offer interesting examples of shared bicycle/bus lanes: this is possible where bus speeds and volumes are not so high and road widths allow sufficient space for bicycles and public transport vehicles. This measure requires appropriate rules and driver training. However, in general one should be cautious with shared bus/cycle lanes as buses and bicycles are not very compatible given their difference in mass and manoeuvrability.
- Drivers should slow significantly when sharing the road with pedestrians and cyclists: regulations, therefore, should emphasize and encourage appropriate cycling-inclusive infrastructure, and include rules governing interactions between vehicles, which give priority to those most vulnerable, not only cyclists but also children, the elderly, the handicapped and others when road space is shared, as part of a general transport policy.
- Passing distances should be at least 1.5 m, when motorized vehicles overtake cyclists: this is normally rejected on the basis of lack of space, but must be enforced in order to arrive at appropriate safety conditions for cyclists. Drivers should be taught that cyclists must travel at least a door's width away from parked vehicles.
- Regulations governing commercial human-powered vehicles should require proper reflectors, lights and other safety equipment: this is appropriate since their operation sometimes implies providing public transport (such as in the case of rickshaws, etc.), or carrying large objects. In the case of bicycle use for personal transport at sunrise, sunset or in the dark, it is recommended that they have at least reflectors, a white light on the front and a red light on the back, and use of a reflective vest is to be recommended.
- Non-commercial cyclists and HPV users should not be required to have operating licenses: these vehicles are not complex to handle nor pose an inherent risk to users.
- Helmet use should be optional: compulsory helmet use is hotly disputed by users, academics and in the press (see discussion below). The main message is that good road design, and not body armour, is what saves

lives on the roads. Moreover, helmets tend to discourage bicycle use, particularly for public bicycle and other rental systems. To put it more radically, helmet legislation is too much an excuse to do nothing substantial to improve the primary safety of cycling.

12.5.1 Registration of bicycles and NMVs

Motor vehicles are regulated for several reasons. If a motor vehicle is not well maintained, or does not have proper lights, it will pollute the environment and endanger others. As bicycles generate no pollution and operate at slow speeds, a mechanical failure is very unlikely to endanger others. As such, many countries do not require bicycles themselves to be regulated, and where regulations exist enforcement tends to be lax.

For motor vehicles, governments regulate the type of vehicles allowed to operate. Vehicles, parts and components are generally certified by the International Standards Organisation (ISO) and new cars generally are subject to 'type approval' standards to certify their quality, safety, and emissions. Motor vehicles are also generally registered with the police or motor vehicles department in case they are involved in traffic offences, criminal activity or theft. In developed countries and more and more developing countries, motor vehicles are also inspected to ensure they comply with tailpipe emission standards and roadworthiness.

Production standards that ensure bicycles and components are of sufficient quality to safeguard operators have been discussed. Because of the complexity, given the large number of new manufacturers and new components, approval through the International Standards Organisation (ISO) is cumbersome and slow, and the cost high relative to the product cost. As a result, the tendency is to approve the manufacturer rather than a specific product.

Figure 170
Bicycle registration is mandatory in some cities, such as Beijing.
Photo by Carlosfelipe Pardo

In terms of bicycle registration (by users, such as license plate issuing), in some countries owners register their bicycles or other vehicles with a registering body. In some cases this is mandatory (as in some Chinese cities) but in most it is voluntary and used primarily as a mechanism to facilitate recovery in case of theft. Bicycle registration as an anti-theft measure has not proven to be very successful when implemented partially. In Bogotá, Toronto and other cities, people can voluntarily register their bike with the police or on the Internet. The National Bicycle Registry (http://www.nationalbikeregistry.com) in the US offers an interesting model in which users register their bikes and receive a hard-to-remove decal. When police recover bicycles they then search the registry database. This has proven quite successful for reuniting recovered bicycles with owners. The key to success in these procedures is to develop a full process of monitoring and policing of registration and stolen bicycles, along with a network of partnerships including bicycle dealers and cycling organisations, which will effectively reduce thefts.

12.5.2 Cyclists, accessories and use

Accessories that enable safer cycling have been subject to debate many times and in many places, reflecting the fact that regulations vary enormously. This section provides an overview.

Helmets

In some US states and municipalities, local laws require the use of a bicycle helmet that meets specific safety and quality standards. In most developing countries, helmet use is less regulated among cyclists and is even rare on motorcycles. In Bogotá, helmets for motorcycles and bicycles is now mandatory, but in the case of bicycles it is not enforced. Helmet laws, in fact, exist in several countries and states. Some only require that children wear helmets, while others require all cyclists to wear helmets. Note, however, that the countries with the highest levels of bicycle use, such as the Netherlands and Denmark, do not have helmet laws, and also have the best record for bicycle safety in terms of risk per km cycled.

Many cycling advocates oppose mandatory helmet laws for different reasons: some see them as too paternalistic (the person affected should decide) or argue that they create a false sense of security. Experience indicates they discourage bicycle use, by making it less convenient or contributing to its image as a disproportionately dangerous mode of transport.

In fact, helmets may reduce damage in the case of some accidents, but they do not prevent accidents. Moreover, the effectiveness of bicycle helmets is heavily disputed (see more in depth in http://www.cyclehelmets.org and http://en.wikipedia.org/wiki/Bicycle_helmet). Normally, health departments and hospitals strongly encourage the use of helmets. However, the reductions in head injuries expected to arise from requiring helmet use do not actually materialize, if figures are corrected for changes in bicycle use. A British study from 2006 found that car users would drive closer to people with helmets than to those who did not wear a helmet, thus increasing the risk of injury for bicycle users with helmets. In fact, the same study found that drivers accorded cyclists with long hair (perceived to be women) the widest safety margin. Many think that high-speed roads require more helmet use. However, various studies developed by the European Cyclists Federation have shown that helmet use is not a decisive protective factor in collisions.

Cyclists' safety essentially depends on the primary safety conditions created by road infrastructure, their own and drivers' behaviour, all of which directly influence accident frequencies. When accidents involving cyclists are compared to fatalities from heart and other sedentary-related pathologies, risks are much higher for drivers than for cyclists. This makes it poor policy to legally require helmet use, given that this discourages bicycle use. In general, authorities should not make a bicycle helmet law the focal point of cycling policy, but should instead focus on providing safe infrastructure.

Lights, reflective vests

In most developed and some developing countries, it is illegal to sell bicycles without reflectors in the front and rear and users are required to have both the reflectors and front and rear lights after sundown. Fulfilling this requirement ensures cyclists, even in poor lighting conditions, are visible, a key factor in safety. Enforcement is generally lax. Some laws require the use of reflectors that meet a specific quality standard. Some safety experts have suggested that requiring the bicycles and cycle rickshaws to be painted yellow might also solve the visibility problem, but this seems to run against strong desires to personalize vehicles.

When analysing the effectiveness of reflective equipment on bicycles and comparing with the conditions of roads at night in many developing cities, it is highly recommendable to promote the mandatory use of equipment (at least reflective) on the bicycle. Where cost is a barrier, policy should address this issue.

12.5.3 People per vehicle

Some rules define how many people can ride on a single bicycle. In China, it is most common to see women passengers on bicycles. In the Netherlands, cyclists often carry passengers, mainly one or more children. In Uganda and Kenya there is a complete industry of two-wheeled bicycle taxis, called boda-bodas, which carry passengers on a back seat. In Colombia, regulations go as far as to restrict use of any object or person that "restricts" proper handling of the vehicle (though this is not further specified).

Figure 171
It is common to see two people sharing a bicycle in China.
Photo by Carlosfelipe Pardo

12.5.4 Fines

Traffic departments, the police and municipalities sometimes see fines as a good way to reducing unsuitable behaviour and enforcing regulations. However, they are not always effective in the long run. It is mainly the possibility of "getting caught" and peer supervision/

enforcement that determine the effectiveness of such repressive approaches.

In the case of bicycle-related regulations, the fact that they are inexistent, unknown or unclear makes it easy for traffic police to stop bicycle users and give them fines and even confiscate their vehicles. In some cases, fines imposed or impoundment penalties are actually higher than the cost of a bicycle itself.

Furthermore, when fines are used as the sole instrument to enforce regulations, users will tend to find ways to evade these. In the case of mandatory helmet use, especially among low-income cyclists, users may wear a cheap helmet, which offers no real protection, just to avoid being fined.

12.6 Current debates

This section explores some of the debates that stem from today's problems in developing cities. While some of the information provided may seem discouraging, this overview offers the opportunity to learn from others' experience. Most of the conflicts described here result from poor design and unsatisfactory or non-existent participating in making key decisions. When these aspects are addressed, users tend to respect the rules more, making punitive measures a small part of successful enforcement.

12.6.1 Should bicycles be required to use bicycle facilities?

While, in theory, separating motorized and non-motorized travel through special facilities should be to the benefit of both, in practice, inadequate designs often mean bicycle lanes and pedestrian facilities offer a reduced level of service and are designed primarily to get these users out of the way of motorized traffic, rather than to improve their safety, ease and comfort. Forcing cyclists to use cycling facilities that do not meet their needs is counter-productive and a waste of public resources (policing, courts, etc.). The focus should be on providing a competitive, safe road environment for cyclists and other vulnerable users.

In many countries, where no segregated bicycle path is provided, cyclists are required to operate in the curb (slow) lane except when turning. Similarly, in some countries (including several US cities), if a bicycle lane or path is provided and is not obstructed, its use may be required by law. The most cycle-tolerant policies are found in Sweden and Germany, where cyclists are allowed to ride on the road even if a segregated bicycle path exists, if this is more suitable considering the destination, and if done with care.

Fostering better design standards and better quality facilities, which cyclists prefer of their own volition, is a more suitable response to these issues. The prevailing trend in Canada, the US, Europe, and some developing countries involves laws requiring better designs for both cycles and pedestrians, rather than heavy handed rules that many simply ignore.

Many experts feel that forcing cyclists to use cycling facilities is counter productive or even discriminatory, and oppose such regulations. Indeed, some cycling advocates (mostly masculine aged 20–50 years) oppose segregated cycling facilities altogether, because they may force cyclists to use sub-standard facilities and they also tend to make them less visible to drivers, and therefore more at risk. This may not be totally untrue, but in doing so these 'biased' cyclists tend to overlook the Importance of *good quality* segregated facilities for less experienced and less confident cyclists, such as children and learners who don't dare cycle amidst busy motorized traffic. To avoid confusion, it must be noted that facilities meeting mandatory quality requirements would not pose such a problem.

In the curb lane, cyclists face conflicts with turning vehicles, double-parked vehicles, taxis picking up and dropping off passengers, bus stops, and numerous other uses that slow down travel in the curb lane. On roads with relatively high speeds, cyclists eager to maintain constant speeds do not want to be forced into curb lanes when motorists are not.

12.6.2 What to do about cyclists using sidewalks?

While differences in operating characteristics between slow moving vehicles such as bicycles, scooters and pedestrians may be quite modest, they can be enough to create conflicts. The pedestrian environment should be designed as multi-functional public space and, generally speaking, should be treated separately from facilities for through-travel, whether on foot, bicycle, wheelchair or other modes. Pedestrian zones and sidewalks should be designed to let people relax without worrying about being bumped by a bicycle. As a general principle, then, bicycles should be kept off sidewalks, unless riders dismount and walk them.

There are some additional considerations, however, given the wide range of local conditions. In many low-density urban and suburban areas, sidewalks are underutilized, and bicycle use will cause few conflicts. Many cities opt for having children under 14 years ride on sidewalks for safety reasons. In cities with many one-way streets, cyclists may be forced to choose between riding against prevailing traffic or using sidewalks. Good design, with counter-flow lanes for cyclists, is the best and most comfortable solution for cyclists, pedestrians and drivers.

Moreover, some cyclists simply don't have the confidence to ride on the road. This issue is best addressed through widespread educational programs, usually offered through schools and municipal programs, to teach people to ride safely on roads.

Where cycling conditions are inadequate, situations where cyclists use sidewalks will almost always arise. These make campaigns to generate friendly courteous behaviour among all road-sidewalk-public space users the best strategy for heading off potential conflicts and creating better cities to live in.

There is also a difference between sidewalks and (free traced) footpaths, *e.g.* through parks. In the latter it is usually less of problem to mix cycling and walking.

To summarize: in principle cycling and walking should not be mixed, but this principle shouldn't be applied too rigidly. Low volumes can mix, with the right design, sign-posting and appropriate education. One situation that should be avoided is that where fully pedestrianised streets ban all cycling, thus becoming a barrier or missing link within the cycling network. Above all, general road conditions should be improved by planning for walking and cycling, as well as any motorized traffic.

Figure 172
Pedestrians in Concepción (Chile) on the bikeway, for lack of a sidewalk.
Photo by Carlosfelipe Pardo

12.6.3 Should pedestrians use bikeways?

Just as bicycles do not generally belong in pedestrian zones, pedestrians are better kept off bicycle paths unless the facility has been specifically designed for mixed pedestrian and bicycle use, as occurs in Tokyo, Salzburg or other cities. While these facilities are frustrating for cyclists due to the large number of conflicts with pedestrians, they do provide bicycle access to areas with very high pedestrian volumes. In general, mixing becomes a problem with high numbers, but works well where there are fewer people and good visibility.

Note, however, that a lovely paved bike path beside a dirty, gritty pedestrian path will inevitably entice pedestrians onto the cleaner, more comfortable surface. Likewise, if a cycle path takes over a grassy median, especially one frequented by pedestrians, conflicts between the two uses will become inevitable and, in many cases, increasingly bitter.

Again, in our imperfect real worlds, often the best solution is good design, followed by campaigns to encourage friendly, courteous behaviour among all road-sidewalk-public space users. This combined approach is the best strategy for heading off potential conflicts and creating better cities to live in.

12.6.4 How best to determine right of way?

There is a host of subtle ways in which traffic laws can be biased in favour of cyclists and pedestrians or in favour of motorists. Where air pollution, traffic congestion, public space or other quality-of-life concerns are priorities, policy makers should make an effort to favour cyclists and pedestrians over motorists.

In the Netherlands, for example, a cyclist going straight has the right of way over a motorist turning, and motorists are not allowed to overtake a cyclist just before an intersection. In the US, the motorist frequently has the right of way. In Switzerland, when a bicycle path is more than 2 metres from the road, turning motorized vehicles have the right of way over cyclists going straight at an intersection. Such laws are extremely hostile to non-motorized travel. Some cities, such as Portland (US), have also had great success with “bike boxes”, a bright green rectangle painted on the asphalt at intersections, allowing cyclists to stop in front of cars, where they are clearly visible and can get off to a safer start when the lights change.

The rules with respect to bicycle turning movements also differ. In some countries, cyclists may choose to turn directly, manoeuvring to the middle of the road before the crossing like a motorist. Elsewhere, cyclists are not allowed to cross directly, but rather must stay in the curb lane and cross with pedestrians. This is restrictive for cyclists and has to be balanced with safety needs.

Figure 173
Yogyakarta has a great problem with their bikelanes being used by motorcycles.
Photo by Carlosfelipe Pardo

12.6.5 What about other modes on bikeways (motorcycles, etc.)?

There are also debates about whether roller blades, motorcycles, mopeds, motorized scooters, wheel chairs, electric bicycles, cycle rickshaws and other vehicles should be allowed on bicycle lanes. Rollerbladers have very different operating characteristics from cyclists. While their operating speeds and weight are similar to a bicycle, they consume much more lateral road space than cyclists. As such, there is no impediment for sharing use with cycling facilities of a reasonable width.

Similarly, cycle rickshaws or the tricycles used by recyclers and other independent operators share many operating characteristics with bicycles, but are much wider. In Bogotá, cycle rickshaws are currently not allowed on the new bicycle paths, which were not designed to accommodate human-powered vehicles of such width. In Lima and Santiago, bicycle lanes designed under World Bank projects did not anticipate use by non-motorized three wheelers, and hence are too narrow to accommodate their use. It is best practice to take into consideration the wide range of potential users in each design, providing the necessary widths or additional spaces to reduce conflicts and congestion to the minimum. Tricycle users have the same needs for safety, comfort and direct routes as bicycle users and not providing for them often amounts to an unsavoury form of social discrimination.

The topic of motorcycles and other motorized two-wheelers is important. In Asian cities it is common to see them in large numbers, and the externalities they generate, such as environmental, health and traffic problems. Some users see these vehicles as a step up from a bicycle. From a regulatory and design perspective, however, it is unwise to treat human-powered and motorized vehicles as similar, since in terms of speed, weight and general sustainability issues, they are overwhelmingly different. Generally speaking, motor vehicles belong on the road, with normal traffic. Banning their use on cycle paths for safety and comfort reasons is perfectly justifiable.

To put it more generally: dedicated facilities for specific categories of road users are technically intended to homogenise flows. In this the speed and manoeuvrability are the most important aspects. In this respect motorized two wheelers resemble cars more than bicycles.

The Netherlands and Belgium allow light mopeds on some bicycle paths, but their numbers remain low.[51] Chinese, Malaysian, and some other cities don't allow motorcycles on some major roads, and force them to use 'bicycle' lanes. With the growing number of electric bicycles in China, this has become an issue. China is currently deciding whether to require electric bicycles to operate in bicycle lanes or in normal traffic lanes. Currently, solutions range from outright bans in central Wuhan, through legal limbo in Beijing, to required use of cycle lanes in Shanghai, Kuala Lumpur and Malaysia, which has an extensive network of shared bicycle and motorcycle facilities. Motorcycle speeds, noise, and pollution, however, tend to drive off ordinary cyclists. The same is increasingly true for many Latin American cities, where the number of motorcycles is rising, as are the related externalities. There is also a complex debate related to electric bikes, which are either vehicles with an electric engine or bicycles with electric assistance, and have different operational speeds and other characteristics. Thus, recommendations must specify the vehicle covered.

While we generally recommend that these modes not be allowed on bicycle paths, designing the bicycle path for slower speeds, enforcement of speed limits, and very tight emission and noise controls on motorbikes could mitigate many of the conflicts. The Netherlands, for example, allows certain motorized vehicles but lower speeds are enforced using special design features (though these are not very common).

Figure 174

Dutch engineers have developed physical solutions to reduce speeds of motorized two wheelers on cycle tracks, where mopeds are allowed to circulate. The speed bump is designed in such a way that the discomfort for cyclists is minimal.

Photo by Carlosfelipe Pardo

12.6.6 Bicycles and other (motorized) vehicles

In some cases, bicycles and other human-powered vehicles are classified with other, very different, transport modes. For instance, under Colombian law, bicycles are treated the same way as motorcycles, in terms of circulation (always on the right, one metre from the sidewalk), helmet use (mandatory in all cases) and the general definition of the vehicle. Legislation wrongly assumes that both vehicle types travel at similar speeds and have similar risk profiles.

Rickshaws (or bicycle taxis) may receive the same treatment as other, more polluting and dangerous modes, such as motorbike taxis.

Figure 175

Motorcycle taxis differ from the public transport provided by a rickshaw or other HPVs, mostly in terms of motorcycle taxis' greater unsafety.

Photo by Carlosfelipe Pardo

[51] In the Netherlands (and EU) there are three different categories of motorized two wheelers: 'snorfietsen' (electric bicycles), which have a maximum speed of 30 km/h, mopeds (50cc) and motorcycles (>50cc). Motorcycles are always supposed to use the main carriageway. Electric bicycles can use cycle paths, while moped use depends on local conditions.

However, while they may have similar operating problems (oversupply, lack of contractual agreements with drivers, etc.), the risks inherent to their operation are quite different (*e.g.* rickshaws are not as dangerous to passengers as motorbike taxis, given their different speeds).

Further, some vehicles are treated as bicycles, but should be regulated differently, particularly motorized and in some cases electric bicycles (e-bikes). Unregulated, motor bikes typically speed along cycle paths at over 20 km/h, whereas e-assisted bicycles are covered by appropriate rules and tend to behave more safely.

12.6.7 Is restricting human-powered vehicles' road use ever justified?

Restricting bicycle use on some roads has generated significant debate. Some argue that where the aggregate social benefits of restricting non-motorized travel outweigh the aggregate social costs, where a parallel route exists, and where the restriction does not make any population clearly defined as 'poor' worse off, then banning from some roads would not have great implications.

In its urban transport policy document, Cities on the Move: A World Bank Urban Transport Strategy Review, the World Bank states:

> *"Some cases (for example, major arterials designated for faster, longer-distance movements or urban busways) might justify the exclusion of human-powered vehicles on both efficiency and safety grounds. Nevertheless, even in those circumstances, it is important that steps are taken to avoid serious severance of short-distance movements. Moreover, any decisions to restructure roads (for example to introduce new restraints on categories of use or to take away protected bicycle lanes) should be appraised in terms of the net benefit to all types of user and not merely in terms of the speed of motorized traffic." (p. 130).*

A useful rule of thumb is that where motorized traffic is heavy and fast, cyclists require segregated facilities connecting relevant origins and destinations. Provided these facilities exist, excluding cyclists from motorized spaces would be less problematic. The vital condition is that cycling connectivity receives priority to ensure flows throughout the network.

The problem with a cost-benefit assessment of human-powered vehicle road access restrictions is that it may ignore crucial issues, involving social and environmental externalities and equity. Defining 'net benefits' as we have above, to include estimates of the social costs of air pollution and accidents, helps to address this concern.

Equity is crucial within this kind of debate, because restricting non-motorized travel tends to seriously harm low-income operators and users of human-powered vehicles, many of whom depend on these vehicles for their survival, whereas the cars and taxis used by middle and high-income earners receive most of the benefits. Although the equity issue is not always so clear-cut (many users of cycle rickshaws or buses receive mid-level incomes), nevertheless bans on human-powered vehicles (without meeting the condition of maintaining connectivity between relevant origen/destination relations) disproportionately hurt lower income groups and a net benefits calculation does nothing to stop a policy that could have severe adverse impacts on the poor. This is why our definition specifically requires that the measure not make the poor worse off.

Dhaka, for example, banned cycle rickshaws in one corridor despite the fact that "The average net monthly income of rickshaw pullers appears to have decreased by 32%", and "In 36% of the families this resulted in a loss of food intake." This highly controversial move boosed families' travel costs, moreover, by 9% (afterstudy on the Impact of Mirpur Demonstration Corridor Project).

12.6.8 Parking

As discussed elsewhere in this handbook, cycle parking facilities are important to encourage cycling and keep public spaces attractive for all users. Many cities have adopted specific cycle stand or rack designs, offer handbooks to businesses and other institutions, and generally encourage more bicycle-friendly behaviour. Cities like Toronto, with a strong pro-cycling policy, encourage businesses and institutions to be more cycling-friendly by providing information and bike parking infrastructure, on request.

An extreme situation where there are too many bicycles (dubbed "bicycle pollution" in Japan), either abandoned or left for long periods of time in one place, may require regulations, although providing suitable facilities through adequate planning, investment and design is the preferred option. Cities should make provision for cleaning up and retiring abandoned bicycles when necessary, and have an adequate procedure to judge whether a bicycle is truly abandoned (in some cases, leaving a simple sticker with a warning for a couple of days). Sometimes this can be done in conjunction with a program for recovering the vehicles.

12.7 Cycling as an economic and social activity

12.7.1 Bicycle-taxis in their different forms

Bicycle taxis have been described as a viable service in Chapter 10 on integration. Just as commercial motorized vehicles such as trucks and taxis are subject to special regulations, some human-powered vehicles such as cycle rickshaws operating commercially may also be subject to regulation. Most commercial vehicles are regulated for four valid reasons:

- To protect consumers;
- To limit adverse traffic-related impacts;
- To protect operators;
- To avoid oversupply of vehicles.

In most first world cities, cycle rickshaw taxi services are relatively scarce. As such, they have remained completely unregulated. No licenses are required and fares are unregulated and negotiated case by case. Municipal authorities only require that operators hold insurance for the passengers in case of an accident. In some European cities, these vehicles must have a vending or operating license, while in others they do not.

In developing countries, regulation of cycle rickshaws varies from country to country and city to city. In Bogotá, the situation is similar to developed countries, as pedicabs were unregulated in the beginning. They number about 200, and circulate only on the main bike paths, which are wide enough in most places. These pedicabs are privately owned and have ads in the rear (advertising mobile phone and alcoholic products) and there is no formal charge for their use, but a decent tip to the driver is expected for a home-to-work ride. However, around 2004, bicycle taxis were banned from the streets, even though they provide a suitable feeder services to BRT stations.

Often municipalities try to limit the number of licenses issued to reduce total numbers. This may be reasonable: as with motorized taxis, an oversupply of cycle rickshaws can lead to large numbers of unoccupied vehicles cruising for passengers, contributing to congestion. Furthermore, the profits per vehicle drop if there is oversupply. This prevents cycle rickshaw operators from making a liveable wage and undermines reinvestment in modernization. A final reason to at least register cycle rickshaws is that they are often operated by transients who sleep in the vehicles. As such, they are sometimes associated with illegal activities. Registering the operator and the vehicle offers local residents and users some protection.

Cycle rickshaw design requirements and limits on their number can determine how effective a regulation of this nature is. In practice, the effort to restrict their total number has often failed. Thus, regulations should be carefully studied and abuses avoided.

In Delhi, for example, there are an estimated 500,000 cycle rickshaws operating without a license, mostly in outlying areas. In the higher income and hence more profitable parts of the city, licenses are required, giving control of the market over to the *maleks* or big fleet owners, who are sometimes said to form a kind of "local mafia". Thus, the primary result of the licensing requirement is to allow maleks to extract extra rents from the cycle rickshaw *wallahs*.

Figure 176
Bicycle taxis in Europe (in this case, Amsterdam, Netherlands) are increasingly common.
Photo by Carlosfelipe Pardo

Figure 177
Bicycle taxis in Bogotá, though currently illegal, provide a good service.
Photo by INSSA

The Indian Case

In most Indian cities where cycle rickshaws are allowed, operating them requires a license. In Delhi, getting the license is difficult and often requires going through a malek (fleet owner), who rents the vehicles, or a financier (who sells vehicles on credit at fairly high interest rates).

Figure 178: *Rickshaws in Delhi*
Jan Schwaab (taken from GTZ Photo CD 5)

Oddly, the vehicle licenses are issued by the Veterinarian Department of the Municipality, because they were historically lumped together with animal traction vehicles. These regulations stipulate very specific sizing requirements that did not in fact correspond to any of the actual sizes of the mass manufactured models. They also required the presence of mud guards and a canopy for the sun, but do not require that the canopy be functional.

ITDP's improved Rickshaw-Technology Project in India

A recent ITDP project to improve the traditional Indian cycle rickshaw for commercial use was the first of its kind in India. For over 20 years, engineers there had worked on superior cycle rickshaw designs, but none went into commercial use. This reflected the fact that these efforts were based primarily in universities and research institutes, with little connection to the actual cycle rickshaw industry. Designs themselves were not grounded in commercial reality and projects focused on design, and failed to incorporate the marketing and promotion critical to commercial use. In 1997, ITDP and the Indian Institute of Technology put together a team of US and Indian human-powered vehicle designers. Working directly with the cycle rickshaw manufacturers as partners, they developed and commercially tested over 20 new designs, one of which proved to be commercially accepted. This design was 25 kg lighter, had two speeds, a strong integral frame, a more comfortable passenger seat and a permanent canopy.

Ultimately, the new design won commercial acceptance, because ITDP spent over $25,000 on public relations, advertising and promotional events with potential buyers and political leaders. Commercial viability arose from the fact that customers preferred the new designs, because they were more comfortable, while the vehicle itself cost less to manufacture than the original vehicle. The project also worked directly with local financiers and fleet owners, rather than trying to circumvent them for social reasons. Ultimately, a slightly heavier (only 10–15 kg lighter than the original) one-speed retrofit (which allowed the cycle rickshaw owner to retain the original bicycle front-end of his own vehicle, while providing the more comfortable seat) came to predominate commercially in Delhi. In Agra and Vrindavan, a one-speed version of the project's original model remains predominant. To date, over 12,000 of these modernized cycle rickshaws have been manufactured and sold, and they are highly visible particularly in Vrindavan, where the entire fleet has been replaced, certain neighbourhoods of Delhi, and in the Taj Ganj and Dayal Bagh neighbourhoods of Agra.

More modern designs of bicycle taxis have been developed in Europe, as discussed in the chapter on intermodality (see Chapter 10). These have different characteristics than those described above, but could eventually become applicable in the developing country setting.

In Surabaya, there is active debate over the feasibility and desirability of limiting the numbers of becak operators. The ideal number, according to the becak union, is from 30,000 to 40,000, and there are currently around 42,000. Currently, they pay Rp 7,500 (US$0.75) for a three year operator's license to the Road Traffic Office, and they pay a one-time Rp 40,000 fee (US$4.00) to the police to own a vehicle. In Yogyakarta, Indonesia, the situation is similar. Operators pay fees to register and operate their vehicles.

In Delhi, there have been discussions of scrapping the old licensing system and allowing anyone willing to pay a yearly fee to get an identification card to register to operate the vehicle for free. Another proposal has been to divide up the city into green zones (no restrictions on the number of vehicles), amber zones (some restrictions), and red zones (none of these vehicles allowed).

On the other hand, Indonesia's LPIST (an NGO active in 1980s and 1990s) made the most interesting regulatory proposal. They suggested that neighbourhood committees should register and determine the number of cycle rickshaws allowed to operate in their territories. Those with operating licenses would form a small union, in charge of protecting their territory, with support from local neighbourhood committees. This system worked well on an informal basis until a city-wide ban was reintroduced in 1998.

An important reason for adopting regulations is that when no regulations exist, the natural increase in rickshaws will perpetuate its image as a disorganized service, which has sometimes contributed to banning the vehicles. If, as with any other transport service, this one is properly regulated, it would enjoy greater acceptance and pose fewer problems. These considerations also form part of debates about economics and social equality, which are the purview of each country and city.

12.7.2 Cycle-related tariffs

Since bicycles are a sustainable transport mode and generate benefits to the population, it is reasonable to reduce taxes and import costs to promote their use.

Import duties

Imported motor vehicles also generally face tariffs and other user fees. In general, these fees are reasonably progressive in developing countries, where motorists tend to belong to higher income groups, and where motor vehicle operation generates a lot of externalities, such as wear and tear on roadways, obesity-related illnesses, and air pollution.

In contrast, all income groups tend to use bicycles, and in many developing countries

Basic mobility now costs less

Reducing bike tariffs

On June 13th, 2002, the Kenyan government announced the elimination of bicycle import duties. The decision came on the heels of a rise in petrol prices, and should give a significant boost to bike sales and use. The International Technology Development Group in Kenya was a key force behind the decision.

The Tanzanian government has yet to remove bicycle import duties, although they have recently reduced the duty on bicycle tires by 10%. In a country where the average price of a bike is Tanzania Shillings 60,000 and the per capita income is Tanzania Shillings 270,000 per annum, this is an important first step but does not go far enough.

The Association for the Advancement of Low-Cost Mobility (AALOCOM), which lobbied for the reduction, hoped to convince the government to follow Kenya's lead and reduce the duty on the entire bike.

The benefits of reducing or eliminating the tax are numerous. With access to this low-cost transportation, villagers can take grain to the market in larger quantity and more quickly; children in rural areas can reduce their travel time to school by hours; traditionally disadvantaged groups, such as women, can increase their access to self-employment opportunities. In short, the benefits of the reduction or elimination of the import duty are significant.

In 2005, the OECD stated that bicycles and their components could be considered "environmental goods". The report notes: "The environmental benefits of bicycles as flexible, affordable and non-motorized transport have long been recognized, but their full potential has yet to be realised… they are ideal technologies for assisting in poverty reduction, sustainable development and changing patterns of consumption."

Adapted from ITDP sustainable transport newsletter, August 2002 and April 2006.

their use is concentrated among lower income groups. Bicycles do not generate significant negative externalities either in terms of wear and tear of roads or air pollution and they positively affect health. Thus, any tariffs on bicycles tend to be regressive. They vary widely from country to country. In some Asian countries, tariffs on imported bicycles have been kept high to protect domestic industry and discourage their use. In Bangladesh (1989), for example, taxes on imported bicycles and most components were 150%, while import taxes on cars were only 50%, and on small transit vehicles, motorcycles, and trucks, only 20%. While some of these measures aimed to protect Indian bicycle manufacturers, for 80% of the components Bangladesh has no domestic manufacturing capability.

Since both India and China have joined the WTO, tariff barriers on bicycles in both countries are falling. Both have large low-cost domestic bicycle manufacturing, but Indian manufacturers already face competition from Chinese imports and Chinese-owned manufacturers in Bengal.

12.7.3 Regulations to improve human-powered vehicle technology[52]

Regulations, governing imports, exports, technological innovation, different kinds of subsidies, can play a key role in developing new technologies. This section explores some of the areas this kind of regulation can cover and the kinds of impacts that should be sought.

For many years, transport experts comparing Africa and Asia have noted that the vehicle mix in Asia is far more diverse than elsewhere, in terms of both motorized and human-powered vehicles. This offers Asians a broader range of choices involving speed, comfort, load capacity, and costs. Many human-powered vehicles ubiquitous in Asia are rarely found in Africa, among them cycle rickshaws. Asia and Africa share a common problem in that existing human-powered vehicles, namely standard bicycles and work cycles, tend to be of poor quality, and outmoded or inappropriate design.

The typical bicycles in Africa have for years been the traditional black English roadster, which for a while was manufactured partly in Africa, but today is made almost entirely in India or China. Only recently has a market developed for mountain bicycles. Neither type is really ideal for African utilitarian cycling, as the imported mountain bikes are of poor quality and too flimsy for utilitarian or work use, while the old English roadster with its large wheels and frame and narrow tyres is not the best design for operating on dirt tracks or bad roads. Moreover, these bicycles have been designed for men. They do not meet women's needs and physical characteristics, making it more difficult for women to use a bicycle, especially over long distances. Bicycles are normally too big and with inadequate frame design.

Work cycles, vendors' carts and other human-powered vehicles used in Africa today haven't changed for decades or, in the case of animal

Figure 179

Women require bicycles that facilitate the activities that go with their gender/culturally associated tasks and roles. A woman's bicycle must be comfortable for her to use, particularly in terms of the type of seat, positioning of gears and brakes, balance, reach to pedals, and so on. It must also carry diverse, often heavy or delicate loads, including small children, and adapt easily to the specific clothing that women in different cultures wear. All this makes special designs imperative.

Photo by Carlosfelipe Pardo

[52] This section has been adapted from "Human-Powered Transport in African Cities" by Walter Hook and Jürgen Heyen-Perschon.

drawn carts, for centuries. These vehicles tend to be heavy, slow, and of poor ergonomic design. The good thing is: they do tend to be fairly robust, resist damage and are relatively easy to repair.

The human-powered vehicle industry in Africa tends to be dominated by small scale, traditional family-run businesses. Because they require low-capital investment to enter the business, these industries offer low profit margins, making their owners extremely risk-averse. Also, they have little money to invest in marketing, promotion, technological innovation, or even in testing new products commercially available elsewhere but for which a domestic market has not yet been tested.

Development institution-led efforts to foster the development of a steady commercial supply and demand for intermediate human-powered transport vehicles in Africa have had only modest success so far. But there is room for optimism. Ongoing efforts to introduce better utilitarian bicycles are in their early stages. There have been several experiments involving the import of a small number of Asian cycle rickshaws into African cities (in Kenya and Ghana), but none of these efforts became ongoing commercial ventures.

For freight vehicles, in the most successful case, one private manufacturer continues commercial sale of some 25–30 bicycle trailers per year. Many of the vehicles themselves, most made under the auspices of World Bank and DfID[53] –funded initiatives in Ghana, or Institute for Transport Development Policy (ITDP) initiatives in South Africa, have largely been frozen for lack of an institutional framework to provide ongoing maintenance, and the necessary tools, repair skills, and spare parts.

12.7.4 Work with local partners on human powered vehicle development

Commercializing — selling bicycles

Note that local companies are normally key partners in improving human-powered vehicle (HPV) design and development, even when foreign bicycle factories are involved in the process. The California Bike project in Africa was led by a non-governmental organisation (NGO), which worked with a team of 35 independent bicycle dealers and international firms to make high quality, fashionable, utilitarian bicycles, affordable to the African consumer. This resulted in a price 25% below market rates. Prior to this initiative, the African bicycle industry lacked the credit, capital, and contacts necessary to bypass intermediaries and achieve a large enough scale to reduce prices. Many African business owners also lacked the expertise to run a successful bicycle business. The goal of this project is to become financially self-sufficient and run by African entrepreneurs.

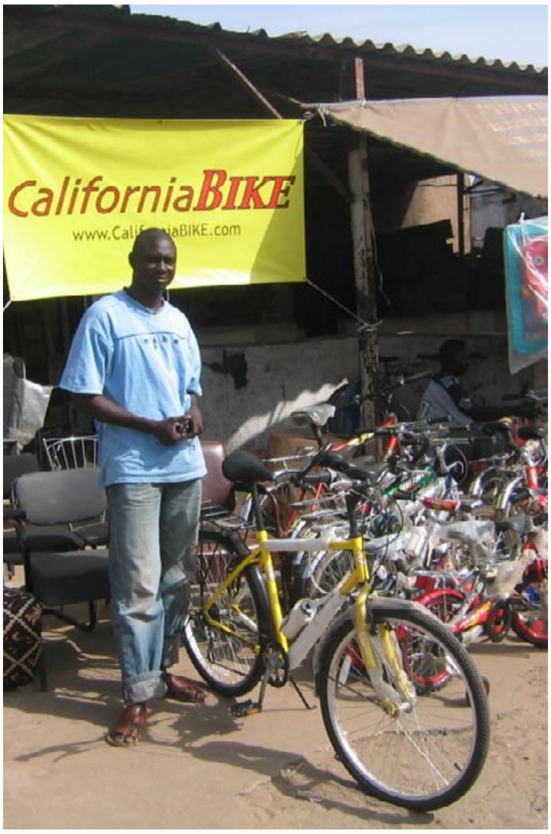

Figure 180
California Bike Project.
Photo by Bradley Schroeder

HPV maintenance

Workshops and relatively simple training sessions with local shops can improve human-powered vehicle maintenance and repair. This works when vehicles are in relatively acceptable condition. When vehicles are in poor shape, maintenance is not enough. (For a more detailed exploration of this issue, see the report Locomotives Full Steam Ahead, volume 2. Practical Action in Sri Lanka organized training courses for bicycle maintenance and repairs which had a positive impact on local bicycle use.)

53 Department for International Development, United Kingdom.

12.7.5 Bicycle availability in low-income sectors

Although usually bicycles are not very expensive, people surviving on very low incomes may not be able to afford them. There have been some initiatives to improve this situation. One way to improve access to bicycles is through bicycle donation programs. Typically, an organisation in a developed country receives used bicycles and ships them to a counterpart in a developing country, which fixes them before donating or selling them. The main cost is shipping, which normally involves a single full container shipment. Repair costs are normally another concern. One major issue is that the bicycles are seldom in acceptable shape. They may lack parts, which may have been discontinued or may not be available in the receiving country. The Cape Town chapter in the Locomotives Full Steam Ahead report, Volume 2, includes a case study on a program of this nature.

12.8 Cycling and the law: red herrings and myths

There are a number of misconceptions regarding bicycles and other human-powered vehicles that must be clarified, since they tend to lead to poor regulations. The most predominant misconceptions are presented below.

Bicycles are relics from the past: in some developing countries, people tend to view bicycles, rickshaws and similar human-powered vehicles as representing backwardness and lack of economic progress. This is normally tied to the assumption that owning and using a car denotes progress and "first world cities". In fact, bicycle use is on the rise in most developed countries, even those that have traditionally given priority to cars. Though cycling is chosen predominantly due to its practicality (which in turn is a result of proper policies), this also reflects rising gas prices and, to a lesser extent, concern about the environment, or strategies to deal with unsustainable congestion, which cannot be resolved through other traditional strategies, as discussed in Chapter 2 of this handbook.

Technically speaking, the bicycle and the automobile are about the same age. Both could only be invented after the ball bearing. In the late 20th century, bicycle technology advanced, making bicycles more versatile, thanks to new gear systems, suspension, bicycle lights, luggage carrier systems, and so on.

Human-powered vehicles are dangerous to users and their use must be limited: Since many road traffic injuries and deaths involve HPVs, it is generally assumed that their circulation poses a risk to all users. Nonetheless,

Figures 181, 182
Bicycles are many times seen as an old, inefficient and dangerous vehicle, while in European cities they are seen as just another transport mode.
Photos by Carlosfelipe Pardo

it should be clear that such risks result from improper planning and priorities based on high-speed networks for motorized vehicles. In fact, research shows that an increase in bicycle use correlates with increased road safety (this effect has been termed "safety in numbers").

Human-powered vehicle users are more at risk due to exposure to pollutants: Many people assume that riding a bicycle is more hazardous to users' health than driving a car. However, as discussed in more depth in Chapter 2, the available studies have found that drivers are exposed to higher concentrations of pollutants and may actually be more at risk.

Bicycle users must wear a helmet due to safety risks: Several researchers have pointed out that the Netherlands, Germany and Denmark have the highest cycling and safety rates and helmets are not mandatory. The United States, typically seen as relatively unfriendly to bicycle use, is very strict on mandatory helmet use, while a UK study found that drivers are more careful of cyclists they perceive to be women, that is, with long hair! In general cyclists do not have more head injuries then other road victims, including car drivers and pedestrians. It is difficult to see why the helmet debate is so much geared only to cycling. Moreover, experts hotly dispute the effectiveness of bicycle helmets in terms of preventing serious head injuries or deaths. Time trend analyses suggest that increasing rates of bicycle helmet use do not result in a significant decrease in head injuries. Even if they would be effective, helmets only could contribute to the secondary safety of cyclists (cushioning the outcome of an accident). As discussed elsewhere in this handbook, measures to improve design and thus

Figure 183
Contrary to what is perceived, people driving cars are more exposed to heavy pollutants than bicycle users.
Photo by Carlosfelipe Pardo

Figure 184
Cycling-friendly facilities (infrastructure, signage, parking, etc.) and policies should be the top priority of governments interested in this topic, and they should avoid relying on highly restrictive and discouraging policies such as making helmet use mandatory.
Photo by Carlosfelipe Pardo

prevent accidents are more effective, as shown by Denmark and the Netherlands.

As Figure 185 illustrates, heavy restrictions feed a vicious cycle that both limits the use of human-powered transport and tends to increase the frequency and severity of accidents.

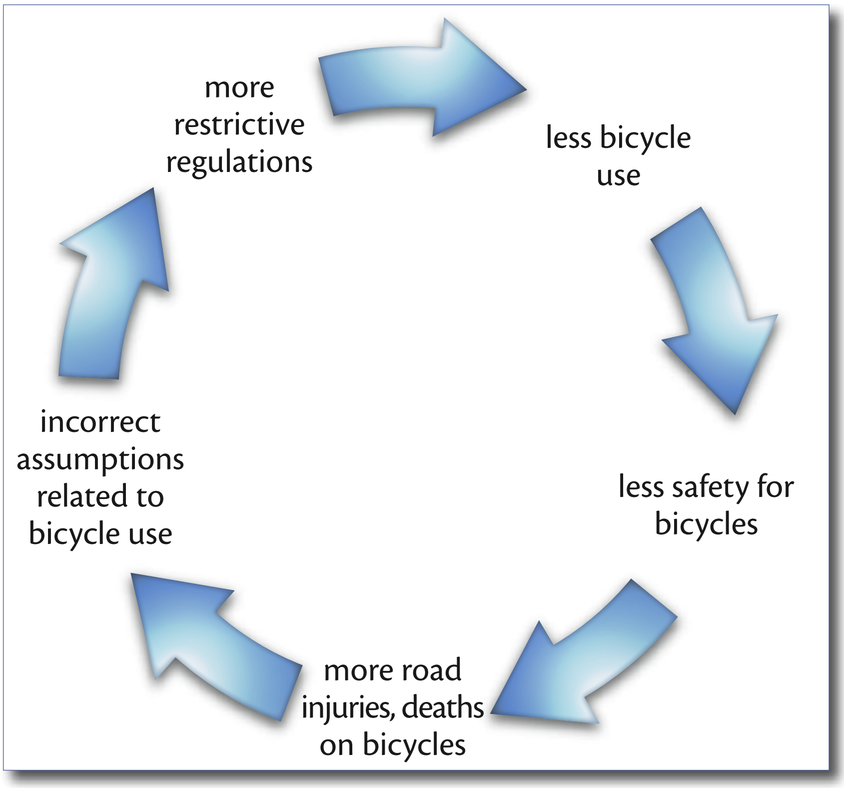

Figure 185
Cycle of assumptions – regulations and safety of bicycle use.

When these assumptions are corrected and regulations suitably adjusted to become cycling-friendly, HPVs tend to become more widely used for urban transport. As this handbook suggests, the best approach is a blend of infrastructure, policy and promotion initiatives, sensitively adapted to local contexts.

12.9 Futher reading

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13. Social marketing and citizens' participation: good relationships build better cycling facilities

Roelof Wittink

Cycling policies only become effective when decision makers have properly assessed cyclists' needs and incorporated them into the planning process. In this chapter we will present two of the main approaches to integrating this component into a successful policy for cycling-inclusive planning: social marketing and citizens' participation. From marketing we learn that a demand orientation is key to selling a product. In social marketing, a social interest is at stake, but the demand orientation is equally important. Theories of governance for sustainability, meanwhile, teach us the importance of active, concerned and committed citizens to both build effective policies and contribute to their successful implementation.

> ***Governments cannot simply rely on their authority to govern and impose solutions. Achieving policy objectives always involves exchanges and negotiations between government and citizens.***

The quality of cycling depends on different kinds of measures, which have to be fine-tuned to the skills, wishes and perceptions of different categories of cyclists. People differ in how they make tradeoffs between options. Road infrastructure is a key product, but many other products and services are needed to complement it, among them parking provisions, proper bicycles and accessories, education, and so on.

Different actors in the public and private sectors and civil society must contribute, to achieve quality cycling conditions. They can participate together in a marketing analysis of cycling, assessing the right mix necessary to meet the needs of a wide range of cyclists. To promote the development and implementation of cycling policies, a structural process of consultation between the public sector, the private sector and civil society is essential, particularly where a cycling policy does not initially exist. The aim of such a consultation process is to ensure that actors contribute according to their particular responsibility or core-business to a concerted effort to meet cyclists' needs.

This chapter will present and explain the components of social marketing and outline an approach for a structured consultation process.

13.1 Social marketing starts long before the sales pitch

The use of traditional marketing techniques to contribute to cycling-inclusive planning processes and promotional campaigns can make the difference between failure and success. This is because many private and public sector actors, who could be contributing to a general effort to improve conditions for cycling, do not understand the needs of (potential) cyclists and the barriers they face.

A city or an individual company may have a policy to encourage cycling and thereby reduce obesity and other health-related problems among its staff, but if, for example, cyclists have to stop every 100 metres at traffic lights and wait behind cars and trucks, inhaling emissions, they will cycle less, particularly if a good alternative route to their destination does not exist. Even the most beautiful looking infrastructure will not be enough to overcome this limitation and cycling promotion will fail.

If only mountain bikes, which do not serve the needs of cyclists who must shop or carry children, are available on the local market, then efforts to get more women riding bicycles will also fail. Therefore it is important to develop cycle-centred components within the local economy. Often, this offers excellent opportunities for the small businesses that provide the vast majority of jobs in many countries' economies.

Social marketing can also help to change cultural attitudes, opening people's eyes to

For related subjects

See ***Chapter 2***, on the City We want to Live In.

See ***Chapter 4***, on How to organize the policy making process.

See ***Chapter 10***, on Modal integration.

See ***Chapter 14***, on Education and promotion.

See ***Glossary*** on civil society and non-governmental organisations.

alternatives they may not have considered previously. For example, bicycles with proper accessories are excellent aids for carrying bulky or heavy packages. Social marketing can show this to users and therefore help to line up their personal experience and perceptions with desired travel behaviour.

Marketing is much more than a promotion strategy. Promotion occurs late in the marketing process. It seeks to make products and services known and invite people to use them. But prior to promotion, people's needs and preferences must be assessed and an inventory compiled to identify what will make people change their behaviour. If a product is not demand-oriented, promotion always fails. Governments cannot simply rely on their authority to govern and impose solutions. Achieving policy objectives always involves exchanges and negotiations between government and citizens.

Like the policy cycle (see Chapter 4), a marketing plan, consists of several stages. It starts with an analysis and proposes measures that, after implementation and evaluation, result in a new situation that must then be analysed anew. A demand orientation should be present throughout the different stages.

Questions to address include the following:

- What are the target markets to promote cycling?
- Which consumers are most sensitive to a message that emphasizes, say, cycling's contribution to society?
- What types of bicycles and bicycle provisions do target market members prefer?
- What is the optimal segmentation for bicycle products and facilities, and for messages to promote cycling?
- What are the best messages to communicate cycling and promote social interests?
- Which public and private actors can we involve to help develop and implement the right mix of actions?
- How do we show the impact of these actions so that we can help sustain cycling policies with a positive impact on societal well-being?

13.2 The marketing plan

Again, the stages involved in a marketing plan represent an ongoing, cyclical process, requiring that the relevant groups follow these steps:

1. Analyse the situation;
2. Break the target group down into more precise components;
3. Set targets;
4. Specify measures;
5. Implement measures;
6. Evaluate.

These steps are described in detail below:

13.2.1 Analyse the situation

A situation analysis involves a set of procedures to define the specific problem, then identify key factors, needs and policy alternatives.

Problem definition

For problem definition it is important to take into account the different settings in which problems are defined: *e.g.* governments and advocacy groups may use different data and categories. Government agendas, for instance, may include costs for health care, climate change, road safety and congestion. Countries with high motorization rates may take the approach that much of the reduction in traffic-related CO_2 or other dangerous emissions can be achieved by changing a specific percentage, say 30%, of short car trips to cycling trips. Countries with low motorization rates may consider cycling facilities one way of reining in rising car use and making a significant contribution to controlling climate change and reducing air pollutants that may be killing thousands of people every year.

How problems are defined depends on who is doing the defining. People's definitions of problems reflect different interests and the problems they experience reaching destinations in a safe, low-cost and comfortable way.[54] Governments may express annoyance at how cyclists behave, while cyclists feel neglected by road design and provisions, leading to very different perceptions about traffic problems.

Influential external factors

External factors of influence can be political, economic, technological, cultural, etc.

Political: Even when politicians are committed to promoting cycling, policies may vary substantially. In one city, cars may enjoy first

54 ICE, Locomotives: Full Steam Ahead; Low Cost Mobility Initiatives Support Program 2003–2006.

Figures 186–190

Positive examples of women who are involved in cycling: promotional activities, educational campaigns, cycle training and instruction.

Top photos, by Tom Godefrooij (Santiago, Chile). Middle row, photos by Bradley Schroeder (left, Senegal), ITDP (right, Cape Town, South Africa) and bottom row Hans de Jong (Paris, France).

priority in road design, with whatever is left going to human-powered transport (HPT). Another city's policy might give first priority to pedestrians and cyclists.

Economic: Africa offers a clear example of the impact of local economic realities. There, the lack of a bicycle industry is an obstacle for cycling use.

Technological: As a third external factor, technology can, for example, encourage cycling by improving bicycle parking in economically developed countries, while in developing countries improving the quality of bicycles themselves may contribute, as these are often of very poor quality.

Cultural differences: These remain enormous. In many countries, bicycles are still considered a vehicle for the poor. Elsewhere, women cyclists are subjected to disrespect and even abuse. In contrast, in the Netherlands, even the queen does not hesitate to use a bicycle.

Analysis of needs

To analyse needs, (potential) cyclists should be regarded as both consumers and citizens, with many interests to stir. Their reasons for not using a bicycle may be reasonably objective: expense, major road risks, long distances involved in daily commutes. Or they may be more subjective, reflecting typical attitudes and habits.

Inventory of potential measures

By defining problems, identifying influential external factors and analysing needs, planners

Figure 191

South Africa (Grassy Park High School). Boys need bicycle training.

Photo by I-CE, Bradley Schroeder

Box 26: Cyclone in Sri Lanka

The Sri Lanka Cyclones offer a good example of problem definition, agenda setting, mobilization and increasing political commitment.

With the popularity of motorized vehicles, a car-centred culture developed in Sri Lanka. As part of this trend, the bicycle was perceived as the poor man's vehicle. Infrastructure does not serve the growing number of vehicles and there are no specific facilities for bicycles. The general perception is that bicycles on the road are an unsafe mode of transport.

Practical Action-South Asia designed user mobilization campaigns to address these problems and achieve the following objectives:

- Emphasise the importance of cycling within urban transport systems in Sri Lanka;
- Popularise cycling among youth, especially school children;
- Reach out to and convince policy makers to create space for cycling;
- Create a platform for policy advocacy, emphasizing cycling's main benefits.

Two annual events, known as ***Cyclones***, have been organised; in 2004 in Colombo and in 2006 in Kurunegala. This is a ***mega cycling rally*** during which thousands of cyclists converged on a central point and main event from two or three directions. The main event involved multiple activities, attracting media attention to highlight the importance of cycling in overall transportation. Major political figures and celebrities participated. The main message was: "Cycling is an environmentally friendly, low-cost, healthier and quality-of-life-improving transport mode." ***Cyclones*** were planned to generate a platform for advocating the inclusion of cycling within overall transport planning.

The ***most significant impact*** of the Cyclones was that, convinced by the preparatory campaign, in 2004 Prime Minister Mahinda Rajapakshemade announced a ***public commitment to mainstream cycling*** within transport development. Later this Prime Minister won the presidential elections and directed the National Roads Development Authority to develop a working mode to implement cycling in future highway development.

Box 27: How changing attitudes is key to improving cycling conditions

The ***Boda-Boda*** business in ***East Africa (Uganda, Kenya, Tanzania and Ruanda)*** illustrates how external influences, in this case cultural attitudes, play a major role in cycle-related decisions. The ***boda boda*** is a bicycle taxi, which technologically speaking is very simple: a bicycle with a cushion on the back seat and a foot support on each side of the main frame. The widespread use of the ***boda boda*** indicates both that many people can not afford to buy a bicycle and taxis are an important source of employment for many. Many young urban men find work as ***Boda-Boda*** operators. Although they play an ***increasingly important role*** in low-capacity public transport in urban areas and offering transport services for many types of goods, their image is rather negative. Sometimes the police confiscate dozens of bicycles. Another major problem is the ever present danger of accidents with motorized vehicles. There is no political support to this very low cost and labour-intensive service.

Box 28: Collecting data on users' needs can strengthen policy proposals

In ***Nairobi***, the civil society organisation ***Practical Action*** collected qualitative data as an entry point and an important way of stimulating demand for cycling at the city and national levels, and integrating planning for cyclists as part of transport policy. Members interviewed cyclists carrying groceries, commuting to and from work, operating ***boda-boda*** taxis, involved in sports and leisure activities, and working as bicycle technicians and repairers. The interviews highlighted the main issues affecting cyclists:

- ***Low quality bicycles and spare parts***, which affected costs and safety;
- Law enforcers' and other road users' ***disregard for cyclists***;
- ***Lack of clearly designated cycling paths*** and signs, which impeded smooth cycling;
- ***Poor knowledge of traffic rules among cyclists and other road users***, making them vulnerable to accidents.

can usually produce a long list of potential measures. These must then be fine-tuned to match different target groups and general policy targets.

In this sense, the list involves three kinds of components within the transport system: people, vehicles and roads. Before people start cycling on roads, they need preparation through education and training, to achieve the necessary skills to ride a bike and knowledge of how best to behave.

The vehicles, in this case bicycles or tricycles have to fit users and their needs. For example, sport or mountain bikes are not well suited to carrying children or goods. Bikes without gears are not suited to hilly terrain, racing tyres often perform poorly on heavily patched or cobblestone roads.

As discussed elsewhere in this handbook, the road system should protect cyclists from accidents, provide direct routes, and offer comfort, an attractive environment and a coherent network of facilities.

13.2.2 Target group segmentation

People's perceptions of cycling and whether it is an option for them varies enormously. The more specific the situation analysis, the more tailor-made intervention design, the better interventions can be defined and the easier it is to exclude measures likely to be ineffective.

It is impossible to develop tailor-made measures for each individual, but some differentiation between users is essential. Gender, age and trip motives are among the most significant variables for target group segmentation. These variables must be concrete and measurable. A target group must be large and significant to justify efforts to reach its members through specific interventions.

13.2.3 Target setting

Targets focus policies and guide resource development. Targets have to be measurable and realistic. Well-articulated targets ease communication between policy makers and intermediate organisations and they enable monitoring and evaluation. But the main issue is to make intervention design tangible through a clearly defined target.

Targets can be set at different levels. Targets for cycling use usually look at bicycle use or cycling's share compared to potential and its relative advantages over other modes. Note, however, that cycling is usually a means to an end, rather than an end in itself. The overall target therefore involves quality of life and awareness of the contribution cycling can make to overcoming poverty, providing access to important services, reducing CO_2 emissions and climate change, improving health and contributing to sustainable development. To justify public investment, the link between increased bicycle and social, economic and ecological needs should be underlined.

At the cyclist level, broader targets may include fostering income generation and a healthier lifestyle. When asked to choose between the eight policy measures applied in Bogotá to improve quality of life, people rated bicycle paths as the second most significant.[55)] Broader targets at

[55] ICE, Locomotives: Full Steam Ahead; Low Cost Mobility Initiatives Support Program 2003–2006; Volume 2, Civil

Box 29: Cycling to school

School children constitute an important target group in many countries. In ***Delhi, India***, the local organisations, *Institute for Democracy and Sustainability* (IDS) and the *Transport Research and Injury Prevention Program* (TRIPP) worked together to develop and analyse the socioeconomic profile of school children and parents using and not using bicycles. Survey sample size was 2,000 and the survey was geographically distributed to be representative of the whole city.

Figures 192– 194

Kids to school on bicycle.

Photo by by ICE, by Rahab Mundara

In ***Bogotá*** (Colombia), the foundation *Por el País que Queremos* started a *speakers in schools program* serving the poorest areas of the city, to promote cycling paths and bicycles. To increase the number of people cycling to school, by supporting them with educational campaigns, necessary infrastructure and other strategies, they spoke at 20 schools, reaching almost 10,000 students.

In ***Ghana***, the *Centre for Cycling Expertise* (CCE) began *safe-routes-to-school projects*, in cooperation with municipal roads units. They interviewed principles, teachers and students at four schools, to find out how students travelled to school and whether they were able to use a safe route. If the routes were identified as hazardous, CCE proposed changes to improve routes. At least one school has already applied several measures to improve the safety of routes to school.

In the ***UK***, a highly successful national charity has pioneered *Safe Routes to Schools* programs that function at local, regional and national levels, involving parents, teachers, administrators and politicians in efforts to get children walking and cycling to school, for their own health and that of the cities we all live in.

the governmental level may be defined in terms of overall risk, emission reduction, reduced health care costs, improved social cohesion, the city climate, less congestion, and so on.

Instrumental targets may include reducing the risk of traffic accidents, providing more efficient and comfortable mobility, improving the status of cycling. By providing quality bicycles and infrastructure and by profiling cycling as fun and a major contributor to individual freedom, children's mental and physical growth can be improved.

Cycling is usually a means to an end, rather than an end in itself.

Copenhagen, for example, set a target of increasing cycling travel speeds by10% to improve efficiency, and implemented this by providing a "green wave" which means that cyclists travelling at 20 km/h avoid having to stop at red lights at 13 signalled intersections.[56] The challenge is to develop a mix of targets over time and to ensure effects are sustainable.

13.2.4 Defining measures

The next stage involves specifying measures for the marketing strategy. This requires specifying the characteristics of the product or service to be offered, the asking 'price' (what can users afford or what are they willing to give up), the distribution location and the promotional activities that must accompany the exchange.

Bicycle rental or public bicycle systems may be successful in some countries and conditions, but not in others. The wildly successful systems in Barcelona and Paris, for example, followed less successful experiences in the Netherlands, where the idea originated. But these were less successful largely because in the Netherlands almost everyone owns their own bike. So good ideas from one city need to be evaluated and adapted to ensure they function elsewhere.

13.2.5 Implementing measures

The ideal assumptions and relationships between targets and measures conceived of when developing a well thought-out plan always face a challenge when it comes to implementation. This makes it important to expect challenges and changes, and also unforeseen opportunities. Organizers should keep targets in mind and yet be flexible regarding interventions. Rigid application of solutions is less likely to win support and build sustainable alliances for immediate and future progress. Sometimes accepting a suggestion, even one that isn't that terrific, can be worth it, because it will turn outsiders or even critics into ardent supports of a plan that now contains something reflecting their own concerns or ideas.

Individualized Travel Marketing is a good example of a very specific marketing approach. The Sustrans program in the United Kingdom involved working directly with households to offer personalized information and support.[57] The city of Odense (Denmark) engaged eight people to knock on doors and briefly chat about alternative transport modes. There, people received a special transportation package. They were invited to fill out travel diaries and calculate health and other benefits, and received lottery tickets too.[58] Toronto (Canada) uses a program of cycling "ambassadors" to bring cycling information and assistance to potential users.

13.2.6 Monitoring and evaluation

Monitoring and evaluation examines the outcome of interventions and offers the opportunity for meaningful exchanges between planners and users. A good evaluation teaches everyone involved how needs and wants develop, what relevant dynamics are occurring

Society and Cycling Development; The Locomotives City Status Reports. Chapter 7, Bogotá, Colombia, p. 140. ICE 2007.

56 Nicolai Hoeg, Lars Bo Frederiksen, Traffic and Planning Office, Roads and Parks Department, Copenhagen: Green waves for cyclists in Copenhagen, in: Velo-City 2007, Munich, Conference program; Stadt- und Verkehrsplanungsbüro Kaulen, Aachen, Germany, 2007.

57 Neil Smith, Sustrans and Erhard Erl, Socialdata: Realising the Potential for Increasing Cycling through soft measures, in Velo-City 2007, Munich, Conference program; Stadt- und Verkehrsplanungsbüro Kaulen, Aachen, Germany, 2007.

58 Troels Andersen, Parks and Roads Administration, city of Odense: Active ways to promote cycling, in: Velo-City 2007, Munich, Conference program; Stadt- und Verkehrsplanungsbüro Kaulen, Aachen, Germany, 2007.

Box 30: "Public Bicycle" systems sweep major cities around the world

Bike rental or "public bicycle" systems came into their own during 2007, when Paris' new system attracted attention worldwide, inspiring cities all over the world to start developing similar systems. There are many variations on the basic idea, which is strongly market-driven and which requires a solid marketing plan for success. The key operational issues of public bicycle systems are presented in Chapter 11, whereas below are indications as to marketing issues related to such systems. We summarize a few of them here, because of how well they illustrate the principle of matching programs to people's interests and needs.

Germany's Call a bike

One example of a complete marketing plan is Germany's *Call a Bike*.[1] This initiative makes it possible for users to hire a bicycle any place (every intersection), any time, in many cities. The whole process, including payment, can be handled simply and conveniently by telephone.

Figure 195

The Deutsche Bahn (DB), the German Railway, supported local government in promoting cycling, by introducing the DB bicycle in many cities. In 2007, at the Velocity conference in Munich, Germany, they made 900 bikes available to conference participants.

Photo by I-CE, Roelof Wittink

The project also delivers an instant mobility service to tourists.

The problem definition that inspired this project was the need for a bike for a quick trip while in the city centre. Walking takes too long, car parking costs money and time, and public transport does not afford door-to-door service.

A bicycle hire system can work well with modern technology, making cycling an easy, low-cost mobility strategy. Even those who commute daily by car can contribute something to emission reduction by using the bicycle for additional trips.

German Railways market this product, with support from local governments. It has made a major effort to make the bicycle attractive: wherever they are, users can pick up a bike nearby, which they then drop off near their destination. There's no risk of theft, the rental is low, no coins are needed, and the bicycles are kept in good condition.

Bicycles also offer an attractive opportunity for advertisements, as other campaigns demonstrate. In 2006, the UK Bike Week campaign cost £150,000 for 1,717 local events, which generated media coverage worth £1,812,500, 12 times the budget.[2]

Paris' Vélib

Another program backed by a strong marketing plan is the Vélib public bike system in Paris. Vélib started in 2007 with 10,000 bicycles available at 750 stations and within six months had doubled these numbers. Every 300 metres in downtown Paris, users can pick up a public bike. Payment can be via a membership or a short-term subscription.

In 2001, Paris started to double its cycle ways. Early in 2006, the city tendered for a project won by JC Decaux, an outdoor advertising multinational, in alliance with Publicis, a large advertising and communications corporation. This joint venture covered the entire cost of implementing and managing Vélib, receiving exclusive rights to operate bus shelters, public announcement boards and

1 Juliane Uhl, DB Rent GmbH-Call a Bike: Call a Bike as supplement to public transport, in: Velo-City 2007, Munich, Conference program; Stads- und Verkehrsplanungsburo Kaulen, Aachen, Germany, 2007.

2 Ian Aitken, Cycling Scotland Bike Week: Promoting events that get more people cycling more often; in: Velo-City 2007, Munich, Conference program; Stads- und Verkehrsplanungsburo Kaulen, Aachen, Germany, 2007.

other street furniture (resulting in 1,628 lucrative advertising outlets). Revenue from the Vélib subscription and fees, expected to reach over €30 million yearly, goes to the city.

Vélib is an important component of Paris's new mobility plan, and has cut back on private vehicle traffic. Vélib alone is expected to double or triple the number of daily bicycle trips in Paris.[3)]

Bicing in Spain

Barcelona, Santander, Valladolid, Gijón, Córdoba and Seville are among the Spanish cities implementing public bicycle systems similar to that of Paris. Seville's Consortia de Transporte Metropolitano has gone one step further, with its BUS + BICI program, which provides free public bicycles to public transport users, who sign a simple contract that gives them access to a bicycle 24 hours a day during the work week. In Latin America, both Buenos Aires (Argentina) and Santiago (Chile) are investigating how to develop similar systems in down town and university neighbourhoods. For more information and a guide to setting up public bicycle systems, in Spanish, see: http://bicipublica.org/index.php?option=com_content&task=view&id=48&Itemid=42.

3 Luc Nadal, Bike Sharing sweeps Paris off its feet; in Sustainable Transport, Fall 2007, Number 19, ITDP New York.

within society and organisations, and what follow-up is most appropriate. This takes us back to the first stage of the process cycle. Indeed, it is important to incorporate users' views from the start of the policy or planning cycle, to prevent conflicts and generate broad understanding of and support for new measures.

13.3 Citizens' participation: both an art and a science

Direct exchanges between government and individual citizens are difficult to establish, given the diversity of citizens and the distances between national- and user-level perspectives.

We have shown how government can do a lot to meet citizens' needs through a social marketing strategy. Collective interest, however, is more than the sum of individual demands. Government measures are essential, especially regarding traffic rules, road standards and investment in infrastructure. While separate initiatives from government or civil society can be very important, getting the two to work together offers the most powerful combination.

The private sector, starting with the bicycle manufacturing, import and retail sectors, and society as a whole also have a great deal to contribute.

Finding a good set of measures is, therefore, a policy issue, but also requires leadership. The question is how to link a collective problem to individual behaviour. One solution is to create processes that foster exchanges between public and private organisations. This way, marketing elements can be added to central government directives and, at the same time, direction can be integrated into market mechanisms important to the private sector, and civil society initiatives. In this process, citizens' organisations or the government may take the initiative and spearhead participation from other actors. In a democratic process, the government must guarantee equality among citizens, establishing rules with regard to health care, risk prevention, climate change, and so on.

The public sector, the private sector and civil society organisations can jointly develop and implement policy, through working groups, round tables (such as the "platform" developed so effectively in the Netherlands), commissions, and so on, according to democratic traditions. Conditions that foster the healthy functioning of these instances include: a common definition of the problem, genuine and effective representation from citizens' organisations, and mutual cooperation among representative bodies and the public and private sector. Consultation, negotiation, compromises and exchanges are all vital instruments in this process. One key element is the flexibility in the composition of the working group, task force or "platform", which breaks with more rigid sector-based approaches.

Some recommendations for structuring consultations include:

- Rather than focusing on collective problems or individual freedoms, this process should be based on the connection between the two and should focus on building effective solutions;

- The institutional framework for public and private sectors and civil society is based on and makes the most of each sector's different approach to relations with citizens;
- It offers an opportunity to learn and adapt;
- It goes beyond single specific prescriptions to develop integrated strategies aiming to change behaviour.

Creating a suitable working group of this nature involves 12 steps:

1. Defining the mandate: since the government has to protect policy aims and democratic rules, it should formulate the basic guidelines for this instance. In the Netherlands a platform's mandate defines:
   a. Policy goals (such as a cycling-friendly city);
   b. Selection criteria for partners that can contribute (representation, problem relevance);
   c. A procedure that leads to results (data collection, decision-making, facilities, etc.).
2. Defining the scope and appointment of a coordinator: the scope could be a whole city or a municipality within the city, depending on the extent of the problem and the policy areas controlled by different governance structures. Typically, cycling coordinators come from outside of the government and their primary task involves managing interactions and building relationships through specific activities.
3. Preparing an inventory of the problem, social differences and institutional structures: This will produce a problem map (economic, social, environmental, health aspects), a social map (who are the users, how to differentiate) and an institutional map (organisations that can articulate the problems and organisations that can offer products or services).

Box 31: Ways citizens' groups and Government can work together

There is an enormous range of tools, instances, mechanisms for encouraging greater cooperation between governments and users' groups representing citizens that government policies attempt to serve. The *Bicycling Empowerment Network* in **Cape Town (South Africa)**, for example, brings together provincial departments responsible for transport, education and security to make bicycles available for school children, create road safety on school routes, and involve security guards in preventing bicycle theft and damage.

Under the auspices of **Living City (Ciudad Viva)** and *Ciclistas Unidos de Chile* (a pro-cycling coalition), a working group for cycling-inclusive design in Santiago (Chile) meets monthly to prepare an ***urban design manual*** based on the one developed by CROW (The Netherlands). The working group brings together a wide range of cyclists (beginners, experts, women, people of all ages and backgrounds), and representatives from Transantiago, the Bus Rapid Transit system; the national transport ministry; transport and urban planners from local municipal governments; academics; designers and other interested people to debate key issues and, based on the consensuses they are building, develop Chile's first design manual for cycling.

In **Toronto** (Canada), cyclists' organisations participate in regular meetings of the **cycling policy committee** (http://www.toronto.ca/cycling/committee/index.htm) and have access to city councillors and staff working on crucial areas, including budgets. Indeed, in many developed countries, governments put civil society organisations in charge of crucial programs, such as the Safe Routes to School program (http://www.saferoutestoschools.org.uk, UK), the National Centre for Bicycling and Walking (http://www.bikewalk.org/aboutus.php), the Active Living Resource Centre http://www.activelivingresources.org/index.php, US), and the Fietersbond the Netherlands), which is involved in certifying the quality of bike parking infrastructure, among its multiple activities.

Often, a city staff member who is also an enthused cyclist becomes a **key liaison** between colleagues, politicians and cycling groups or individuals, pushing policy and infrastructure in the right direction thanks to formal and informal relationships that provide firsthand information on what is needed and how those needs can best be met.

These initiatives reflect the **enormous flexibility of civil society organisations**, their ability to build the kinds of horizontal rather than hierarchical or authoritarian relationships necessary for successful policy innovation, and their many relevant skills.

4. Defining standards and targets: for example, a target percentage for cycling's share among urban transport modes, or for cyclists' road safety.
5. Reflecting on the scope (considering standards and targets): if the work area is very complex and the problem structure very heterogeneous, it may become necessary to reconsider the scope of the initiative. At this stage, it is important to search for opportunities to bring about change. Much of investment in urban road infrastructure is linked to huge public transport projects or events, such as the Olympic Games or World Cup Soccer. If such significant opportunities arise, this working group should make the most of these opportunities. Stakeholders in cycling will find new partners if they can make cycling part of the planning targets for larger projects.
6. Selecting and inviting relevant stakeholders: The selection of partners should result in good representation of users and those who can contribute to solutions. Users' participation is important to defend quality requirements. Governments and other service and product providers and experts, who contribute data and information on the costs and benefits of different measures, are also vital. In terms of key players, among those who can deliver services and products it is important to bring together those relevant to road provisions, vehicles, and those expert in focussing directly on users, through education and promotion.
7. Specifying and focusing the problem: all partners have to recognize the collective problem and at the same time feel their own interest represented. All potential stakeholders must deal with factors beyond their control, so it is rewarding to build long-term partnerships with friendly, capable people. Road behaviour is a result of road features, vehicle quality, and users' skills, knowledge and attitudes. If the focus is lack of mobility opportunities, several possible issues could be tackled: barriers to road infrastructure use, vehicle affordability, micro-credit schemes, and parking.
8. Making an inventory of behavioural factors: Here we lean on social marketing and/or citizens' participation to better understand why so many people are unable to cycle or feel unable to do it safely and efficiently. In developing countries, major barriers include road safety, bicycle affordability, lack of appropriate bicycles and related equipment for specific groups, such as women, and lack of specific provisions on roads. In developed countries, barriers include the priority given to cars, habits regarding car use, and again, road safety.
9. Integrating state-of-the-art solutions to problems: the different opportunities for interventions have to be evaluated against the group's mandate. Based on an analysis of the constraints on cycling, policies have to target the most influential factors. At the least, people and organisations responsible for road planning and design, for the bicycle market, for parking, for road safety, for public transport, for education, for police enforcement, have to be represented, together with users' organisations, governmental authorities and experts.
10. Defining measures needed, with reference to the available resources: Besides recognizing the different roles that different members of the working group can play, experts have to assess the impact of measures according to their substance, quality and integration into other, related measures.
11. Offering feedback, evaluation and adaptation: It is important to specify broader targets, the outcomes and the outputs expected from the different measures and actors, in order to monitor progress and adapt the total package, when results indicate this is necessary.
12. Recycling the process: After some time, a review of the scope and mandate will be necessary, particularly if significant new developments and opportunities arise.

Box 32: Governance structures that build strong effective participation

Cape Town (South Africa)

A good example of an effective structure for citizens' participation in cycling policies is the Non-Motorized Transport Forum (NMT Forum) established in Cape Town. The forum is part of the follow-up to an infrastructure subcommittee set up to support the Velo Mondial Conference (2006) in the city. This *Forum*, as it is known, shares a vision of Cape Town growing into a city with a general sense of well-being, through the development of quality, dignified urban environments, where people feel free to walk and cycle, space is shared, and everyone has access to urban opportunities and mobility.

The goal is to increase bicycle use and walking by creating a safe and robust bicycle and pedestrian network of paths to serve all the citizens in the Cape Town Metropolitan Area. In addition this should contribute to Cape Town becoming a world-class, cycling-inclusive city, thanks to the collective efforts of the City of Cape Town, the Cape Town Partnership, the province of the Western Cape, the University of Cape Town, civil society organisations such as Bicycle Empowerment Network (BEN), private agencies, and I-CE's Bicycle Partnership Programme.

The Forum will monitor the city's human-powered transport (HPT) strategy, particularly its Bicycle Master Plan, developed in cooperation with the province, and support the planning and implementation of several HPT projects, currently underway. It will support a network analysis and help identify key routes of prime quality, to bring cyclists from different points straight into the central business district no later than 2010. It supports the integration of facilities for walking and cycling into every plan to improve public transport.

The Forum will also focus on the needs for HPT surrounding the FIFA 2010 World Cup Stadium in Green Point and additional parks and act as a watchdog to ensure that HPT is sufficiently addressed. It will also identify key routes and projects needed to support the event. It will promote cycling in all its forms and facilitate projects, in partnership with the other stakeholders, providing the coordination necessary to ensure that car-free days, bikes to work, and special events such as the *Tour d'Afrique* are adequately planned and executed, maximizing media coverage and public interest.

It meets on a monthly basis in the city Cape Town offices or at the Cape Town Partnership, to discuss projects and the strategic planning necessary to meet its objectives. These meetings are open to visitors from the industry and interested parties and from time to time focus on specific subjects and include keynote speakers.

Forum participants exchange plans to maximize opportunities for contributions from different sectors. The city will provide chairperson and secretary, to facilitate the Forum's work. Every three months, the mayor is invited to chair a forum meeting.

Plans were for minutes to be circulated in the form of an e-bulletin to members, who were expected to contribute. Information gathered and produced by the HPT Forum may eventually be disseminated to a wider network of planners, engineers, NGOs and interested parties.

Dresden (Germany)

Another example can be found in Dresden (Germany). Here, the city brings all stakeholders together in 'cycling round tables', under management of the mayor. The round-tables are essentially a network that brings together local authorities, companies and pro-cycling groups, to make cycling more attractive and improve conditions. One of the objectives is to increase bicycle use on shopping trips.

Transportation surveys assist in getting the right picture. Shopkeepers tend to think they depend primarily on car drivers. A survey revealed that cyclists, who account for 14% of all shopping trips, are among the most educated of travel mode users and are certainly not poor customers. Exchanges with other towns and regions helped develop an inventory of diverse and innovative measures and to combine the topic with tourism as well.[1)]

Santiago (Chile)

In Santiago (Chile), Living City *(Ciudad Viva)* a community organisation serving local neighbourhoods and the metropolitan region, worked with professors at the urban studies institute at the nearby Catholic University and architects from Boston (US) to adapt the charrette methodology developed by New Urbanism to Santiago's reality and much more limited resources. The

[1] Customer Cyclist? Cycle promotion for shopping trips in Dresden, in: Velo-City 2007, Munich, Conference program; Stadt- und Verkehrsplanungsbüro Kaulen, Aachen, Germany, 2007.

result was a highly successful tool for bringing together all stakeholders and local, regional and national officials in an intensive three-day planning workshop that focuses on a specific social problem or design challenge.

The first charrette, held in November 2003, produced a plan to remodel Pío Nono street in the Bellavista heritage neighbourhood, to widen sidewalks and incorporate a cycle path. The second, 2006, produced a neighbourhood management plan that includes detailed sustainable transport measures including more cycle ways and routes, traffic calming and integration into the city's new bus rapid transit system.

Above all, the charrettes fundamentally changed relationships between neighbours, small businesses and local authorities, generating ties of mutual respect that have facilitated a wide range of formal and informal instances of participation, some as simple as calling up a local planner to comment on a problem and others as sophisticated as formal participation in reworking the zoning plan for a whole municipality.

Lessons learned

Among the lessons from these and other experiences:

- Building effective participation goes hand in hand with building effective citizens' groups and requires goodwill, horizontal relationships, and considerable expertise.
- Government officials involved in participatory exercises require preparation and support from experts. In transportation circles in particular, where engineers tend to predominate, not everyone has the "people" skills to handle social actors who, on first contact, may be angry, frustrated or downright incredulous about officials' willingness to participate in a genuine exchange.
- Where a wide range of citizens' groups exist, it is essential for the officials involved to be impartial in their treatment.
- It is extremely unwise for "experts" who are not very familiar with the real-life experience of cycling in a city to base planning and design decisions solely on their own criteria, without testing their views on the wide range of cyclists who will actually be using the facilities. Many cities can attest to the sad spectacle of significant investment in specialised cycling facilities going unused, due to design errors, many of which are obvious to users.

14. Education, awareness building and advocacy

Roelof Wittink

For related subjects

See ***Chapter 4*** on How to organize the policy making process.

See ***Chapters 6 and 7*** for sample check-lists and facility audits.

See ***Chapter 12*** on Social marketing and citizen participation.

See ***Glossary*** on civil society and non-governmental organisations, advocacy, education.

14.1 People are what make systems fail — or work as planned

This chapter focuses on three instruments that target the active involvement of people. These are different, therefore, from measures that primarily involve vehicles, infrastructure or other technical devices.

Education refers to systems that teach people to use their bicycles and the relevant infrastructure in the best possible way.

Awareness building refers to ways by which we teach people about the benefits of cycling.

Advocacy refers to the way individuals and particularly groups participate to promote cycling and move cycling up personal, private sector and governmental agendas.

Each approach involves different actors. Education requires primarily teachers and instructors, along with students, and in some cases, parents. Awareness building involves primarily marketing and communications techniques, while advocacy is usually driven by user representatives, that is, civil society organisations. Notwithstanding, the line between each can blur. Advocacy and awareness-building combine well. Many campaigns involve civil society organisations building awareness and advocating in favour of a new policy or initiative. Often advocacy groups also drive awareness building processes or start up educational activities that may later be taken over by the formal education system or the municipality. In the case of all three approaches, however, activities yield more when they are geared to specific target groups, identified in advance.

14.2 Education

Teaching people to use a bicycle well and safely in a wide range of traffic condition requires a great deal of learning by doing, combined with good preparation, knowledge of basic skills and education to reduce risks to a minimum.

This means that in the context of cycling, education must:

- Teach the skills necessary to ride a bicycle;
- Teach cyclists how to cope with traffic;
- Teach other road users how to cope with cyclists.

14.2.1 The function of education

Education's added value compared to planning or design measures is highly significant and, at the same time, relative. It is significant since it teaches people about safe, efficient and comfortable behaviour. Education also stimulates self-awareness, self-confidence and self-respect. Since traffic planners and designers use to give priority to the needs of motorized vehicles and since cyclists are more vulnerable when it comes to an accident, many drivers tend to act as kings of the road. Cyclists have to learn how to cope with this, handle frustration and to persist in cycling.

The significance of cycling education is relative in the sense that both road and vehicle design can have more influence when it comes to preventing serious accidents. Education and regulations alone cannot control traffic behaviour. For this, road and intersection designs are vital allies.

Education adds value to road design, because the latter does not explain precisely what behaviour is most appropriate. In urban areas in particular, traffic situations vary enormously and there is no set standard that applies everywhere, every time. Road users have to be flexible to cope with each other. Education can help.

Education adds value to regulations, because the latter don't always explain precisely what behaviour is appropriate. Like road design, rules help, but do not hold in every circumstance. They often do not differentiate between rain and sun; icy, wet and dry road surfaces; heavily congested or empty roads; simple and complex situations. Traffic functions according to a blend of formal and informal rules

Road design, regulations and education together should help all road users cope with each other according to the circumstances and conditions. Where cyclists, pedestrians and drivers share the same space, road design should enforce lower speeds. Design should strive to ensure that any mistakes, such as an incorrect interpretation of traffic situations, will be "forgivable".

Thus, technical provisions and education complement each other. Road design should evoke safe behaviour and education should teach defensive behaviour under varying circumstances. Technical measures can never make traffic 100% safe; education must provide support. People have to learn skills, rules, how to respond differently to different road conditions, and how they can make good use of facilities.

One example of this complementary strategy was the Kids Safer to School, or KISS, Guidelines, developed as part of the LOCOMOTIVES program.

14.2.2 *Different target groups*

Who are the main target groups for education and who should be involved in the education process?

Education plays an important role with regard to all novice cyclists. People have to learn skills such as controlling their bicycles and then know how to behave in traffic. When people's basic skills change due to a handicap, behavioural options may also have to change.

Box 33: Cycling education around the world

In cities and countries, such as the Netherlands, with a significant cycling culture, most children learn when they are young. Parents typically start teaching their children when they are still small, but do not allow them to ride in traffic. By age four, a significant number ride on certain urban streets, guided by an adult, usually a parent. At school they receive instruction to improve their skills. At eleven, they do both a theoretical and practical exam. They are also taught to ride the route to their secondary school, which is often further from their home and requires facing more complex situations.

For immigrants, training programs introduce adults who did not grow up with bicycles to important skills and knowledge. Most are women. Theory and practice are well integrated. Lessons are for groups, which enhances motivation. In Tilburg, for example, each year 70–90 women participate. The city supports women, particularly when cycling will facilitate their opportunities for income generation. These courses also result in promotion activities, such as tours for "cycling women friends".[1]

Elderly people, even those with extensive experience, may ask for additional training when they notice that their physical functions and skills are not as good as they were. They can compensate for this by more defensive behaviour. Many like to learn new behavioural patterns. Some additional organisations run adult training programs. The Dutch cyclists' union, for example, recently started up the "Fietsschool" (the Bicycle School), a network of trainers teaching different target groups at different levels.

Elsewhere around the world, a wide range of initiatives seek to bring cycling skills to those interested in making the bicycle part of their daily transport habits. In many cities, municipal or other levels of government offer courses to anyone interested, either as part of cycling promotion programs or as part of general recreational services. In Canada, the Canadian Cycling Association has developed CanBike, a comprehensive course that includes preparing and certifying cycling instructors (http://canadian-cycling.com/cca/education/canbike.shtml) who often work for city governments and other institutions (see for example, the Toronto program, http://www.toronto.ca/cycling/canbike/index.htm). In the US, many practitioners offer the Effective Cycling program developed by John Forester (http://www.johnforester.com).

In Latin America, the GEF cycling promotion project in Lima (http://www.proyectozoom.org) has studied European methods and adapted them to the local school system, training hundreds of school children to ride bicycles more safely. In Brazil, the Escola de la Bicicleta (http://www.escoladebicicleta.com.br/) has developed a comprehensive program for individuals, groups, companies and other instances interested in developing these skills. In Chile, meanwhile, the women's cyclists organisation, Macletas (http://www.macleta.org), CicloRecreovía, Bicicultura and Ciudad Viva started Escuela Bici Mujer, a two-month weekly course for beginners (women who had never ridden a bike before) in 2008, with plans for an intermediate course to encourage cyclists to get off sidewalks and take to the roads — safely, as did the women's cycling group in Quito (Ecuador).

1 http://www.steunpuntfiets.nl/English.html

Education to cope with traffic takes place after having acquired basic skills and knowledge. The process might have to be repeated in new situations and when rules and traffic situations change. Education to cope with other traffic also is a must for all other riders and drivers. Therefore, education on understanding the needs and problems of cyclists is a must for driver training. Driver instruction should incorporate information on cyclists' right to share the road, on the problems they face, and on the different problems experienced by different groups of cyclists.

Learning how to cope with each other can be helped along by involving cyclists and drivers in courses together. Typically, a dangerous hazard arises at an intersection when cyclists need to carry on straight ahead, but a car or truck wishes to make a right turn. Cyclists normally have the right of way in this situation and it should be respected. But often truck drivers in particular can't see them, so it is important for cyclists to take this into account. In the Netherlands, there are special education programs for children on this topic, where children can take a seat in a truck and experience what a driver can observe. Then there are instructions for defensive behaviour.

Who to involve?

When it comes to educating children, parents and other care takers, as well as school teachers, play the main role in their education for cycling. Teaching adults to ride well usually involves specific training courses, offered by municipalities, civil society organisations or other bodies. To ensure drivers are familiar with cyclists, driver schools and licensing bodies have to get involved. Often police, especially traffic police, are also important actors.

Apart from these forms of interactive training, information campaigns in journals, on television, radio and other mass media, can also contribute significantly to better practices on the road. Again, choosing the media according to the target group or groups is usually more efficient.

14.2.3 Primary and secondary learning processes

The art of learning starts with acquiring basic skills, knowledge about the rules of the game and how to predict what might happen in different traffic situations. In practice, users must keep their bicycle under control, be able to anticipate potential hazards, and remain predictable in the eyes of other road users. Having control means behaving defensively, foreseeing hazards, and matching skills and knowledge to the traffic environment and conditions.

Cycling education typically follows this sequence:

- Achieving the skills necessary to control a bicycle enough to pay full attention to the traffic environment;
- Learning basic knowledge, such as how to use the road, how personal conditions and external circumstances affect skills, and traffic-related tasks;
- Understanding the need to act defensively in different situations and circumstances;
- Developing the best fit between efficient and safe behaviour.

It follows that the learning process must start in a relatively quiet area, such as a park, before facing more complex conditions. Led by visionary mayors in Bogotá, Latin America has pioneered a particularly potent way of educating drivers, current and potential cyclists alike on the joys of cycling and ways of making cycling safer (http://cicloviasunidas.org). In 1974, Bogotá introduced Ciclovía, a recreational cycling event. Every Sunday morning, 120 km of roads are closed to motorized traffic for seven hours, so that they can be used for cycling, skating, jogging and getting together.

Cycle Sundays have been copied in many cities around Latin America (see http://cicloviasunidas.org for information in Spanish on activities in different cities). It is a way for people to ride safely and freely while they exercise and have fun. Behavioural studies teach us that people are more likely to change their behaviour after a concrete experience, than simply through the receipt of information. Attitudes tend to follow, rather than lead, behaviour.

Today, in many cities, through initiatives such as Quito's Ciclopaseo (http://www.biciaccion.org), Bogotá's Ciclovía (http://www.inbogota.com/transporte/ciclovia.htm), Guadalajara (Mexico, http://www.viarecreactiva.com.mx) and the La Reina and other areas of Santiago CicloRecreoVía, http://www.ciclorecreovia.org), local authorities or civil society organisations organize car-free road networks on Sundays.

These offer ideal conditions for teaching basic cycling skills, since they permit practice on real roads and the gradual accumulation of the necessary practical and theoretical knowledge for safe cycling. These initiatives are particularly useful and combine well with the implementation of new cycling facilities, because they encourage everyone, drivers, pedestrians, cyclists and public transport users, to try out life on the back of a bike, at least once a week, create safe practice areas and encourage better relations between cyclists and other road users.

It is easy to underestimate how long it will take to reach peak skills. Knowing how to ride, start and stop unaided is not enough to ensure riders can pay sufficient attention to the traffic environment. Children in the Netherlands, who ride from four years of age onward, still need to pay attention to their bicycle when they are 10 years old. This comes at the expense of paying full attention to other traffic. Accident analysis has taught us that novice road users (whether drivers, motor cycle riders or cyclists) need at least three years' experience to reach their personal highest possible expert level. They go through a learning process that typically involves many mistakes. As a result, their risk of serious injury per km travelled is two to four times higher than it will be once they have acquired the necessary experience. Only after considerable practice in traffic, do road users reach the best fit between efficient and safe behaviour.

That is why many parents in the Netherlands guide their children to school for a number of years. This might easily result in 50–100 hours lessons per year. Young people and particularly young men face a much higher risk of serious injuries than adults, because they overestimate their own skills and underestimate the range of situations they may run into. Their risk of serious injury is four to eight times higher than when they are experienced and mature.

This all means that most learning occurs once people are actually practicing these new skills, learning to cope with traffic, supported by rules and road design. Education aims to provide them with basic skills and basic information (primary process), to enable people to learn in practice (secondary process). Instructions and the right information at the right time can help people to better understand and estimate potential events, to perceive danger, to direct attention, to behave predictably to others.

Besides stressing the need for defensive behaviour, there is also a need to be clearly present in traffic. There is no general rule to define the right balance. For example, when riding on a narrow road where a car hardly can pass a cyclist, some cyclists prefer to keep on taking space from the edge and forcing a car to stay behind, which a driver may be willing to do over short distances.

There are many, mostly local, handbooks for teaching cyclists how to ride safely and efficiently, whatever the particular conditions in their cities. One particularly good one, itself based on similar efforts in Oregon, Toronto, British Colombia and Calgary, is the British Columbia bicycle operator's manual, Bikesense (http://www.bikesense.bc.ca/manual.htm). Brief, clear and well-illustrated, it offers a good starting point for cyclists' groups anxious to get a similar initiative off the ground in their own cities. The 200-page booklet that accompanies Living City's Santiago Green Map also includes a useful mini-manual, in Spanish (for more information, info@ciudadviva.cl).

14.3 Awareness building

Awareness building teaches people the benefits of cycling.

Who are the actors involved in awareness building? Although school teachers can contribute to knowledge about the benefits of cycling (and are important actors in this sense) awareness building usually takes the form of campaigns through the mass media, and does not typically involve feedback from an instructor. The advantage is that these reach a much larger target group. The disadvantage is that people are often distracted or very selective in terms of the information that they absorb, since they tend to seek confirmation of their existing beliefs.

For many years and issues, governments, marketers and others assumed that mass marketing or informational campaigns would be enough to change people's behaviour regarding smoking, sexual behaviour relating to HIV-AIDS, cycling, walking or whatever. The pitfall, of course, is that simply providing people with information is not enough to change how they act. Information may change perceptions and perceptions can change behaviour, but often further steps, involving, for example, leadership friendly to certain changes among specific peer groups, or hands-on experience, are essential. This has made many events, such as the cycle-Sundays described above, and cycling-friendly events listed below, crucial to encouraging people to try cycling. Furthermore, awareness building efforts can sometimes backfire, for example when drivers contest information regarding how they contribute to air pollution, to avoid the idea of changing transport modes.

Thus, it is very important to consider what drives and motivates people to act the way they do, and based on this knowledge, analyse the best entry point for a change. We recommend combinations of interventions which guide people to new behaviour and confirm its benefits.

14.4 Advocacy

Advocacy involves arguing and campaigning in favour of something, such as a cause, idea, or policy. For advocacy on cycling, target groups include politicians, traffic planners, the business community, schools, supporters or members, and so on. Each target group requires its own specific approach. It is no use to bury superficially interested groups with detailed stacks of information. To experts it is important to recognize their skills. Politicians should not be bothered with technical discussions, but with political choices. Civil servants, on the other hand, need guidelines and are not responsible for political matters, although they can be very influential in this respect.

A useful tool for analysing conditions is an actors analysis (see Chapter 4). Each actor/stakeholder/target group is identified according to their primary and derived interests. Who are potential allies, supporters or opponents? And how influential are they with regard to the issues you want to address? It is a good idea to make a diagram with all target groups and their position. Depending on the level of influence and their positive or negative attitudes, actors can be identified as partners, opponents, fans and outsiders. Of course these are only rough categories, but they help decide on how to approach them. It is a good idea to carry out two versions of the actors' analysis: an initial one mapping the starting point or current conditions, and a second one, charting where actors could be re-positioned, within a reasonable period of time, usually the duration of a specific campaign or on-going working group.

This analysis also helps set priorities, since it also helps to clarify what each group can contribute to a more cycling-inclusive city. In any case, it is important to ask why a specific target group should be addressed and how best to communicate with each one. On the basis of a real understanding of their interests and position this will become much easier.[59]

14.5 Examples of awareness building and advocacy

Some examples of awareness building and advocacy tools are now explored, followed by some conclusions regarding the creation of support for policies and measures.[60]

14.5.1 Audio-visual materials

For changing perceptions, videos, films and other audio-visual materials can have a huge impact, since they present not only information, but practice, highlighting visions and underlining the applicability of ideas.

An excellent film is *Cycling Friendly Cities*, initiated by Enrique Peñalosa, the former mayor of Bogotá. Peñalosa wanted to underline the benefits of the cycling network he had created and the principles behind it. For him, Denmark and the Netherlands were the key examples to learn from when it came to urban design, pedestrian facilities and cycling-inclusive planning. This film shows how cities in Denmark, the Netherlands and Colombia have become better places for people. The main target group are politicians, but the film has been welcomed by a wide range of cycling, professional and other interested groups.

14.5.2 Car-Free Days

Well planned and organized, Car-Free Days combine awareness building and advocacy.

[59] ICE, Locomotives: Full Steam Ahead; Low Cost Mobility Initiatives Support Program 2003–2006; Volume 1: Cycling Planning and Promotion; ISBN/EAN 978-90-79002-01-6.

[60] Most examples can be found in: ICE, Locomotives: Full Steam Ahead; Low Cost Mobility Initiatives Support Program 2003–2006; Volume 1: Cycling Planning and Promotion; ISBN/EAN 978-90-79002-01-6.

They show how people can enjoy the streets in their city when cars give way to people-powered modes of transport. They also offer excellent opportunities to practice cycling and showcase alternatives to the automobile. They increase commitment and encourage behavioural change, and they can also create a sense of belonging.

The World Carfree Network (http://www.worldcarfreeday.net) invites activists and citizens to organize World Carfree Day events, usually some time in the month of September. These help bring the issue of non-motorized transport to politicians' and the public's attention. Often they trigger new policies more favourable to non-motorized transport in general.

14.5.3 Street play days, bike weeks or months

Figure 196
Street Play Days in the Netherlands.

Street Play Days may be organized with car-free days or as stand-alone activities. Every year the Dutch Road Safety organisation (VVN), coordinates a street play day in many cities in the Netherlands.

On that day, some streets are closed to motorized traffic. Children can play there and often this use brings demands for permanent traffic calming measures, which enhance safety and allows them more freedom.

Schools, parents, residents, and city governments participate and help take care of children. VVN develops and distributes posters and other materials.

Many cities also organize bike weeks or even months, often launching important new programs such as bikes-on-buses or new bike facilities during the festivities. See, for example, information from the League of American Cyclists (http://www.bikeleague.org/programs/bikemonth), Toronto's bike month (http://www.toronto.ca/cycling/events/index.htm), the UK's Cycle Campaign network (http://www.cyclenetwork.org.uk).

14.5.4 Advocacy to claim cyclists' rights

Many campaigns aim to highlight cyclists' and pedestrians' rights to safe and efficient mobility. In many developing countries, cycling plays a significant role in the economy, particularly in the informal sector. The civil society organisation, Institute for Democracy and Sustainability (IDS) in Delhi, developed an advocacy campaign on Urban Governance and the Right of Cycle Rickshaws and Cycle Rickshaw Pullers. IDS advocates for the rights of cyclists, rickshaw operators and pedestrians. In this case, it studied the differential ownership, use patterns and widely prevalent attitudes towards cyclists and cycle rickshaw pullers to ensure that social activists, environmentalists, planners and governmental agencies became more sensitive to their problems and possible solutions.

14.5.5 Inspection, checklists, community audits

To convince politicians, planners, designers and other stakeholders of the problems and obstacles cyclists and pedestrians face every day, advocates can invite them for a joint inspection of walking and/or cycling facilities. If some of these stakeholders are not skilled enough to use bicycles for this purpose, they can be offered rides on tandems or tricycles, or the inspection can be conducted on foot. Key to success is that participants experience in their own flesh the problems of pedestrians and cyclists. This helps to commit them to finding easy, safe, efficient solutions.

14.5.6 Bike to work campaigns

"Bike to Work" campaigns aim to involve companies and their employees in the promotion of cycling. There is an international Bike to Work campaign, in which organisations invite workers to cycle to work on specific dates. When companies show significant interest, the accent of the activity shifts from a one-off promotional activity toward ongoing initiatives to create good conditions for bicycle use. In Cape Town, the civil society organisation, BEN, informed employees about the benefits of cycling to work and trained them to maintain and repair their bicycles, as part of employee bicycle purchase programs. In some cases, employees have been offered bicycles instead of a transport allowance.

In South Africa, 1% of company payrolls goes to skills development and training, and they are keen to train employees in bicycle use and maintenance. BEN is encouraging employers to purchase bicycles for employees.

In the Netherlands, the civil society organisation, COS, has run a Fietsen scoort (Cycling pays) campaign. As part of this campaign, COS invites companies to sponsor employees to accumulate cycling kilometres. It teaches them the benefits of increased cycling to individuals and the company (health, savings on parking space, etc.) and to society in general (fewer emissions, CO_2 reduction, and so on). Part of the fund thus created is going to cycling projects in developing countries (carried out by I-CE partners within the Locomotives program, 2003–2006, or the Bicycle Partnership Program, since 2007). This way, companies consider their participation a contribution to Corporate Social Responsibility policies.

14.6 Final remarks on awareness building and advocacy

Awareness building and advocacy are never-ending stories. To change the mind set of people and policies, advocates face many frustrations, but there is also much room for optimism.

The main theme in discussions with people responsible for policies and measurements, is achieving society-wide support. Do people prefer a car parked in front of their home or children playing? It is interesting to see the difference between what politicians think citizens think and what citizens think. Often, citizens have to mobilize their fellows or collect information to demonstrate willingness to change.

People can find it hard to put change in perspective. Demonstration projects help, to make visions tangible. Retailers, for example, often oppose measures that control car use and favour walking and cycling. But all over the world, expanding pedestrian facilities has led to more and better retail opportunities, turning opponents into supporters.

People are also reluctant to change. A survey in a Dutch city showed that although about 70% of residents in a specific area favoured reducing speeds to 30 km/h, 70% opposed the city's measures in this sense! Usually it is better to involve citizens in developing measures. There is a risk that debate will focus on pro's and con's of different measures, making agreement difficult. To prevent an endless debate, facilitators skilled in participatory methods should manage these exchanges so that they lead to agreements. It helps to guide the process toward solutions, based on a shared view of problems' causes. Then common targets can be defined, and criteria for solutions developed. Sometimes it is easier to leave concrete proposals to professionals, but these should always be brought back and reconfirmed by the representative groups that began the process. This is the best way to build consensus and reduce the complexity of public acceptance of changes, large and small.

15. Researching cycling needs and possibilities

Mark Zuidgeest, Anke Rouwette, and Roland Kager

15.1 Introduction

In a setting with limited resources, we should strive for suitable data collection. Adequate data collection is always strongly linked to the questions at hand and cost-effective ways of obtaining answers to them ("question-driven"). The aim is to ask meaningful questions, in line with objectives, that can be answered by (secondary) empirical, easily obtainable data.

Questions can be categorized according to the six stages typical of the policy cycle. We could deal with (I-CE, 2007):

1. Exploration: This phase involves describing situations, so requires questions such as "what", "where", "when", and "who", *e.g.* Where do fatal accidents occur that involve a high proportion of NMT travellers?
2. Diagnosis. These questions examine "why" the situation exists, *e.g.* Why do commuters not cycle to work?
3. Design. These focus on "how" we can improve the situation, *e.g.* How can we accommodate street vendors, NMT and MT traffic on the same road?
4. Intervention. These deal with operational issues, such as "which" actions should be taken and "by whom", *e.g.* Which steps should be taken to avoid unsafe traffic situations during the reconstruction of the road profile?
5. Monitoring. These examine specific policy outputs, that is, they reflect actions ("how many") and results that change over time and therefore data that is collected at different intervals, *e.g.* Is there a positive trend in annual bike sale figures?
6. Evaluation. These examine the effectiveness of interventions ("do, is, have"), *e.g.* Has personal income increased, because of the distribution of bikes?

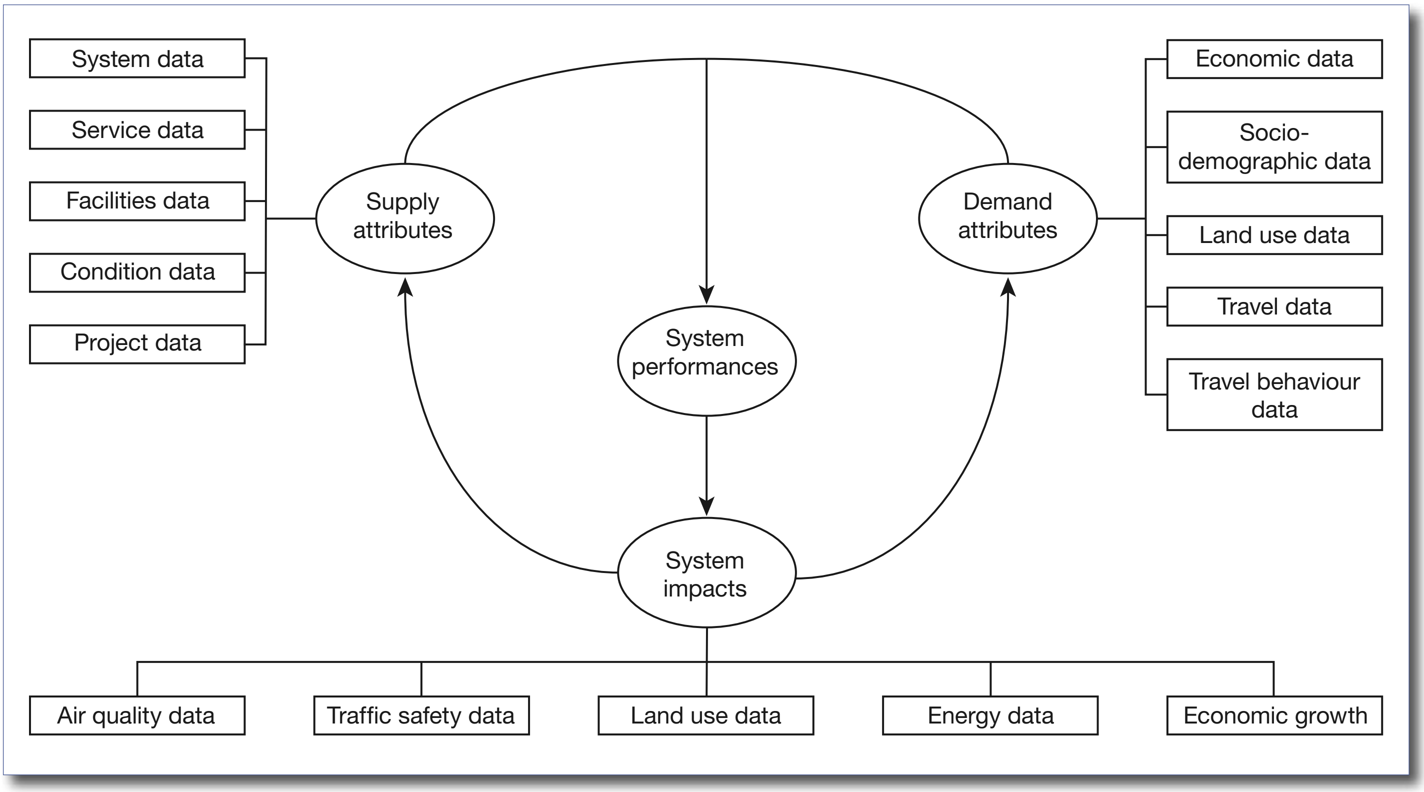
Data can be qualitative or quantitative, depending on the source, collection method and the question to be answered. If a question can be properly answered with either quantitative or qualitative data, the preference is often to obtain quantitative data for scoring indicators. Quantitative data is very useful for monitoring and evaluation, since 'objective' measures can be derived from them. Qualitative data, on the other hand, can be quite useful at the exploration and

For related subjects

See ***Chapters 2 and 3*** on key concepts and process organisation, and ***Chapter 5***, on network design.

See also, ***Glossary***.

Figure 197
Data organisation framework.
(Jack Faucett Associates, 1997)



diagnosis stages. It can tell a story that cannot be deduced from objective measures. This data can be merely descriptive or may be arranged in a specific order (I-CE, 2007).

To explore the present traffic and transport situation, an assessment of supply and demand is needed. The word "supply" here refers to the transport system, *i.e.* the infrastructure and the means of transport. The word "demand" stands for the actual use of the transport system, *i.e.* the trip makers wishing to travel to destinations, using certain modes and routes, and at a certain frequency. Figure 1 by Jack Faucett Associates (1997) shows some attributes involving demand and supply and can be applied to cycle planning too. Data on the supply side relates to, for example, road conditions and available cycle facilities, while the data on the demand side relates strongly to land use characteristics and demography.

In this chapter, four types of data are discussed, related to:

(1) travel demand,
(2) infrastructure supply,
(3) traffic safety, and
(4) general institutional issues.

For each type: (1) elements, (2) key variables and (3) dimensions are given and discussed. The elements describe the kind of data that belongs to one type of data. For example traffic volumes are an element of data on traffic demand. For this element, the number of bicycles per survey point can be a key variable. A key variable must be measurable. The dimension describes how the key variable can be measured, for example as bicycles per survey point per hour or per vehicle type per hour.

Each element is explained and we discuss when data on this element should be collected, and where and how this should be done. Furthermore, we provide information on instruments and/or methods that can be used for data collection. Each section ends with a table identifying suitable instruments/methods for collecting data on the different elements.

This chapter is not a manual on data collection. However, it does introduce major concepts concerning when, why, where and how to collect what types of data. Furthermore, we provide detailed references on data collection and examples.

15.2 Data on travel demand

15.2.1 Introduction

Travel demand refers to actual use of the transport system. How many vehicles are using the network? What type? Which routes do they use? When investigating cycling demand, it is often necessary to investigate the demand for motorized transport as well. By researching both together, we can gather information on

Table 9: Elements, variables, and dimensions related to data collection for travel demand

Elements	Key variables	Dimensions
Traffic volumes	Number of bicycles per survey point Number of motorized vehicles per survey point	Per hour/day Vehicle type By sex
Origins/Destinations	OD flows Location listing	By motive Per hour/day By sex
Traffic composition	Modal split	By motive Per OD relation By sex
Travel motives	Shares	Per OD relation Per period By sex
Reasons for mode choice	Listing and ranking	By sex
Potential demand	Number of potential bicycle trips	Per OD relation Per period By sex

actual use, traffic composition and potential demand at the same time.

When developing a bicycle network, current use is important. But potential demand may be even more important, especially where cycling is not a common transport mode. This section discusses data collection concerning actual and potential demand for cycling.

Six elements can be identified with regard to demand for cycling: (1) traffic volumes, (2) origins and destinations (OD), (3) traffic composition, (4) travel motives, (5) reasons for mode choice, and (6) potential demand. These are the main elements required for collecting data on demand. They can be expressed in several key variables for which data can be collected. The data per key variable can again be divided into data for different dimensions.

Table 9, provides an overview of elements and variables with their possible dimensions. These are only the most widely used dimensions. Many others are possible. Each is presented, with appropriate collection methods, below.

15.2.2 Elements

Traffic volumes

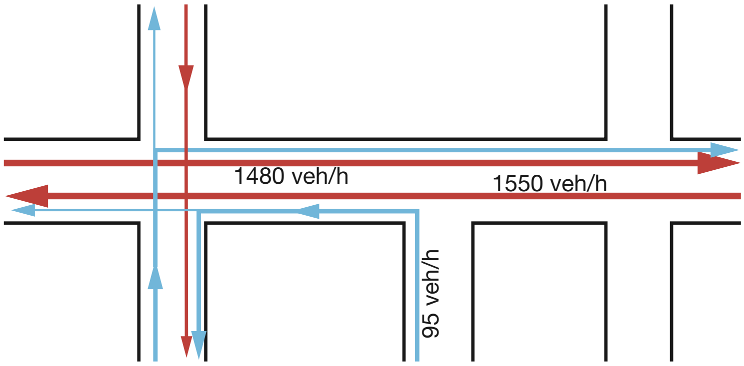
Traffic volume is the most logical element when thinking about demand.

(*What*) Traffic volumes give the number of cyclists (or other modes of transport) per survey point (usually in one direction). The volumes can be expressed in different time intervals (per day or per hour), per vehicle type or even by sex. Traffic volumes can be obtained through traffic counts at road sides or at junctions. Another option is to obtain the volumes by video data collection.

(*When*) Traffic volumes are very useful when planning for a cycle network or when dimensioning a network. The main routes in the network should be planned where most cyclists (want to) cycle and the design should be adjusted to the (expected) number of cyclists on the stretch. When using traffic counts the volumes in peak hours should be used in dimensioning and planning.

(*Where*) It is not necessary to determine traffic volumes on every single road in a network. Most important is to find out which road sections are part of the main (potential) cycle routes and what the volumes are on these sections.

Traffic volumes per mode



Map the traffic volumes in the network per mode and add the direction of each flow. The map can help to indicate important cycle routes

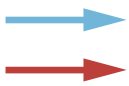


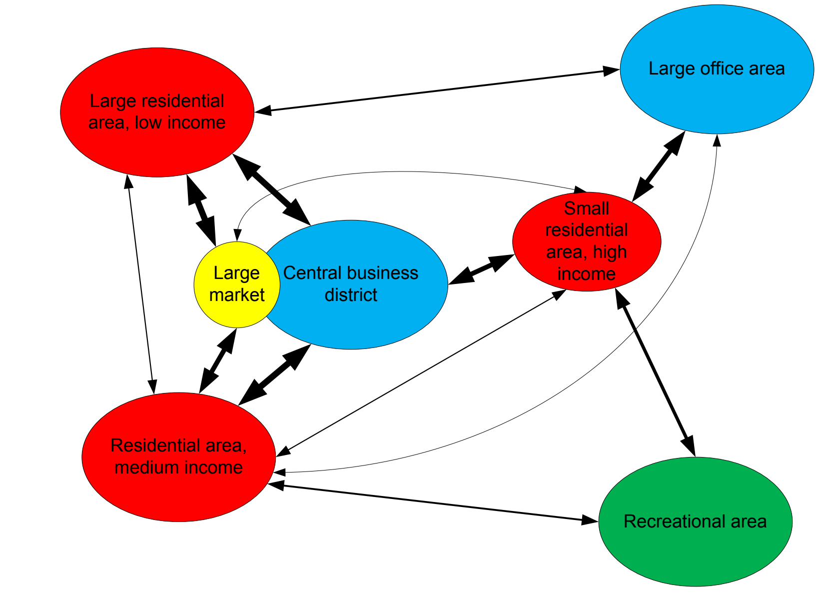
Figure 198
Measuring traffic volumes per mode.

Origins/Destinations

When planning for cycling, one important element is the location of typical Origins and Destinations (ODs) and their interaction, representing travel patterns.

(*What*) There are many possible variables concerning ODs, but most important are the location of the main origins and destinations of cyclists in a given area and the volumes of cyclists travelling between a certain origin and a certain destination (OD flows). Important ODs can be listed through site visits, counting at origins or destinations, through household or roadside surveys. OD flows are more difficult to obtain. An OD or household survey covering large parts of the city is necessary to get a complete overview of the OD flows. However this is a very expensive exercise. Most important OD flows can also be found through OD mapping and by conducting small travel surveys in the places concentrating the most origins and destinations. This is perhaps less accurate, but in most cases sufficient.

(*When*) Knowledge of (potential and/or future) origins and destinations and OD flows is the most important data for planning bicycle networks. Without this knowledge it is hard to design a good network. It is important to choose the right period to gather the OD data. In most studies data is gathered during



Map the main origins and destinations in the area and the OD-flows in between. The size of the OD-relations can be indicated with the bandwidth of the arrows. The main (potential) cycle routes can be found from the OD-flow pattern.

Figure 199

Mapping main origins, destinations, and the flows in between.

weekday peak hours, since traffic flows are largest. Furthermore, data varies by season, particularly between summer and winter.

(*Where*) Data on ODs is most important in larger cities. In small cities there are often only a few important origins, destinations and routes. An analysis of OD flows is not necessary in such a case. However, in larger cities it is important to identify the main routes habitually used by cyclists as these are major candidates for improvements and inclusion in a cycle network. They also help to prioritize routes. In these cases OD information is necessary.

Traffic Composition

What percentage of trips (from one location to another location for a single purpose) is completed by a bicycle? And what share (%) could potentially be done by bicycle?

(*What)* Traffic composition on a route or road stretch can be expressed in the modal split as the relative amount (%) of traffic per mode. The modal split can be found most easily by doing traffic counts, but also with road side or household surveys an estimate of the modal split can be made.

(*When)* It is very useful to have an idea of the traffic composition when planning and designing a network or when trying to influence bicycle use. If for example the modal split is known on short distances it is possible to get an idea of the cycle potential.

Travel motives

Why do people travel? This provides very relevant information, revealed by asking for travel motives.

(*What*) Travel motives indicate whether people are travelling between home and work or school, shopping areas or for social purposes. Questionnaires and interviews can be used to identify reasons for travel. Household or road side surveys, for example, can ask about for travel motives.

(*When*) Questions on this item can identify the kind of trip for which people use bicycles.

Reasons for mode choice

Asking why people choose certain modes for their trips is very important when planning for cycling. Asking why people do not use a bicycle for short trips, *i.e.* what barriers stand in the way of their cycling can be even more interesting.

(*What*) Reasons for (not) choosing a certain mode for a trip can be identified, listed and ranked using questionnaires and interviews. Household or road side surveys, for example, can ask about reasons for current mode choice.

(*When)* Information on reasons for using or not using a certain transport mode can be used to either encourage or discourage use of any given mode. This type of information is useful for reducing or eliminating (critical) barriers, improving cycling facilities and stimulating cycling.

Potential demand

Potential demand involves asking how many people would travel along a certain route using a certain mode if barriers were removed.

(*What*) Because the focus is on potential demand, a typical question would try to find out how many people would use the bicycle if provided with a good network? There are several ways of estimating potential demand for cycling. One is to investigate bicycle ownership /user characteristics and to estimate the proportion of the group with similar characteristics in the total group of non-bicycle owners/users. Similarly, comparing the socio-demographic and travel characteristics of non-cyclists with cyclists can help to identify target groups for a marketing strategy. Again, questionnaires and interviews can be used to estimate potential demand.

(*When*) An estimation of potential demand is very important in campaigning for the bicycle and in planning for a network. The network should be located where the most demand (including potential demand) is.

15.2.3 Possible instruments/collection methods

Traffic counts

Traffic counts can take the form of screen line counting in one or both directions and stream counting at intersections. In stream counting at intersections, for every 'leg' of the intersection, the streams in different directions are counted. Thus, detailed information becomes available on how much traffic is being exchanged between side streets and main streets. One drawback is that, in busy intersections, it can be quite difficult for one person to count the different streams from one leg, so more persons per leg are necessary.

Screen line counts

Screen line counts are easier, but also result in less information. Screen line counts can be performed on the 'legs' of an intersection, if traffic numbers are needed for all 'legs'. Screen line counts can also be performed on one road section away from an intersection.

The first diagram in Figure 200 shows the technique of stream counting at intersections. If personnel numbers are limited or the stream information is not necessary, you can choose to screen line counting at the intersection (the second diagram in the figure). To avoid motorized traffic blocking the view, survey centres should be positioned next to the exits.

One advantage of counting at intersections in comparison to screen line counts elsewhere is that the survey team members stay in visual contact and can therefore help each other in case of incidents. If the intersection is controlled by traffic lights, moreover, it is often easier to count both directions at the intersection than at screen lines further away. This is due to the fact that traffic lights cluster traffic in stages. Further from the intersection, the clustering disappears and counting both directions may become more difficult, especially when there as is a lot of traffic blocking the view and the road is wide. Counting at intersections may be more difficult, on the other hand, if there is a lot of non-travelling activity going on. At screen lines away from the intersection you can choose an optimal location where only travellers use the road.

Although some general rules can be applied when counting, the best technique is the one that fits the situation. Therefore it is absolutely imperative to visit sites beforehand and study traffic volumes, look for strategic spots, possible

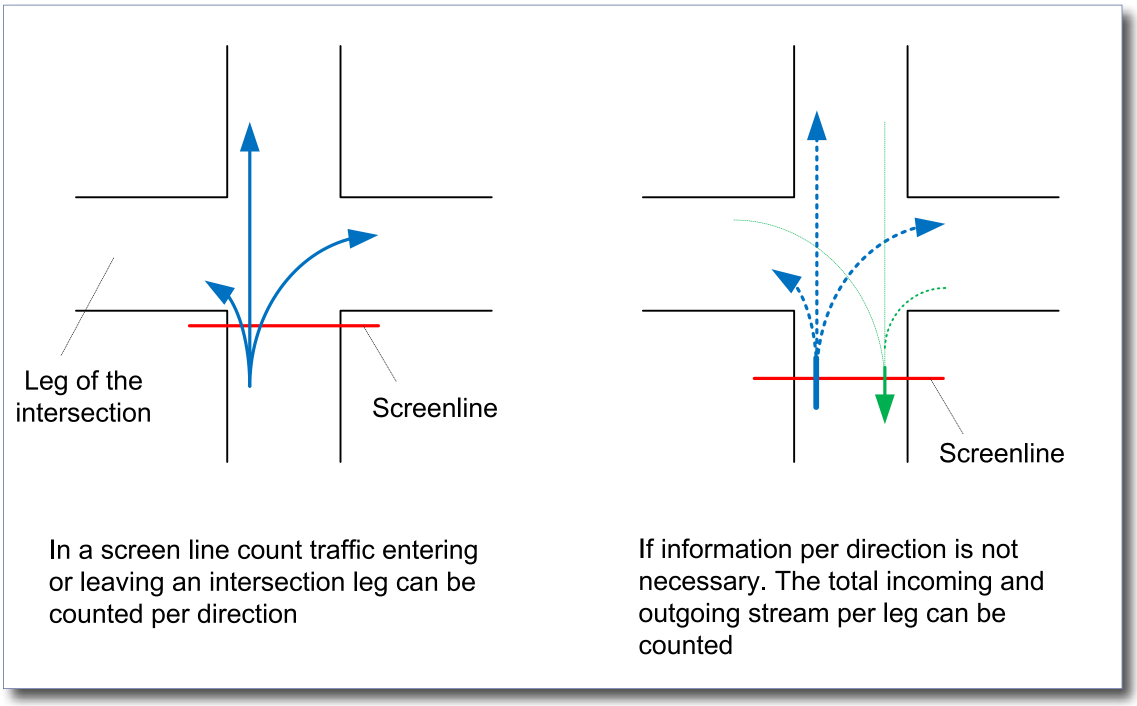


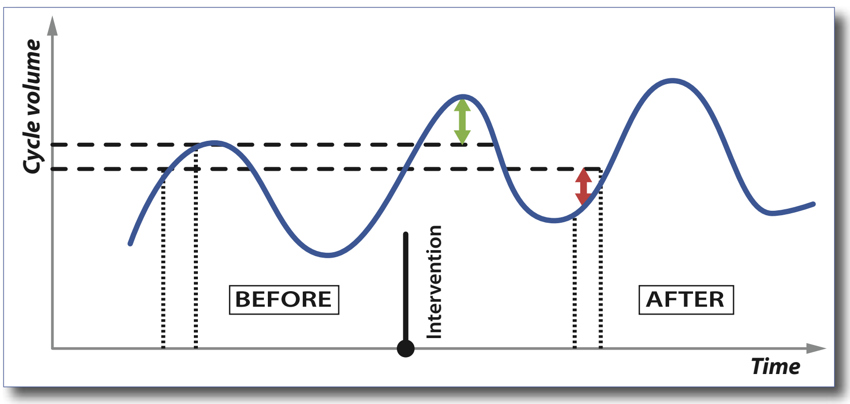
Figure 200
Screen line counts.

occurrences, view blockages, street lighting and so on. Back at the desk, this information is used to calculate the number of persons and to design a survey scheme, containing precise information for each survey team member about what, when, where and how to count.

As for counting periods, it is good practice to use peak periods on ordinary weekdays and to repeat counts for at least one other week in the same period of the year. Counting in peak periods produces a fair idea of peak cycle demand. Moreover, counts are more reliable with higher numbers. Disturbing factors should be handled by either eliminating them or keeping them constant, keeping in mind that counts should be representative of the periods for which they were conducted. For instance, if a count is disturbed by heavy rain fall, it is best to redo it another day (eliminating the disturbing factor). The periodicity in traffic demand is controlled for by using the same periods for counting during several subsequent days (keeping disturbing factor constant). In evaluation studies especially, pay a lot of attention to disturbing factors. If periodicity of demand is neglected, for instance, one can easily end up with spurious results.

Figure 201 by I-CE (2007) visualizes this problem. Let us assume that cycle demand varies over the year, due to different road and weather conditions, and demand follows a recurrent annual pattern. The before and after measurement have been carried out almost at near-peak and near-bottom demand levels. The red arrow shows the difference in cycle volume between the before and after measurement; cycle demand went down. It is a spurious effect however, since no control on periodicity has taken place. The green arrow shows the real effect (cycle demand went up!), but has not been measured.

Figure 201
Periodicity in evaluation studies.
Source: I-CE, 2007



Since visual counting is hindered by personnel costs, fatigue and lack of daylight, it is quite difficult to obtain counts for a full day. It is therefore wise to identify mode shares during the daily cycle of demand. These shares have proven to remain quite stable over time. With this knowledge, you can make fair estimations of demand during unmonitored periods.

Most general traffic and transport engineering books discuss traffic counting. The reader is for example referred to Slinn *et al.,* (2005).

Surveys

Many questions on traffic behaviour cannot be answered by counting traffic. Questionnaires gather information on travel motives, reasons for mode choice, characteristics of road users, etc. Survey types include:

Household surveys: in these kind of surveys questionnaires are distributed in the study area among a representative part of the households. Usually household surveys are comprehensive questionnaires asking for information on trips made by every household member, socio-economic data, trip purposes, mode use, and so on. Households are asked to fill out and return the questionnaires. This kind of survey is time-consuming and costly. To get a reasonable return, many additional surveys have to be handed out, to take non-responses into account. Often rewards are promised to those returning the questionnaires to raise the response rate.

Road side surveys/interviews: these are less comprehensive than household surveys. Surveys are handed out at a certain location (for example at an important origin or destination or along a busy road) or people are interviewed at such a location. Most of the time, there are fewer questions than in household surveys to ensure that the questionnaire does not take too much time.

Internet/e-mail surveys: these surveys can be the same as the preceding two types except for the fact that now the surveys are distributed through e-mail or internet and respondents can return the survey again through the internet. These types of surveys save time and money, but are only possible if most respondents have access to the internet.

Five main topics that typically recur in surveys on bicycle use are briefly discussed here:

Income: Often respondents are asked about their income, since this is a strong determinant of travel behaviour and vehicle ownership. However, in most cultures income is a delicate subject and respondents may be reluctant to answer. If this is the case, it is better to ask alternative questions on income-related topics, such as vehicle ownership, living conditions, residential location or occupation.

Ownership and availability: When studying bicycle use it is important to know if people own a bicycle or are able to use one. A survey should not ask for ownership alone, since many people borrow, share or hire bicycles. If surveying availability, a distinction should be made between personal availability and availability in terms of bicycle taxis.

Trip making: Usually, much of the questionnaire is dedicated to travel behaviour. Respondents are asked about the trips they usually make: the number, distance, transport mode, purpose, and so on. It is important to select those questions that give the information that is really needed, since otherwise questionnaires easily grow too long.

Desired trip making: Especially when surveying cycling trips, questions on actual trip making alone are not sufficient. In many survey areas, only a few people cycle, but potential demand is much larger. Questions relating to desired trip making determine the potential demand for cycling. However it is difficult to include this topic in questionnaires, since often people can not tell what their travel behaviour would be if, for example, there were a cycle network. In open interviews more information can be gathered on desired trip making.

Constraints on bicycle use: A key question is why people do not cycle. This question identifies constraints and barriers. It is important to find out which barriers are the most important, for example, by having respondents rank barriers.

Of course these five topics do not cover all possible questions, but they do give an idea of key subjects to be covered by questionnaires.

OD mapping

Traffic counts and questionnaires are often time-consuming and costly and may provide more detailed information than necessary. Origin-Destination (OD) mapping costs little and still yields useful information. OD mapping is used to identify the main origins and destinations on a road network map. These origins and destinations can be selected through site visits or with the help of a discussion group. OD mapping information, the current network and any information on OD flows can be combined for insight into the main destinations for a cycle network, cycle routes and missing links.

Table 10 provides an overview of elements/variables and collection methods. Crosses indicate that data for a certain variable can be found using the indicated collection method.

Table 10: Data and methods for obtaining data compared

		Household survey	Road side survey	Traffic counts	Site visits	OD mapping	Internet survey	Video data collection
Traffic volumes	**# of bicycles**			x				x
	# of motorized vehicles			x				x
Origins-Destinations	**OD flows**	x	x					
	Locations	x	x		x	x	x	
Traffic composition	**Modal split**	x	x	x			x	x
Travel motives	**Shares**	x	x				x	
Reasons for mode choice	**Listing**	x	x				x	
Potential demand	**# potential bicycle trips**	x	x				x	

15.3 Data on infrastructure supply

15.3.1 Introduction

Bicycle infrastructure supply data consists of data related to existing or planned cycle facilities, for:

- Network elements, such as those used for assessing network connectivity;
- Route elements, such as those used to assess route conditions;
- Nodal/intersection elements, such as those used to assess safety at intersections and integration into transit facilities at intersections, *i.e.* at transfer nodes;
- Infrastructure and cycling facilities, such as bicycle parking places, typically used for design and diagnosis; and operations.

In areas where there is hardly any specific cycle infrastructure, data collection for infrastructure supply mainly consists of an inventory of the goodness of fit of road stretches and junctions for bicycle infrastructure. These can then be used as possible indicators for evaluating the feasibility of a cycling network.

In this section, we will distinguish between six types of infrastructure supply elements for which variables and dimensions can be derived: (1) networks; (2) routes; (3) nodes/intersections; (4) road infrastructure; (5) facilities; and (6) their operation. The quantity and quality of each can be measured through (combinations) of variables and can be subdivided into different dimensions (units of analysis), such as per unit of time [h] or unit of distance [km].

We make such distinctions even though all elements are interrelated. A network is a collection of routes, while a route consists of nodes connected by pathway segments, with facilities positioned along routes or at intersections.

For each variable, collection methods are available. A distinction is made between direct collection methods, based on primary data collection on-site, and indirect collection methods, which are generally a combination of primary data collection and a basic calculation or modelling activity.

Table 11 offers an overview of elements and variables and their possible dimensions. Subsequently each will be discussed, along with appropriate collection methods. We also discuss specific methods for measuring and analysing (sets) of variables, and methods appropriate for overall network assessment.

Table 11:
Key elements, variables, and their dimensions for infrastructure supply data

Elements	Key variables	Dimensions
1. Network characteristics ▪ Network coherence ▪ Network connectivity ▪ Accessibility	1. Bicycle path to network density 2. Connected node ratio 3. Link – node ratio 4. Alpha index 5. Network coherency ratio 6. Access and egress to a bicycle network	• Per network
2. Routes ▪ Directness ▪ Safety ▪ Comfort & convenience ▪ Attractiveness ▪ Accessibility ▪ Crossability	1. Bicycle route directness 2. Bicycle route safety index 3. Route comfort index 4. Route attractiveness index 5. Route accessibility index 6. Route crossability count	• Per route
3. Multi modal integration	1. Facilitated bus stop index	• Per segment • Per kilometre • Per area
4. Bicycle infrastructure ▪ Quantity ▪ Quality	1. Infrastructure measurement and count	• Per segment • Per kilometre • Per area
5. Bicycle infrastructure facilities	1. Facility count	• Per segment • Per kilometre • Per area
6. Bicycle operations and compatibility	1. Bicycle Level-of-Service 2. Bicycle Compatibility Index	• Per segment • Per kilometre

15.3.2 Key elements in getting the right information

Measuring Network Characteristics

Three elements important to bicycle networks are network coherence, connectivity and accessibility. In this context, coherency refers to an uninterrupted, consistent network, while connectivity is about linking locations that people want to travel between. In other words, network coherence and connectivity relate to the extent to which all (potential and main) origins and destinations in a network are linked by routes that are continuous and recognizable. Accessibility relates closely to these first two elements, integrating the time and distance (or in the jargon: disutility or impedance) involved in cycling between origins and destinations or accessing the network structure.

To measure connectivity, the literature proposes several variables. Dill (see Further Reading) provides a good overview, listing about 13 measures for cycling and walking connectivity. We will discuss six (slightly adapted for cycling networks):

Bicycle path to network density

(what) Bicycle path to network density, measured as the number of linear kilometres of (possible) bicycle paths per area of land. A higher number would indicate more bicycle paths and, presumably, higher connectivity.

(when) This variable is useful when you need to *compare the total length of bicycle paths* in an area with kilometres of other infrastructure, such as for motorized traffic, and can be used to argue for extending bicycle infrastructure.

(how) Map-based. Outline an area using a road map or an aerial photo (for example, a Google Earth print-out), define bicycle route (for example, according to certain quality requirements) and road categories for comparison. Draw the different types of infrastructure (use different colours or dash style) and calculate and compare the total lengths.

(remark) This variable would logically correlate positively with other possible measures, such as intersection density, which is the number of (safe and comfortable) intersections per area of land or per kilometre bicycle paths.

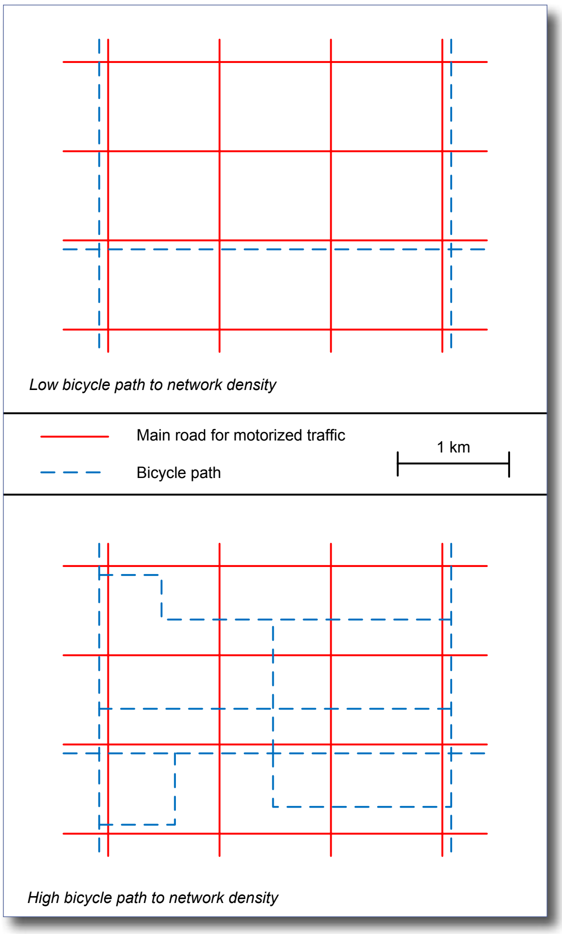


Figure 202
Measuring bicycle path to network density.

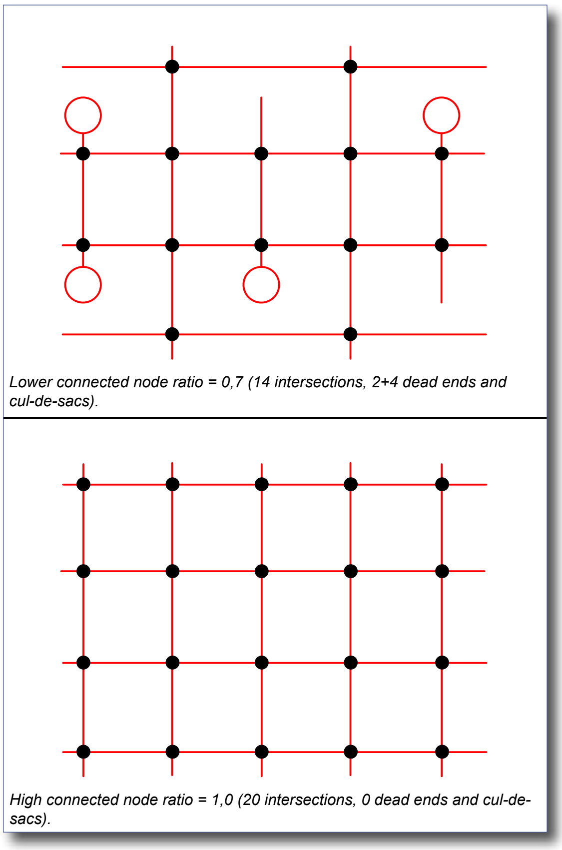


Figure 203
Measuring connected node ratio.

Connected node ratio

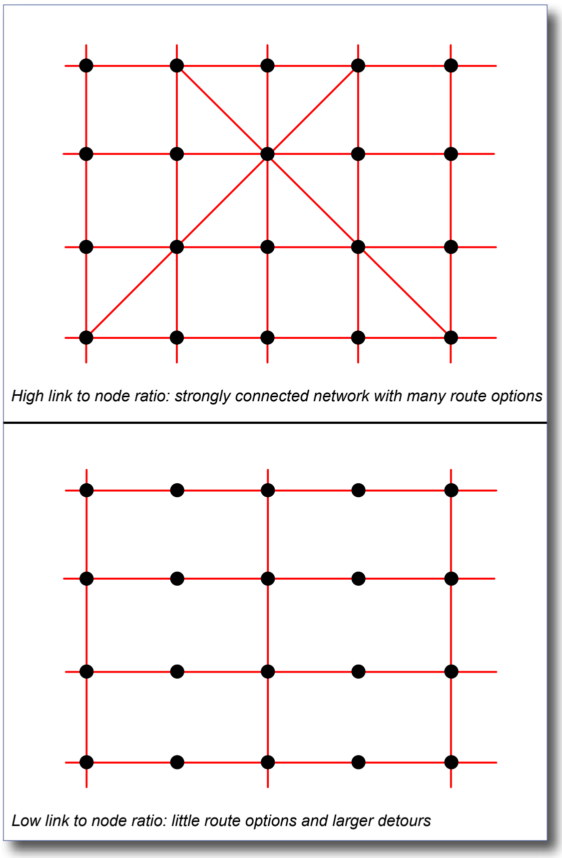
(what) Connected node ratio is the number of street intersections divided by the number of intersections plus cul-de-sacs (or dead ends) in an area.

(when) This variable is typically used to *indicate network structure*. A highly connected network increases directness (reducing detours) of routes through a large number of direct connections, such as occur in a fine grid network. This variable should be used in networks with a relatively large number of dead ends.

(how) Map-based. Outline an area using a road map or an aerial photo (for example, a Google Earth print-out), then count the total number of intersections, and the number of intersections that occur at the beginning and/or end of a loop (cul-de-sac). Divide the total number of intersections minus the number of cul-de-sacs by the total number of intersections.

(remark) Higher numbers (maximum is 1.0) indicate that there are relatively few cul-de-sacs (or dead ends) in the bicycle network and, presumably, a higher level of connectivity.

Figure 204
Measuring link node ratio.



Link-node ratio

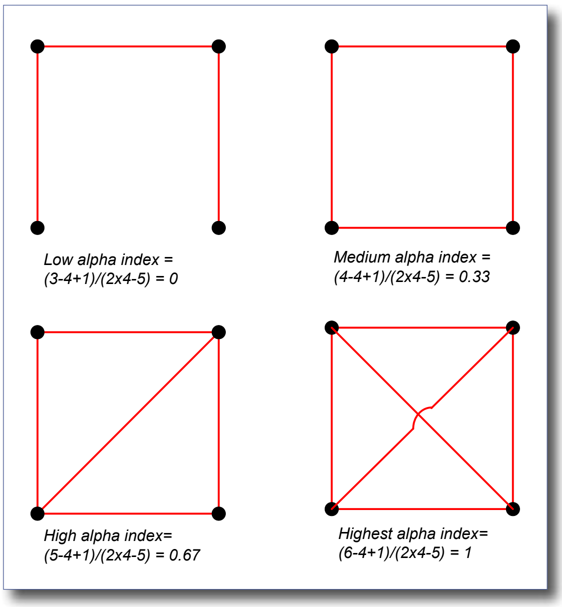
(what) Link-node ratio is the number of links divided by the number of nodes in an area. Links are pathway segments between two nodes (intersections or the end of a cul-de-sac).

(when) This variable is also used to *indicate network structure*. A highly connected network allows for many possible routes and increases directness (reducing detours) of routes through a large number of direct connections such as occur in a fine grid network.

(how) Map-based. Outline an area using a road map or an aerial photo (for example, a Google Earth print-out), count the total number of links between intersections, and the number of intersections including those that are the beginning and/or end of a loop (cul-de-sac). Divide the total number of links by the total number of intersections.

(remark) American literature suggests a ratio of 1:4 would be a good target for a well-connected network (Ewing, 1996).

Figure 205
Measuring alpha index.
Adapted (Rodrigue *et al.*, 2006)



Alpha (α) index

(what) Alpha (α) index, often used in transport geography, is based on the concept of a finite circuit, or closed path starting and ending at a single node. The alpha index is the ratio between the actual number and the maximum number of circuits.

(when) This variable is again used to *indicate network structure*, and compares the existing network to an idealized network structure. A highly connected network allows for many possible routes and increases directness (reducing detours) of routes through a large number of

direct connections such as occur in a fine grid network. Trees and simple networks will have a value of 0. A value of 1 indicates a completely connected network. It measures the level of connectivity independently of the number of nodes. It is very rare that a network will have an alpha value of 1, because this would imply very serious redundancies.

(how) Map-based. Outline an area using a road map or an aerial photo (for example, a Google Earth print-out), count the total number of links between intersections in the area, and the number of intersections *excluding* those that begin and/or end in a loop (cul-de-sac). Use the following formula to calculate the alpha (α) index:

$$\alpha = \frac{\#links - \#nodes + 1}{2(\#nodes - 5)} \quad (1)$$

(remark) The value of alpha ranges from 0 to 1, with higher values representing more connected networks. Related to this, the *gamma (γ) index* considers the relationship between the number of observed links and the number of possible links. The value of gamma is between 0 and 1 where a value of 1 indicates a completely connected network and would be extremely unlikely in reality. Gamma is an efficient value to measure the progression of a network in time, see (Rodrigue *et al.*, 2006).

Network coherency ratio

(what) Network coherency ratio is measured as the number of Origin-Destination (OD) pairs connected by the bicycle network, divided by the total number of OD pairs in the area.

(when) Even though this ratio is highly subjective, it can be used to argue for expanding the bicycle network to certain areas where (relatively) few bicycle network connections exist.

(how) Map-based. To measure network coherence, list the main origin (Os) and destination (Ds) points or locations in a specific territory, such as a market, hospital or residential area, which should be or should have been connected. It is important to agree on the definition of a proper connection (in terms of route quality requirements, such as directness, comfort and safety). The coherency ratio can then be calculated by ticking off OD-pairs in the OD trip table that are connected without interruption, and dividing that total by the total number of OD-pairs (#Os x #Ds).

(remark) In a perfectly coherent network, all origin-destination combinations (ODs) are linked without interruption (interruption is defined as the absence of bikeways of a certain standard along the route). A high coherency ratio (maximum is 1.0) in combination with high connectivity suggests a well-designed network. An indicator of design coherency is the continuity of the road profile, when road profile lines up with the chosen functional class of the bikeway.

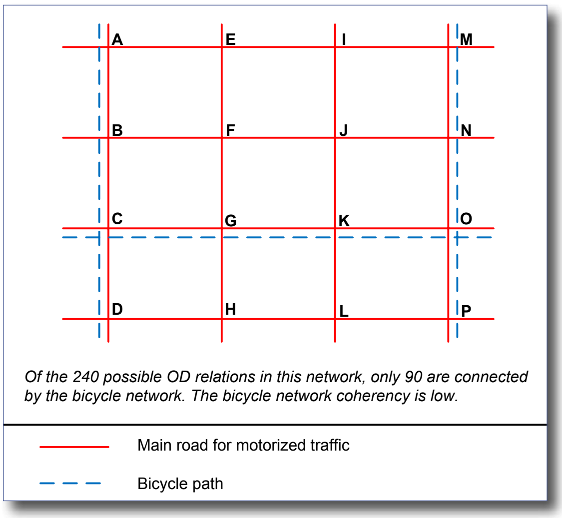


Figure 206
Measuring network coherency ratio.

Bicycle network access and egress

(what) Bicycle network access and egress: defined as the average time or distance it takes for people in a certain area to access the bicycle network or egress to their final destination.

(when) To show that although a proper bicycle network exists, certain locations may have very poor access or egress, constituting significant obstacles to bike use.

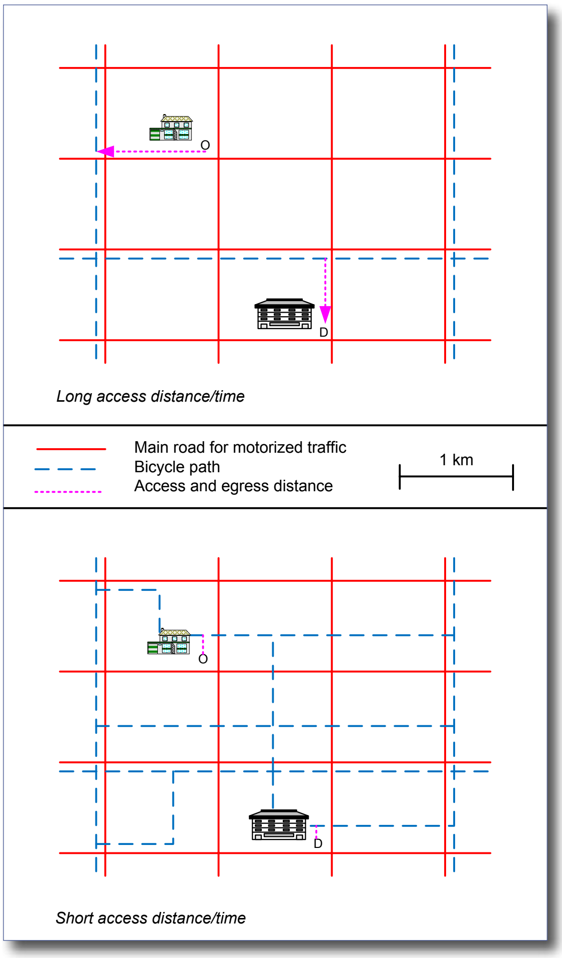
(how) Direct measurement or map-based. To calculate network access or egress time and distance, list the main origin (Os) and destination (Ds) points or locations in an area, such as a market, hospital or residential area, and calculate the average distance or travel time to reach the network (from an aerial map or using on-site measurements).

(remark) The higher the access/egress time, the less attractive it becomes for people to use the bicycle.

Measuring Route characteristics

Typical requirements for cyclists' routes have to do with directness, safety, comfort and

Figure 207
Measuring bicycle network access and egress.



convenience, attractiveness, accessibility and crossability. Cycle routes should be direct, ideally based on desire lines, with minimal detours (or delays) from origin to destination. Cycle routes should be safe, provide personal security, and limit the number of (possible) conflicts with other cyclists or road users. They should be smooth, non-slip, well maintained and clean, have gentle slopes, and be designed to avoid complicated manoeuvres. Cycle routes should integrate with and complement their surroundings, enhance public security, look attractive and contribute to a pleasant cycling experience. They should be accessible from and provide good access to surrounding areas (ingress and egress), and provide fast connections between origins and destinations. Specific locations along cycle routes should be crossable by other cyclists and other modes of traffic, in a safe and comfortable way, without too much interruption.

In this chapter we define a route as the bicycle connection between two important locations in an area. Such a route should ideally follow cycle route quality requirements for consistency, directness, attractiveness, safety and convenience as discussed above, following, for example ASVV – Recommendations for traffic provisions in built-up areas (2004).

Six related measures include:

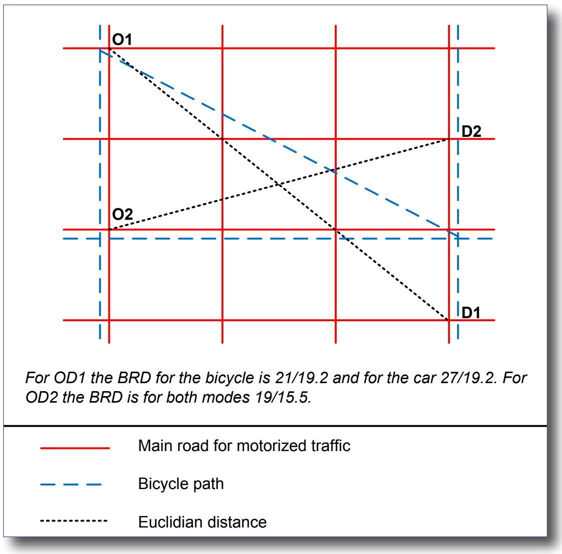
Bicycle Route Directness

(what) Bicycle Route Directness (BRD): Based on the Pedestrian Route Directness (PRD) index (Ballou *et al.*, 2002), this is the ratio of route distance to Euclidian (straight line) distance for two selected points.

(when) To show the (average) detour factor (for one or more routes) as compared to direct, desire line, connections. This can also be used to compare with a similar ratio for other modal infrastructure in the area.

(how) Map-based. Indicate on a map the origin and destination of a certain route (or for several routes between main points of attraction). Draw a direct line (or use a string to connect the O and D), and measure the desire line distance. Then draw the most realistic bicycle route (ask local stakeholders to help) or shortest bicycle route in the network and measure the distance also. Divide this distance to the desire line distance to get the BRD ratio. Some software (*e.g.* ArcGIS) can also be used to calculate an average BRD for a large set of origin and destination points.

(remark) A direct route obviously has a ratio of 1.0. The higher the ratio the greater the detour factor. Some literature suggests that an indirect route has a value larger than 1.6.



For OD1 the BRD for the bicycle is 21/19.2 and for the car 27/19.2. For OD2 the BRD is for both modes 19/15.5.

Figure 208
Measuring bicycle route directness.

Bicycle route safety indices

(what) Bicycle route safety indices. These compare the number of (reported) accidents or casualties involving cyclists along a route (including at the intersections) per unit of cyclist volume or distance, possibly distinguishing type of accident, other traffic volume, gender, age, time of day, weather condition, intersection/non-intersection, type of movement (turning, crossing, riding), etc.

(when) This index could be used to compare safety with other bicycle routes or with other modes.

(how) Counting and map-based. Count the number of (reported) accidents, incidents involving harassment, etc., along a route.

(remark) Because safety is so localized a phenomenon, this index should always be used in combination with a mapping survey to study the specific locations where accidents occur, perhaps in combination with a spot conflict analysis (Lund University, *n.d.*). Beware that accident reports are often incomplete. Also talk to local stakeholders. Alternatively, a route social safety index counts (reported) cases of harassment per location, unit of cyclist volume or distance. Bicycle route safety can also be measured indirectly as the percentage of segregated bicycle paths along a route, the type and quality of crossing facilities (including control strategy for cyclists), and so on.

Route comfort index measures

(what) Route comfort index measures the percentage of a total route length that is covered by smooth, skid-resistant, convenient pavement and non-steep sloping alignment.

(when) This index could be used to measure and compare route comfort with other bicycle routes or with infrastructure for other modes.

(how) On-site and map-based. The route should be cycled and pavement quality, road geometry, lining, and so on inspected (manually or automated) and compared to previously defined benchmark figures. The percentage of good to bad portions can then be derived. Overall quality can be rated on a normative scale from not comfortable to very comfortable (0 … 5).

(remark) Other indicators might include amount of shade, number of resting places, proper road drainage, bikeway level of service (LOS) (LTSA, 2004), density of street lights, number of intersections per km, obstructions (including encroachments), absence of route signing, emission levels and noise. This index is closely related to route attractiveness.

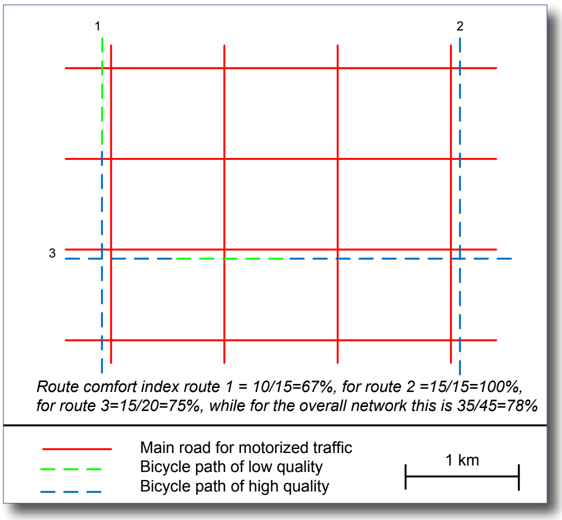


Figure 209
Measuring bicycle route comfort.

Route attractiveness index

(what) Route attractiveness index is closely related to route comfort and measures the integration of the bicycle route with its surrounding environment. It also measures lighting, shelter, traffic signs, waiting times at intersections.

(when) This index could be used to measure and compare route attractiveness.

(how) On-site. The route should be cycled and parameters of local environment quality, such as shade, shelter, lighting, liveliness of surrounding area, etc. be inspected and compared to benchmark figures set out beforehand. This index could be used to indicate and compare route attractiveness of a route. Route attractiveness is best measured on a normative scale from not attractive to very attractive (0 … 5).

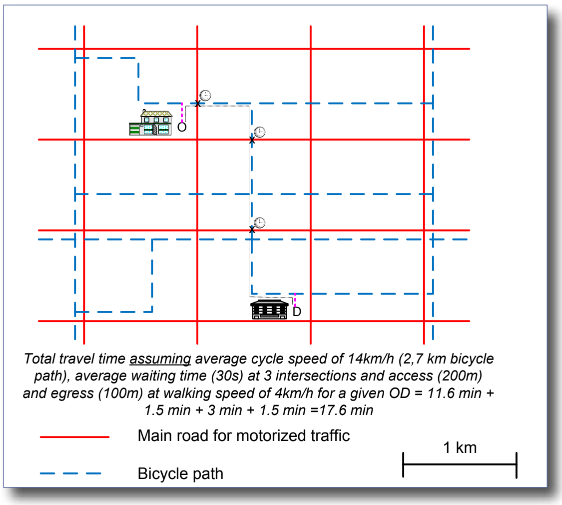
(remark) Beware that this index is closely related to route comfort. An easy distinction that could be used is leaving physical indicators of riding comfort to the route comfort index.

Route accessibility

(what) Route accessibility can be defined as the time or distance to cycle from the route origin to the route destination (including intersections), assuming an average cycling speed along the route.

(when) This measure is particularly useful when comparing travel time or travel distance on a

Figure 210
Measuring route accessibility.



route with other modes of transport, like walking or transit, or other routes in the network.

(how) On-site or map-based. Travel time can be directly measured by cycling the route several times during different hours of the day, different days of the week, and then comparing with similar measures for other modes. Alternatively, distances can be measured using a map or software such as ArcGIS.

(remark) This indicator is related to the bicycle route directness indicator, when compared to the airline or also called Euclidian distance[61]. Other indicators of route accessibility relate to average or maximum waiting time at intersections and access to shops and services along the route.

Route crossability index

(what) Route crossability index counts the number of safe and comfortable crossings for bicycles and/or other traffic along a route. It can also be indicated as a percentage of the total route length.

(when) This index gives an indication of the safety and comfort of a route, particularly at the intersections, and could be used to study the need for improved crossing facilities.

(how) On-site counting. Agreement should be reached on the quality characteristics of a proper crossing facility and then these aspects should be used as a benchmark against which crossings are checked. Alternatively, average crossing time can be estimated using a stop-watch (try, say 30 times during peak, and 30 times off-peak and take an average).

(remark) Crossing here is related to bicycles crossing intersections, and other traffic crossing or blocking bicycle paths (at bus stops, or market areas for example). In the Netherlands, an average waiting time for a crossing of 15 to 30 seconds is considered too long, because the longer the wait, the more risks people take.

Measuring Multi-Modal Integration

Few variables indicate the possibility and ease of transfer between the bicycle and other modes of transport, particularly with public transport. Good transfer options are said to stimulate multi-modal integration. One variable could be:

Facilitated bus/Metro/train stop index

(what) Facilitated bus/Metro/train stop index, which counts the relative number of official bus stops or bus terminals with adequate bicycle facilities. The type of facilities may range from simple bike parking facilities (guarded or non-guarded) to bicycle repair and rental facilities near bus stops.

(when) This variable is used to indicate the absolute or relative number of possible bus to bike, or bike to bus transfer points in the system. Bus stops without adequate bicycle facilities are unlikely to be used by cyclists.

(how) On-site counting. When agreeing on what adequate facilities are, count the number of bus stops with a minimal adequate level of facilities and compare with the total number of bus stops in the area.

(remark) A distinction can be made between 'normal' bus stops and bus terminals or bus stops at major attraction points in the area. Another aspect of an adequate transfer point might be the ease of reaching the bus stop by bike.

Measuring infrastructure

Many variables can be used to study the quality and quantity of bicycle infrastructure, distinguishing between segregated bicycle paths, cycle lanes or mixed traffic lanes open to cycling.

Infrastructure counts

(what) Infrastructure counts and measurements for:

- Average lane width (preferably also indicating minimum width, maximum

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61 Desire line is different from airline distance (even though both are straight lines from an O and D).

Table 12: Infrastructure inventory, specific ward, Dar es Salaam (Terlouw, 2007)

Location: Tandale - Sokoni junction Date: 10/18/2005

Traffic	Count	
Means of transport	**Transport of passengers**	**Transport of goods**
Pedestrian	(101)/Too many to count	29
Non-motorized vehicle	0	9
Bicycle/Tricycle	26	18
Motorized traffic	7	1

Environment	Presence	Condition/Remarks
Road-surfacing	Yes	Dirt road not smooth, putholes
Drainage	Yes	A very poor drainage system, which is open, smells and obstructed on many places, also water stagnation on the road
Electricity	Yes	
Street lighting	No	
Plants/trees	No	Only a few trees
Shade	No	No shade provided routes possible
Shops	Yes	Retail shops and workplaces all around
Bicycle shops/repair	Yes	There are some repair shops around
Hawkings	Yes	People are selling fruits on a newspaper
Kiosks	Yes	A lot of kiosks, selling fruit, fish, other food, clothes, electric, etc.
Carts	Yes	Some people are selling fruits from their bicycles and push cars
Parking	Yes	Parking of tricycles, non-motorized vehicles and every now and then a truck
Bins	No	The waste is collected at some points on the street even on a big heap, but is also on the roads
Slopes	Yes	There is a slope at the Sokoni street
Market	Yes	A lot of kiosks here form a market, there is a food market (Tandale) and a clothes market (…).
Loading/unloading goods	Yes	Some people are loading or unloading their non-motorized vehicles
Schoolchildren	No	Only a few school aged children
Other	Yes/No	

Road function						
Residential area	Population density					
Gathering points	Yes, people are gathering on the street					
	Schools	Church	Hospital	Market	Residential	Other
Origins				x	x	Workplaces
Destinations		x	x	x		Shops
Other						

Dimensions	Metres	Remarks	Varying from… to…	
Constant width	Yes/No			
Average Width				

Other remarks
There is a lot of activity
A lot of road space is used by waste heap, hawkings and people working, *e.g.* with sugar cane.

width, and standard deviation to show consistency in design);

- Total length of (adequate) bicycle infrastructure (adapted to local categorisation);
- Cycle paths (% and/or absolute length);
- Cycle lanes (% and/or absolute length);
- Mixed traffic lanes open to cycling (% and/or absolute length);
- Total length of (adequate) infrastructure with drainage facilities along cycle paths (% and/or absolute length);
- Total length of infrastructure with adequate pavement (segments between intersections free from potholes or obstacles in the drive way like trees or poles);
- etc.

(when) Infrastructure counts are used to gather quantitative and qualitative data on available and adequate bicycle infrastructure in the area (as compared to other infrastructure or size of the area).

(how) On-site counting and measurement. Most of these measurements can be used in a bicycle compatibility index (BCI) calculation or Cycling Level of Service (Cycling LOS) calculation.

(remark) The BCI method is discussed in the next paragraph as one of the composite methods using bicycle infrastructure supply indices.

Table 12 presents an infrastructure inventory for cycling in the city of **Dar es Salaam**, Tanzania (Terlouw, 2007).

Measuring facility characteristics

Many variables can be used to study the available quality and quantity of bicycle infrastructure facilities. Facilities can range from trees providing shade to street lights and parking places or benches en route.

Facility counts

(what) Facility counts for:

Bicycle parking places, including:

- Average occupancy level per location and/or over time;
- Ratio bicycle parking to bicycle parking places required per type of land use;
- Visibility, security, weather protection and adequate clearance;
- (working) Street lights along cycle paths;
- Number of trees along cycle paths;
- Number of bike repair shops in an area;
- Number of safe bike crossings;
- Benches;
- etc.

(when) Facility counts are used to gather quantitative and qualitative data on the completeness of bicycle infrastructure in the area (as compared to other infrastructure or size of the area).

(how) On-site counting and measurement. Most of these measurements can be used in a bicycle compatibility index (BCI) calculation.

(remark) The BCI method is discussed in next paragraph as one of the composite methods using bicycle infrastructure supply indices.

Operational bicycle infrastructure assessment

Level of Service (LOS) is a traffic engineering term that describes traffic quality. Usually LOS is applied to motorized traffic, where it is primarily concerned with delays and interruptions to traffic. When applied to cycling some additional aspects are also important. Therefore, LOS for cycling is related to cyclists' (observed) views and reactions to specific road environments. LOS levels are particularly useful when comparing routes and options.

Two measures for operational assessment (LOS indicators) are given below.

Cycle review LOS scales

(what) Cycle review LOS scales indicate different LOS levels based on a composite of typical traffic and infrastructure characteristics (for all modes) on a road segment.

(when) For evaluating, reviewing and/or comparing current LOS scales for different segments of the bicycle network. This method is particularly useful for mixed traffic networks (that is there are no separate bicycle facilities).

(how) On-site observations and counting. Several, mostly traffic, characteristics should be identified for each road segment or route to determine the LOS. Possible characteristics (both qualitative and quantitative) that apply are:

1. Motorized traffic flow level (no, light, moderate, busy, heavy, very heavy) in vehicles/hour;
2. Motorized traffic speed in km/h;

3. Ease of passing/overtaking other bicycles (lane width as compared to safe and comfortable lane width);
4. Conflict level (bicycle to bicycle and bicycle to other modes, including walking);
5. Riding surface;
6. Street lighting;
7. Social security;
8. etc.

After agreeing on the nominal scales with each of the characteristics, the user should be able to fill in Table 13. Different characteristics can also be weighted, to decide the LOS level through applying multi-criteria analysis.

Table 13: Cycle review LOS scales (LTSA, 2004)

LOS	Score	Typical traffic characteristics	Likely road/path type
A	81–100	Little or no traffic; low speeds; good passing width; no significant conflicts; good riding surface; good street lighting; good social security.	High-quality bicycle path; well surfaced; minor rural road; 30 km/h limit urban road.
B	61–80	Light/moderate traffic flows; good/adequate passing width; few conflicts; good social safety.	Minor road; well surfaced but unlit cycle path.
C	41–60	Moderate traffic flows; 85th percentile around 50 km/h; adequate passing width; some, but not major conflicts.	Minor road/local distributor
D	21–40	Busy traffic, heavy commercial vehicles/buses; speeds around 70 km/h.	Urban single carriageway; poor-quality cycle path
E	1–20	Heavy traffic flows; speeds >70 km/h; heavy commercial vehicles/buses.	Dual carriageway speed limit 70 km/h or higher; large roundabouts
F	< 0	Heavy traffic flows; heavy commercial vehicles/ buses; speeds 100 km/h; narrow lanes; no street lighting.	Narrow rural single carriageway or dual carriageway; grade separated junctions.

REMARK: The Cycle review LOS scales are very context dependent. Before using the table, local users should adapt it their own circumstances!

Bicycle Compatibility Index

(what) Bicycle Compatibility Index combines several measures of infrastructure supply, including those used in the LOS levels discussed above, based on a composite of typical traffic and infrastructure characteristics (for all modes) on a road segment.

(when) For evaluating, reviewing and/or comparing current BCI/LOS scales for different segments of the bicycle network.

(how) On-site observations and counting. Several, mostly traffic, characteristics should be obtained for each road segment — or even route — in order to determine the BCI and LOS. The main characteristics for the BCI (both qualitative and quantitative) are:

- Geometric and roadside data.
- Traffic operations data
- Parking data

After agreeing on the nominal scales with each characteristic (see below), users should be able to fill in the equation below and calculate the Bicycle Compatibility Level, based on LOS and BCI values, using the following method, developed by FHWA (1998) to describe a facility's compatibility with cycling. The BCI model is a regression-based formula, with parameters estimated for traffic volume, speed, lane width and other indicators for cyclists' stress. It is used to rank a road segment for compatibility with cycling, like the LOS rating presented above.

The FHWA model is defined as follows:

$$BCI = \alpha_0 - \alpha_1 BL - \alpha_2 BLW - \alpha_3 CLW + \alpha_4 CLV + \alpha_5 OLV + \alpha_6 SPD + \alpha_7 PKG - \alpha_8 AREA + AFs \quad (2)$$

With *:

Constant (α_0 = 3.67)	Constant
BL (α_1 = 0.966)	Presence of bicycle lane or paved shoulder (no = 0; yes = 1)
BLW (α_2 = 0.410)	Bicycle-lane (or paved shoulder) width (metres to the nearest tenth)
CLW (α_3 = 0.498)	Curb-lane width (metres to the nearest tenth)
CLV (α_4 = 0.002)	Curb-lane volume (vehicles per hour in one direction)
OLV (α_5 = 0.0004)	Other lane(s) volume — same direction (vehicles per hour)
SPD (α_6 = 0.022)	85^{th} percentile speed of traffic (km/h)
PKG (α_7 = 0.506)	Presence of a parking lane with more than 30% occupancy (no = 0; yes = 1)
AREA (α_8 = 0.264)	Type of roadside development (residential = 1; other type = 0)
AF (f(t) + f(p) + f(rt))	Adjustment factors for large truck volumes, on-street parking turnover, and volume of right-turning vehicles, respectively.

* *Note:* Factors are estimated by FHWA for conditions in the US. For use elsewhere, factors should be critically reviewed and/or specifically estimated for local conditions.

Table 14 provides an example of an adapted application of the BCI model for three road segments in New Zealand. Here, other variables and factors have been added (the final BCI model used is not presented here). The results presented below indicate that none of the segments was suited to bicycle traffic, given ratings of moderate and low bicycle compatibility.

To estimate and calibrate the factors for local circumstances, extensive observations combined with interviews with (potential) cyclists on their preferences and attitudes to bicycle compatibility should help to develop a reliable model. The reader is referred to (FHWA, 1999) for some explanation on the definition and estimation process for BCI models.

Table 14: Sample BCI calculation (LTSA, 2004)

Location		Segment A	Segment B	Segment C
Geometric & road side data	Length (km)	0.62	1.87	1.19
	No. of lanes (one direction)	2	2	2
	Kerb lane width (m)	3	3.4	3
	Bicycle lane width (m)	1.5	1.5	1.5
	Paved shoulder width (m)	0	0	0
	Residential development (yes/no)	Y	N	N
Traffic operations data	Speed limit (km/h)	60	60	60
	85th percentile speed (km/h)	60	50	60
	Traffic flow (AADT)	28,000	28,000	31,000
	Large trucks (%)	0.50	0.50	0.5
	Left turn (%)	0.00	0.09	0.05
Parking data	Parking lane (yes/no)	Y	n	n
	Occupancy (%)	50		
	Time limit (h)	120		
Results	BCI	4.74	3.78	4.00
	Level of Service (LOS)	E	D	D
	Bicycle compatibility level	Very low	Moderately low	Moderately low

REMARK: The Cycle review LOS scales and BCI characteristics are very context dependent. Before using these methods, planners should agree on and adapt the table to local circumstances! The model presented here is based on parameter values derived in the USA, and should be critically reviewed against local standards before application elsewhere.

The bicycle balance sheet: a comprehensive indicator for cycling quality

Several indicators have been discussed, along with the BCI method, useful for evaluating a set of indicators. For any combination of indicators, *Bicycle Balance Sheets* and/or spider diagrams can help to visualize the performance of a set of indicators compared against a threshold. The example below is for measuring the quality of cycling in a Dutch municipality against a predefined standard.

The *Dutch Bicycle Balance Sheet,* developed by the *Fietersbond* (Dutch cyclists' union), assesses ten different dimensions (and 24 sub-dimensions) of local cycling conditions. The results are compared with:

- Existing and developed standards;
- Average scores for all towns assessed and towns of roughly the same size;
- The best scoring towns.

This way the participating towns gain a clearer understanding of their cycling policy strengths and weaknesses and can compare their efforts, results and effects to those of other (comparable) towns. They can reliably determine which aspects most urgently need improvement. The following main dimensions of cycling conditions are assessed in the Bicycle Balance Sheet (for a detailed explanation, see Borgman, 2005, or CROW, 2006):

- Bicycle use (a/o's modal split);
- Bicycle route directness;
- Route comfort (obstruction);
- Road safety (of cyclists);
- Route comfort (road surface);
- Urban density;
- Attractiveness;
- Cyclists' satisfaction;
- Competitiveness, compared to the car;
- Cycling policy on paper.

To make the diagram, planners must agree on normative scales (and accompanying values) for each bicycle indicator and include lines, indicating these scales, perpendicular from the centre (indicating worst possible quality) to the edge (best possible, or norm/threshold value). This way, a whole set of indicators can be compared, visualized and communicated at a glance.

Figure 211

Cycle Balance Assessment Sheet (Borgman, 2005)

Source: Fietsbalans®, Fietsersbond

General overview of the Cycle Balance assessment results 2000						
Assessed (sub)dimension	Standard	Interval	**Overall Average**	**Average big cities**	**Average medium size cities**	**Average small cities**
Directness						
Detour factor (ratio)	1,25	0,1	mediocre	mediocre	very good	mediocre
Delay (sec/km)	16,5	10	good	mediocre	good	very good
Actual cycling speed (km/h)	15,5	1	mediocre	mediocre	mediocre	good
Overall judgement directness			**mediocre**	**mediocre**	**mediocre**	**mediocre**
Comfort (obstruction)						
Chance of stopping (N/km)	0,75	0,5	mediocre	bad	mediocre	good
Slow cycling and walking (% of time)	7,5	5	mediocre	mediocre	mediocre	mediocre
Traffic-obstruction (v-Fv)	1,75	1,5	mediocre	mediocre	mediocre	mediocre
Infrastructural impediment (v-Fi)	0,75	0,5	mediocre	mediocre	mediocre	bad
No right of way (N/km)	2,5	1	mediocre	mediocre	mediocre	bad
Turning off(N/km)	2	0,5	mediocre	mediocre	mediocre	bad
Overall judgement comfort (obstruction)			**mediocre**	**bad**	**mediocre**	**mediocre**
Comfort (road surface)						
Hindrance caused by vibrations (v-Ft)	100	40	**mediocre**	**mediocre**	**mediocre**	**bad**
Attractiveness						
Noise pollution (v-Fg)	130	40	**mediocre**	**bad**	**mediocre**	**good**
Competitiveness						
Journey time ratio (ratio)	1	0,1	good	good	mediocre	mediocre
Journey bikes faster (% of journeys)	70	20	mediocre	mediocre	bad	mediocre
Costs per journey (cents)	100	30	bad	good	bad	very bad
Overall judgement Competitiveness			**mediocre**	**good**	**mediocre**	**bad**
Bicycle use						
Share in trips to 7.5 km (%)	43	4	**mediocre**	**mediocre**	**bad**	**mediocre**
Road safety of cyclists						
Victims per 100 million cycle km (N)	14	4	**mediocre**	**mediocre**	**bad**	**mediocre**
Urban density						
Adresses per square kilometre (N)			**mediocre**	**good**	**good**	**mediocre**
Cyclists satisfaction						
Bicycle parking (% dissatisfied)	17,5	15	mediocre	mediocre	mediocre	bad
Comfort (% dissatisfied)	17,5	15	mediocre	mediocre	mediocre	mediocre
Road safety for cyclists (% dissatisfied)	17,5	15	mediocre	mediocre	mediocre	mediocre
Social safety (% dissatisfied)	17,5	15	good	good	good	good
Approach to bicycle theft (% dissatisfied)	17,5	15	very bad	very bad	very bad	very bad
Municipality's cycling ambitions (% dissatisfied)	17,5	15	good	good	good	good
Report mark	7,25	0,5	mediocre	mediocre	mediocre	mediocre
Overall judgement cyclists satisfaction			**mediocre**	**mediocre**	**mediocre**	**mediocre**
Cycling policy on paper						
Policy papers and plans (N)	16	4	mediocre	mediocre	mediocre	bad
Bicycle network (N)	13,5	4	mediocre	mediocre	mediocre	mediocre
Bicycle parking (N)	14	3	bad	mediocre	mediocre	bad
Budgets (N)	4	1	bad	mediocre	bad	bad
Council as employer (N)	5	1	mediocre	mediocre	good	mediocre
Overall judgement cycling policy on paper			**mediocre**	**mediocre**	**mediocre**	**bad**

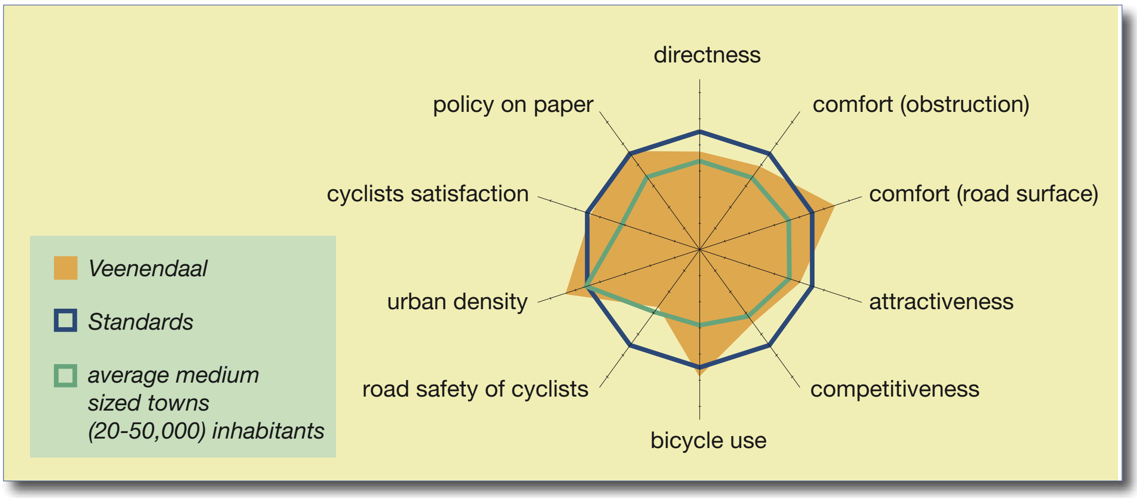

Figure 212
The Bicycle Balance Sheet: benchmarking local cycling conditions (Borgman, 2005).
Source: Fietsbalans®, Fietsersbond

Rapid assessment methods

Rapid assessment methods focus on key elements that describe the current state of the art (good and bad practice). At the same time, it identifies opportunities for urban change, including levels of accessibility, safety levels and quality of public space. Implementing cycling in urban situations can be considered 'environmental innovation' within city development programs.

For the development of a cycling network one can try to avoid time- and money-consuming quantitative origin-destination (OD) analysis. Instead, one relies on existing qualitative knowledge about the city, labelling and categorizing that knowledge for its relevance to cycling. Visualising this knowledge on a map helps to develop a clearer structure.

Areas and routes are categorized according to their specific predominant function or characteristics with regards to cyclists' needs and opportunities, and (wherever relevant) the dominant stakeholder involved. An icon on a city map represents each definition, among them:

- Safe routes to school areas;
- Mixed land use areas with internal cycling (city centres, shopping areas, markets);
- Corridors with investment in public transport (potential mode segregation);
- Corridors with road maintenance priority (opportunity to improve road design, *e.g.* Potential mode segregation);
- Hubs for intermodal change (bus and railway stations);
- Habitat and urban infrastructure upgrading areas (internal network potential);
- Attraction points (University, working areas, and so on);
- Black spots (danger, social importance);
- Barriers, missing links;
- Points for orientation, land marks, and so on.

The icons can also highlight relevant features in the cityscape: what problems need to be solved where, what type of bicycle trips should be provided for, where opportunities exist, and so on. This way, the strategic outline method provides a tool for *network differentiation*.

For such an analysis, you need both professionals and cyclists familiar with the cycling topography. A workshop, curriculum of a training course can be used to generate the necessary knowledge for the map, but informal discussions work too. Involving a wide range of personalities will enrich the knowledge available, multiplying perspectives. In some cases, a skilled moderator is worthwhile for knowledge generating sessions. The product of such a rapid assessment should be considered a communication instrument for organising involvement, commitment and consensus, the maps must be easy to read and appealing.

Such methods can also be used to identify and position stakeholders, both geographically and institutionally. To understand cultural blockages for cycling one needs to apply a 'holistic approach'. This means that every city, region or country has its own key social, economic and technological aspects. Many of the attitudes, opportunities and barriers towards durable cycling can be explained.

Table 15: Methods for infrastructure quality assessment

		Map-based	Direct measurement	Counting	On-site
1. Network characteristics ■ Network coherence ■ Network connectivity ■ Accessibility	1. Bicycle path to network density	X			
	2. Connected node ratio	X	X		
	3. Link – node ratio	X			
	4. Alpha index	X			
	5. Network coherency ratio	X			
	6. Access and egress to a bicycle network	X			
2. Routes ■ Directness ■ Safety ■ Comfort & convenience ■ Attractiveness ■ Accessibility ■ Crossability	1. Bicycle route directness	X			
	2. Bicycle route safety index	X		X	X
	3. Route comfort index	X		X	X
	4. Route attractiveness index	X			X
	5. Route accessibility index				X
	6. Route crossability count				
3. Multi modal integration	1. Facilitated bus stop index				X
4. Bicycle infrastructure ■ Quantity ■ Quality	2. Infrastructure measurement and count		X		X
5. Bicycle infrastructure facilities	1. Facility count		X		X
6. Bicycle operations and compatibility	1. Bicycle Level-of-Service	X	X	X	X
	2. Bicycle Compatibility Index	X	X	X	X

15.4 Safety analysis

15.4.1 Introduction

An important aspect of any traffic plan, particularly a bicycle plan, is its impact on safety. As discussed previously, in places where there are currently no cyclists on the road, this aspect may deserve the most attention. Where bicycle usage is on the rise, thanks to an emerging bicycle culture, safety may improve thanks to the safety-in-numbers effect (this reflects studies that indicate that an increase in bicycle trip volumes can reduce the risk of accidents per cyclist, but also lead to a decrease in total accidents, see below for details). Where safety is an important concern, a safety audit can help to qualify these concerns and to focus budgetary means and political willpower on the most crucial locations and measures. This section lists several key variables that should be part of a safety audit and methods for collecting data on these variables.

Table 16 offers an overview of elements and variables with their possible dimensions, discussed below.

Table 16: Overview of elements and variables with dimensions

Elements	Key variables	Dimensions
1. Number of accidents	1. Absolute number 2. Proportional frequency	● severity (fatal, severe injury, light injury, property damage only) ● location (intersection or road section) ● transport mode of victim ● gender ● age category
2. Causes of accidents	1. Inventory of probable causes	● per risk hotspot ● gender ● age category
3. Composed safety indicators	1. Weighted accident count 2. Relative Risk	● per road-section ● per OD-route

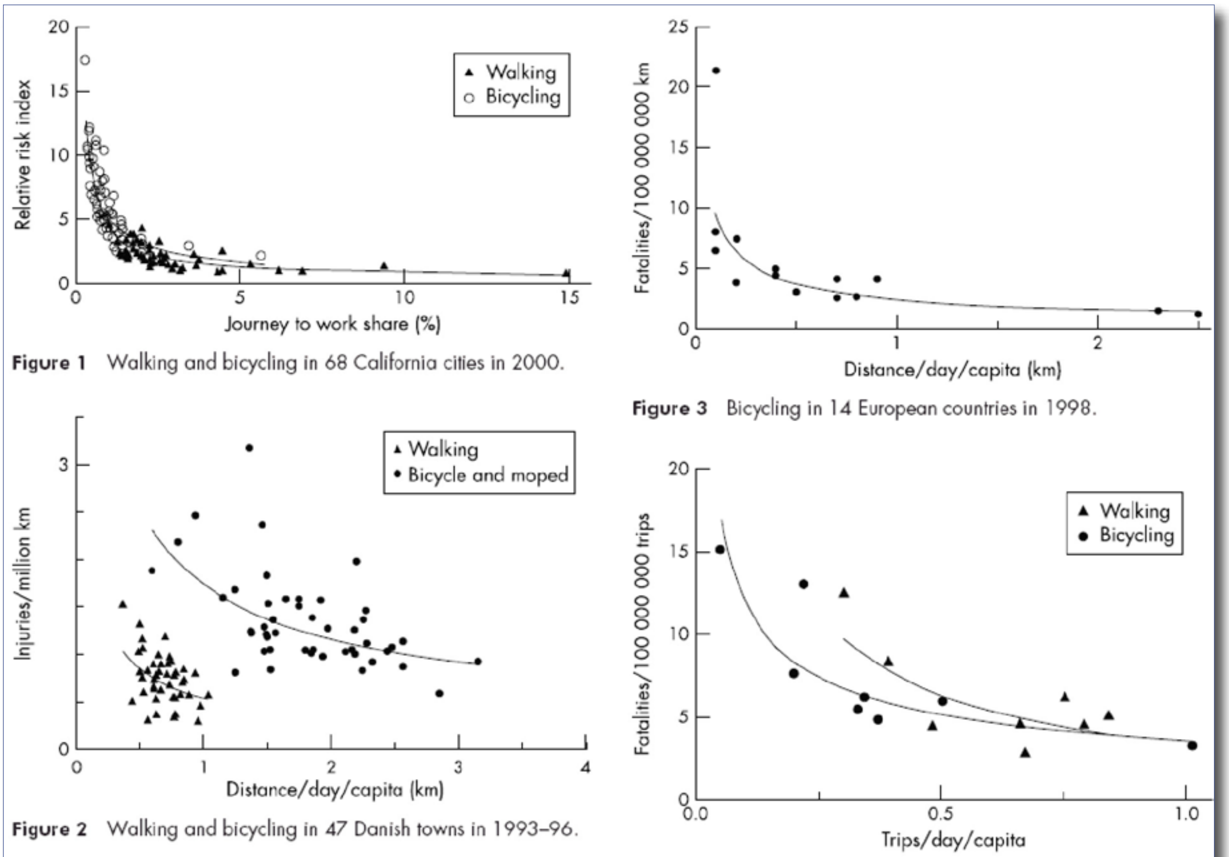

Figure 1 Walking and bicycling in 68 California cities in 2000.

Figure 2 Walking and bicycling in 47 Danish towns in 1993–96.

Figure 3 Bicycling in 14 European countries in 1998.

Figure 4 Walking and bicycling in eight European countries in 1998.

Walking and bicycling in California cities

Fig.: 213, Figure 1: Walking and bicycling in California cities. Per capita injury rates to pedestrians and cyclists vary fourfold among the 68 cities, and the portion of journey to work trips made by foot and bicycle varies more than 15-fold and 20-fold (respectively). Dividing the per capita injury numbers by the fraction of work trips on foot or bicycle results in a fivefold and eightfold range of risk for a person walking or bicycling in the 68 cities. Figure 1 shows that the likelihood of an injury is not constant but decreases as walking or bicycling increases.

Figure 2: Walking and bicycle and moped riding in 47 Danish towns. Per capita injury rates to pedestrians and cyclists varied two-fold, and the number trips made by foot and bicycle varied more than fourfold and three-fold (respectively). Dividing the per capita injury numbers by the aggregate distance walked or bicycled indicates a fivefold range of risk for a person walking or bicycling for the 47 towns. Figure 2 shows that despite considerable scatter in the results, pedestrians are safer in towns with greater walking and bicyclists are safer in towns with more bicycling.

Figures 3 and 4: Walking and bicycling in European countries. In the 14 countries with data, distance cycled per capita varied 10-fold. Across them, the number of persons killed while bicycling varied fourfold. Dividing the number of bicyclist deaths per capita by the distance bicycled per capita indicates a nearly 20-fold range of risk for a person bicycling a given distance. Figure 3 shows that the number of bicyclist fatalities/distance bicycled decreases with increasing distance bicycled per capita. In the eight countries with person trip data, the number of bicycle trips per capita varied by more than 10-fold and the number of trips on foot varied three-fold. Dividing the per capita fatality rate by the daily foot and bicycle trips per capita data indicates a nearly fivefold range of risk of death for each trip. Figure 4 shows that the risk decreases with increasing trips on foot or on bicycle.

Figure 213

Safety in numbers. Injury Prevention, 2003:9; 205–209

Illustration by Jacobsen, P. L. (2003)

15.4.2 Elements

Key variables in safety studies can be classified according to three main categories of elements:

- Number of accidents;
- Causes of accidents;
- Composite safety indicators.

Number of accidents

The number of accidents can be expressed as either absolute or relative numbers. Which is most useful depends on the context, but generally speaking it is good practice to state both where feasible. However, when stating a relative number of accidents, think carefully about which main indicator to choose. Possibilities include per person-km, person-trip or, less frequently, per km of road length.

Figure 214

Mapping Traffic Accidents. Annual pedestrian – vehicle crashes as reported by the California Highway Patrol result in a detailed map of absolute pedestrian injuries. Note the concentration within the downtown area (circle).

(Raford and Ragland, 2003)

Another issue is what dimensions to use for the number of accidents or a subdivision thereof. Frequently used dimensions include: severity of the accident, the specific location or location type, the transport mode of either the causer or the victim of the accident, gender and age category. As this is a long list (and one that is in no way exhaustive), an argued choice of dimensions is necessary. This choice should be based on the main questions that the study is supposed to answer. For subdividing by location, maps are useful to identify black spots or relatively unsafe streets and intersections, see Figure 214.

Causes of accidents

A study of the deeper causes of accidents can help to look beyond simple accident statistics, telling a more complex story with clearer implications for improvements.

> ***Note:*** *There are several well known problems with typical police data, and analysts need to take these into consideration. Vehicle-vehicle incidents and incidents involving fatalities are typically reported with reasonable accuracy, but only 35–85% of vehicle-bicycle and vehicle-pedestrian incidents involving injury are included in typical crash statistics. These*

> *estimates were developed by comparing accidents reported by police and hospital admission records.*
>
> *A study of California children estimated that police reports covered just 80% of hospital admissions. A British study found that only 67% of minor injuries to pedestrians were reported, 85% of serious injuries. In Germany, figures were 50% for major injury and 35% for minor. Based on this research, it is appropriate to adjust vehicle-bicycle and vehicle-pedestrian injury statistics upwards by at least 50%.*

This data is typically qualitative and typically involves listing likely causes, as these may follow from visual inspection of the location, analysis of safety statistics or comparison with other locations. In all likelihood, this kind of inventory will take the form of a short narration for each important location. Additionally, these locations may be ranked, based on one or two location-specific factors relevant to the proposed bicycle plan.

Composite safety indicators

In the vast literature on traffic safety, many indicators have been proposed to combine multiple aspects of traffic safety that are otherwise hard to compare. This 'combining' of factors can be useful when mapping overall safety and for starting and influencing discussions. At the same time, this 'combining' aspect is also the main drawback of composite indicators: unavoidably, they reveal just part of the complex and multiple realities behind traffic safety. Also, outcomes of composite indicators are heavily influenced by the assumptions that go into creating them.

Weighted accident count

Crash statistics of accidents of different severity can be combined using weight factors. For example, the following crash cost factors (Homberger *et al.*, 1992) are used in the United States:

Crash Cost Factors Used in the US (Homberger *et al.,* 1992)

Factor	Severity
1,300	Fatality
90	Incapacitating injury
18	Evident injury
10	Possible injury
1	Property damage only

Relative risk

The relative risk is a means to combine accident statistics with traffic volumes. For pedestrians, it is defined as the annual number of pedestrian-vehicle collisions divided by the annual pedestrian volume. A possible tool for implementing a relative risk measure is the space syntax method. This is a theoretical modelling approach developed at the Institute of Transport Studies of Berkeley University (Raford and Ragland, 2003). It estimates pedestrian exposure to moving vehicles.

Possible instruments/collection methods

Sources for key safety variables include:

Police accident statistics

Researchers should take care when using police data, because underreporting rates vary by accident type. Vehicle-vehicle incidents and incidents involving fatalities are typically reported with reasonable accuracy, but only 35–85% of vehicle-bicycle and vehicle-pedestrian incidents involving injury are included in typical accident statistics. Based on comparing accidents reported by police and hospital admission records in several countries, vehicle-bicycle and vehicle-pedestrian injury statistics from police data should be corrected upward by at least 35% for major injuries and 60% for minor injuries.

Hospital admission statistics

This data source often does not specify location and does not cover fatalities or injuries that did not result in hospital admission.

Site surveys

Observation *in situ* of the relevant physical features (lack of sidewalks or refuge islands, lack of street lighting and so on) can help identify the likely causes behind high accident rates.

Table 17: Potential sources for accident statistics

		Police crash statistics	Hospital admission stats	Site surveys
Number of accidents	Absolute numbers	x	x	
	Proportional frequencies	x	x	
Causes of accidents	Inventory of causes	x	x	x
Composed safety indicators	Weighted accident count	x	x	
	Relative risk	x	x	

15.5 Institutional analysis

15.5.1 Introduction

Data on the institutional context is important, not so much for the technical quality of bicycle plans themselves, but rather, such data increases the chances that plans can indeed be implemented as envisaged, and that unexpected circumstances will receive a suitable response. A structured set of information on institutional arrangements helps to eliminate the risk of encountering unforeseen institutional barriers later in the process and identifies possible institution-related threats. A systematic institutional analysis can also identify unexpected opportunities, such as joining forces with other initiatives, plans, developments and officials. It can also help to identify good opportunities within the timing and scheduling of a bicycle plan, its communication and its implementation. Thus, data on the institutional context is collected less to offer arguments supporting the bicycle planning process in external communication directed at policy makers, officials and the public and more for internal purposes, particularly designing and steering the planning process. As a consequence, such data is best collected early on.

An overview of elements and variables with possible dimensions follows, and is further discussed below (Table 18).

15.5.2 Key variables

Key variables for institutional analysis include the place where executive responsibilities, budgetary control and advisory power are located, with regard to each relevant aspect within the proposed bicycle plan. This could be a council or formal governmental department, a single official, a police department, but also local interest groups, private bodies and informal groupings. Apart from identifying each influence per aspect and all relevant sub-aspects, this influence often varies for different areas of the proposed project, for example according to whether the issue is being dealt with at a local or regional level. Often, many powers are shared among different bodies, so the division of power should be described.

15.5.3 Possible instruments/collection methods

Collecting the above data may be extremely confusing and sometimes nobody really knows who is responsible. Some aspects may be completely out of the hands of local government and effectively controlled by local mafias, such as those controlling local parking in some cities or areas. Others, such as the design and placing of street furniture, may fall under the administrative control of a half-dozen public authorities. Therefore, multiple sources must be used to collect this information. Possible means include:

Expert interviews

Using a structured questionnaire, such as the checklist matrix presented below, experts on

Table 18: Elements, variables dimensions of institutional analysis

Elements	Key variables	Dimensions
Institutional analysis	Place(s) of budgetary control and decision-making	per aspect and subaspect per area/district
	Place(s) of executive responsibility	per aspect and subaspect per area/district
	Place(s) of advisory power	per aspect and subaspect per area/district

administration, urban planning and local politics can be interviewed for their knowledge. This is a flexible and low-barrier approach. The individual approach has the added advantage over group approaches in that where responsibilities are only vaguely assigned, this method is likely to reveal ambiguities, particularly when different answers are obtained for the same question.

Expert seminar/workshop

Alternatively, workshops (possibly thematic) may be organized, to discuss these issues with a broad group or panel of experts. This may be part of a larger activity, congress or fair. It could also be organized in coordination with a third party involved in organizing an event on a different, but related, issue. Different stakeholders should be invited, among them politicians, neighbourhood groups or civil society organisations (CSOs). Such multi-stakeholder involvement contributes opinions and interests and involves key groups at an early stage.

Participatory GIS (PGIS)

This is a particular kind of expert seminar. In this data collection method, maps are a major conduit. By providing large maps and by pointing out specific infrastructure, districts or urban blocks, a number of residents and/or local experts can contribute their knowledge of local relationships and institutional arrangements. This can be as structured as

Table 19: Places (administrative unit, private bodies)

	National govt. (specify dept.)	Municipal govt. (specify dept.)	sub-municipal govt.	City police	Traffic police	Local interest groups	Private bodies	Informal, unregulated (specify)
Aspect of executive responsibility, advisory power or budgetary control								
Main urban roads ■ planning ■ construction ■ regulation ■ enforcement ■ maintenance								
Small local roads ■ planning ■ construction ■ regulation ■ enforcement ■ maintenance								
Sidewalks and roadsides ■ regulation of activities ■ street parking ■ street furniture ■ enforcement								
Design (standards) and architecture ■ roads ■ cycling Infrastructure ■ cycling facilities ■ public transport facilities ■ sidewalks								
Land tenure (= local land regulation and administration)								

simply as just letting them speak freely about the respective infrastructure and urban blocks, their planning and operation, and taking notes on the discussions (for more information, see http://www.iapad.org/participatory_gis.htm).

To systematically collect and present institutional information, it is probably best to work with a checklist matrix. This matrix should store all relevant aspects and sub-aspects in its rows, and all possible places, such as administrative units or bodies in its columns, preferably grouped thematically. An example of such a matrix follows. Each cell offers room for comments about the type and strength of influence that each actor brings to bear on each aspect and sub-aspect. Separate matrices can be developed for different districts (Table 19).

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Glossary

Compiled by Lake Sagaris

Creating an international terminology

In preparing this Handbook we have worked hard to develop an internationally useful glossary of bicycle and related terminology. Given the multi-disciplinary, multi-cultural approach of the team of authors and editors, we have also acted from the conviction that to some degree we are not only using key terms here, but also have the opportunity to define many key concepts. This is based on the knowledge that this training handbook will be used all over the world, wherever there is interest in cycling-inclusive urban planning, and in many other languages. Indeed, we expect this glossary to form the basis of similar efforts in Spanish, Portuguese and several Asian languages. We have, therefore, attempted to use existing definitions or at least base more specific definitions on existing uses, to facilitate understanding. But where we have felt that the current terminology is confusing, contradictory or inadequate, we have taken the opportunity to produce what we hope will become definitive international definitions and usages.

Along the way we have had to make many decisions. For comprehension, brevity or other reasons, within the main text we have chosen, for example, to use transport rather than transportation; public transport rather than transit, despite the wide use of the latter in Canada and the US.

As users and professionals in this field we have become increasingly uncomfortable with defining the modes of travel that most interest us by what they are not — "human-powered" — instead of in terms of what they are, human-powered modes of transport (HPT). We are aware that "active transport" is a term and a concept that is increasingly coming into use, particularly among pioneers in North and Latin America. This, because of its possibilities for expanding to include not only the human-powered staples of walking and cycling, but also wheel chair and other differently abled users; those who depend on tricycles, especially for recycling and other sustainable activities; parents with children in strollers; and the elderly or those using carts, wagons or other elements to carry groceries and packages.

We like "active transport", because of its potential for clearly linking sustainable transport and social inclusion, and because it also underlines the community, mental and physical health benefits of these modes of transport. We have seen growing use of this term and more in-depth exploration of its implications, particularly in Chile where a multi-disciplinary, multi-stakeholder design manual working group is working to define and genuinely incorporate the full gamut of meanings into their practical work.

The focus of this training handbook, however, is specifically cycling-inclusive urban and transport planning. We have, therefore, opted for using a language that maintains this focus.

We also remind readers that bicycle or bike is the object on which we travel, while to cycle is the action, and cycling the activity. In some cases we have opted to use the term "cycle" as the generic noun, because it includes all wheel-based, human-powered vehicles (including the tricycles, rickshaws and other work-based vehicles common in cities around the world).

Similarly, we have generally used "road", but this generic title is considered synonymous with "street".

In all cases, we use bicycle, cycling and cyclist in the sense of human-powered users, reserving the terms motor cycle, motor cyclist, and so on, for motorized users.

To prepare this glossary we used a series of glossaries prepared by local, regional and national authorities in Canada, the United States and the United Kingdom. For those who would like to explore even further, a list of these is included in the references at the end of this section and we thank everyone whose research and experience has contributed to this process.

Access road or **street** means a street generally limited to providing access to abutting property and tributary to major and secondary thoroughfares (Section 35.78.0l0 of the Revised Code of Washington).

Accessibility describes the degree to which people using different transport modes, and particularly, in the context of this handbook, a bicycle, wheelchair or other human-powered transport mode, can access and/or participate in the employment, shopping, education, health, entertainment, social and other opportunities available in any given area.

Accessibility Requirements In the US and many other countries around the world, these requirements refer to measures to ensure that persons with physical disabilities can safelty and easily approach, enter and use specific sites, buildings, facilities (See also *American National Standard, Council of American Building Officials* or national legislation in many countries).

Active Transport refers to travel modes that involve physical activity and can generally be considered health enhancing. These include walking and cycling. This term is increasingly used instead of the more traditional "human-powered transport", to focus on the positive, health- and education-related forms of transport. Because this new use requires new definitions, it also opens the way to more socially inclusive terminologies, policies and design. Many cities and citizens' groups use this term to refer to walking, cycling, tricycle and wheel chair use, skates, skateboarding, baby carriages/strollers, people with carts for packages, etc.

Advocacy In the sense used in this Handbook, advocacy refers to interest groups actively organizing and arguing, through public and private means, on behalf of a cause, idea, or policy.

Alley means a public right of way not designed for general travel and primarily used to provide vehicular and/or pedestrian access to the rear of abutting properties.

Appropriate means right for the purpose, suitable to the occasion or circumstances. In this handbook it refers to taking into consideration the context for new policy and infrastructure initiatives, particularly the character of local communities and the environments that may be improved or harmed by changes to existing facilities.

Appropriately-Scaled Right for the purpose; adequate for the use and volume and location intended.

Arterial road or **street** A main travel route which connects major activity centres, typically used primarily for fast or heavy traffic. In some cities, speeds and traffic volumes may approach those of highways, increasing hazards to all users, particularly the most vulnerable. Arterials typically connect two or more subregions; provide secondary connections outside of cities; and may complement highways in high-volume corridors. Some local authorities define them by traffic volumes of more than 10,000 vehicles per day. Others consider them roadways designed to carry large volumes of traffic to and from collector streets, placing the emphasis on mobility, rather than access functions.

ASL Advanced Stop Line

ASL Reservoir Area of an ASL where cyclists can wait at junctions, also referred to as "bicycle boxes".

Attached/Detached: Used in reference to sidewalks as physically connected or not physically connected to a street.

Attractiveness see **Five Main Requirements**

Audit, (Cycling) Safety A formal process to identify hazards that may increase the general risk of traffic-related accidents involving cyclists, or increase the severity of cyclists' or pedestrians' injuries in the event of an accident. In many countries, local authorities and community organisations carry out pedestrian and other audits to improve local facilities for walkers, cyclists and the differently abled.

Automatic bicycle parking facilities (mostly paid) involve cyclists storing bicycles in protected facilities that register and store them. Upon return the cyclist has to use an electronic key, receipt or some other kind of voucher to recover the bicycle. An organisation is responsible for key distribution and administration. These usually require a managed, operating system. (Planning and other authorities should increasingly think in terms of including parking facilities for tricycles and other human-powered vehicles typically used as part of daily commutes (especially to take children to school), micro-business and informal sector economic activities (recycling, cycle-taxis, etc.), as well as bicycles.

Average Daily Traffic refers to the total traffic volume during a given period (from 1 to 364 days) divided by the number of days in that period. Current ADT volumes can be determined by continuous traffic counts or periodic counts. Where only periodic traffic counts are taken, ADT volume can be established by applying correction factors such as for season or day of week. For roadways having traffic in two directions, the ADT includes traffic in both directions unless specified otherwise.

Awareness building Awareness building is a process in which knowledge is shared and used to change people's perceptions. This is generally considered an important step toward changing long-standing habits that may be damaging for social, environmental, political or other reasons.

Becak (Indonesia), samloo (Thailand), rickshaw (India) three-wheeled bicycle taxis widely used in many Indian and Asian cities.

Bicycle parking facility See **Cycle parking facility**

Bike on Bus (BOB) systems or **Bus-Bike Racks** Bike racks attached to a bus allow cyclists to commute part of the way by bike, board a bus, and take their bicycle with them. Used by one of every five transit agencies in the US, the most popular model is mounted on the front of the bus, holds two bikes and adapts easily to all types and sizes of frames. This ensures the bus driver can see cyclists as they load and unload. The most common problem with this system is cyclists' forgetting their bikes. Public transport agencies quickly discarded related measures, such as requiring training, special licenses or other components, upon discovering the system is quick, easy to use and creates few delays or additional safety hazards, despite initial fears.

IMPORTANT NOTE

ALL BICYCLE- AND TRICYCLE-RELATED FACILITY TERMS ARE LISTED UNDER "CYCLE".

Bike share See cycle share.

Bikeway, cycle way "Bikeway" is a rather generic term, which in some places refers to physically segregated facilities for cyclists, while in other places it refers to visually segregated facilities, and it may even refer to routes suitably sign-posted for cycling along shared roads.

Bikeways, shoulder ***(See under cycle for a more detailed description of bicycle facilities)*** See bikeway, above. Shoulder bikeways are cycling facilities that make use of the paved shoulder on a roadway, which avoid conflicts with fast moving motor vehicle traffic. Bicycle traffic is usually one-way in the same direction as the adjacent outside travel lane. (Transport Association of Canada, 1999).

Build-out, bulb out, "bubble" An extension of the curbed pavement area or a planter into the road which is used to artificially narrow it for the purposes of traffic calming. Cyclists are concerned about these because they can form pinch points which put them at risk. Attempts are sometimes made to provide cycle bypasses.

Bus Lane or **Busway** usually refers to a segregated or preferential roadway or ramp designed for exclusive use by buses, located in a separate right of way or within a special road or freeway corridor. Some local authorities refer to these as "diamond lanes". However, some cities, such as Paris, combine exclusive bus/taxi/cycling lanes, and may therefore use the term **exclusive bus lane** to designate a bus lane that cyclists cannot use.

Capacity typically refers to the maximum number of vehicles that can pass over a given section of a lane or roadway in one direction (or in both directions for a two-lane or three-lane road or highway) during a given time period under prevailing roadway and traffic conditions. In this sense, it is considered the maximum rate of flow that can reasonably be expected to take place during a specific period of time. Usually it is measured in terms of number of vehicles per hour. This may also be measured as persons per hour. Traffic flow may involve transportation units, public transport, or bike/pedestrian.

Chain of Trips as used in this handbook refers to the fact that virtually all trips can be analysed as a *chain of trips*. The simplest and most typical chain has three links: a walking trip to a vehicle, a vehicle ride, finding a parking place if the vehicle is a private car or bicycle, and a walking trip to one's final destination.

Chicane Deflection in the carriageway used as a traffic calming measure.

Choke points Places where the roadway narrows and motorists and cyclists share a tight space. These usually occur when crossing bridges and overpasses or passing through underpasses.

Cities for Climate Protection is a campaign by ICLEI – Local Governments for Sustainability, involving International Council for Local Environmental Initiatives. Based on five milestones that local governments commit to, CCP helps local government and communities reduce greenhouse gas emissions by establishing baseline emissions, adopting reduction targets, developing a local action plan, implementing measures, and monitoring and verifying results. Currently the campaign is active in Australia, Canada, Europe, Japan, Latin America, South Africa, South Asia, Southeast Asia and the United States. See http://www.iclei.org/index.php?id=800

Citizens' representation, "Negotiated government" Terms referring to some of the instruments used to create working spaces where public, private and civil society actors can discuss and develop or implement policy.

Civil society organisation (CSO): Non-private sector, non-governmental sector, citizens' organisations, typically organised along thematic (NGOs such as Greenpeace, the Sierra Club, etc.) or territorial (often on the level of a specific community or neighbourhood) lines. For the purpose of this Handbook, we have preferred CSO, since this includes both NGOs and Community Based Organisations (CBOs).

Coherency see **Five Main Requirements**

Collector is a term with many, sometimes contradictory definitions, depending on the local context and defining authority. It usually refers to a road or street carrying traffic between local access streets and arterials. It may also refer to a street providing some access to abutting property and connecting to a major system of arterials and highways; or connecting neighbourhoods within and between subregions. Some authorities define by daily traffic volumes, which range from 8,000–10,000 vehicles per day.

Collision, traffic An unintended event that causes a death, injury, or damage and usually occurs on a public roadway and involves at least one vehicle and some other road user(s).

Comfort see **Five Main Requirements**

Community Liveability see **Liveable community**

Community A physical or cultural grouping of stakeholders with common interests created by shared proximity or use. Community can be defined on different scales associated with specific places or territories (neighbourhood, city, metropolitan region) or by themes (cycling community, gay community, etc.).

Community-based organisation (CBO): Usually refers to groups organised on a local, territorial basis, such as neighbourhood associations, committees, and local environmental groups. These tend to have much more heterogeneous membership bases, more democratic governance structures and hence very different dynamics and spheres of action from traditional non-governmental organisations (NGOs). Because of this, for the purposes of this Handbook, we have chosen to use the term **civil society organisation (CSO)** to refer to both NGOs and CBOs.

Commuters A person who travels daily or regularly between (at least) two destinations. Sometimes the term is used for all **utilitarian** as opposed to recreational cyclists, but strictly speaking, not all utilitarian cycle trips are daily or even regular.

Congestion, traffic a term typically used to refer to the level at which transportation system performance is no longer acceptable due to excessive presence of motorized vehicles, particularly cars, which reduce average speeds on roads and may even block access to some destinations at peak hours of the day. Governments often use congestion to define the level of acceptable system performance.

Connector Roads Access between roadways which would otherwise be considered "dead-ends" and which provide for alternate egress during storm and other emergency conditions. See also *Collector* and *Arterial* as these terms tend to overlap.

Consultation One party confers with another identified party and, prior to taking action(s), considers that party's views.

Continuity Availability of existing (or proposed) suitable roadways or off-road bikeways for cycling, along with measures that enable users to overcome bottlenecks and hazards, which would otherwise block or hamper their progress. *Continuity* is considered an important parameter of *coherency* one of the five main components defining the quality of any cycling network.

Contraflow Cycle Lane Is one in which the bicycle travel is opposite to the flow of traffic and is extremely useful to allow two-way bicycle travel on a one-way street. A cycle lane would be constructed on the left-hand side of the street, opposite the flow of motor vehicle traffic. Design criteria are the same as for conventional cycle lanes (Vélo Québec, 2003).

Controlled Access Facility Refers to a roadway where the spacing and design of driveways, medians, median openings, traffic signals and intersections are strictly regulated due to traffic volume, number of lanes and adjacent land use. This may also refer to a roadway design, such as a highway, that permits no access to adjoining land, just access to other public roads.

Corduroy slabs (UK) Large tiles, usually a beige colour, with a long, shallow, parallel ribbed texture set into the start and end of shared-use pavements which aid blind and partially sighted people to distinguish when cycles are likely to be present on a shared-use footway (pavement). Where the path is unsegregated, the slabs are placed so the ribbed texture is aligned across the path so a cane would smoothly pass across it, but on the cycle side of a segregated shared-use path the ribs are oriented in the other direction so that a cane would rattle when drawn across them, thereby alerting the user that they should use the other side. See also Tactile paving. Some version of this kind of paving is increasingly common in developing as well as developed cities.

Corridor A service or planning area through which a major transportation route passes. This term is also used to refer to highways, rail lines or waterways and the adjacent land that connect major travel markets within the region, the state or the nation.

Crosswalk The portion of a roadway usually denoted using lines, signage and sometimes traffic lights, to indicate the pedestrians have a preference. See also Traffic Calming, for related road safety and comfort measures.

Cul-de-sac refers to a dead-end street that includes sufficient space for cars to turn around in.

Curb bulb (see **build-outs, bulbs and bubbles above)** Refers to a bulge or extension in a sidewalk, usually at an intersection, designed to shorten the crossing distance for pedestrians.

Curb cut means a depression in the curb for the purpose of accommodating pedestrians, wheelchair users and cyclists at intersections or driveways. Where there is no curb, the point at which the driveway meets the roadway pavement can be considered the curb cut. These often constitute hazards to walkers and cyclists, as drivers back out of driveways onto the street.

Curb Means a physical curb constructed from cement concrete, asphalt concrete, or granite. Sometimes spelled kerb.

Cutline An imaginary line placed at strategic location to intercept all the links in an identified corridor. Traffic counts and trips assigned to the corridor are compared as a check of survey accuracy or model calibration. See "Screenline", below.

Cycle Every device propelled solely by human power upon which any person may ride, having two tandem or more wheels, and including any device generally recognized as a bicycle though equipped with two front or rear wheels.

Cycle Facilities Infrastructure that is cycle-specific, such as cycle lanes, paths and parking. The *Community Cycling Manual* (Canadian Institute of Planners, CIP, 2004) defines a bicycle facility as "any facility designed to assist cyclists. It includes any physical construction — such as parking racks, roads construction with bike lanes or signage." *The Technical Handbook of Bikeway Design* (Vélo Québec, 1992) includes bikeways, parking areas, signage and related facilities (*e.g.* rest areas) within this definition. Facilities may be developed, provided and maintained by public agencies, non-profit institutions, businesses or other institutions to accommodate or encourage cycling. Proper signage is also included in the definition.

Cycle Facilities, Other These are sometimes referred to as "non-pavement facilities", *i.e.* a broad category, which includes anything except physical changes to the road surface. Examples include road signs to guide cyclists, mapping, cycle-specific signals, and temporary or permanent barriers that limit car access.

Cycle Only Paths These are separate paths for cyclists commonly constructed in urban parks, where they are usually constructed parallel to a footpath and are open to various types of wheeled vehicles (bicycles, in-line skates, scooters, wheelchairs, Vélo Québec, 2003).

Cycle, Bike or **Bicycle Lane** A portion of a roadway, which has been designated by striping, signing and/or pavement markings such as bicycle symbols for the preferential use of cyclists, visually separated from adjacent travel lanes for motor vehicles. Cycle lanes should be used for one-way travel only, either in the same direction as the adjacent traffic flow in the case of twoway streets, or as a **contraflow lane** (see there) in one way streets. Where parking is permitted, the bike lane is usually between the parking lane and the through traffic lane. In some instances bicycles share a designated lane with other specified vehicles such as in a Bike/Bus (Diamond, in Canada) lane.

Cycle or **Bicycle-Pedestrian Path (Shared** or **Multi-Use Path)** A path designated for the preferential or exclusive use of bicycles and pedestrians. Sharing requires that the stronger, faster vehicle (the bicycle) sacrifice many of its key advantages out of concern for more vulnerable users (pedestrians).

Cycle or **Bike Lockers** Parking units for individual or collective use. They can be opened by a conventional or an electronic key. An organisation is responsible for key distribution and administration. Requires a managed, operating system. • Lockers made with wire or mesh (do not keep bike out of sight from thieves or protected from the elements. • Lockers with plastic or metal walls that keep the bike out of sight and protect it from the elements. See also **Bicycle Parking Facility**.

Cycle or **Bike Racks** These come in different designs, usually for six or more bicycles. Optimum designs support the bicycle *frame* in a *vertical* position at *two* points and permit the use of at least one, ideally two, locks. Models include: • Post and ring, • Post, • Inverted U • Wall rack • High-density rack • Hanging racks. Two typically used designs that are NOT recommended are the "toaster" model, and the u-wave. See also **Bicycle Parking Facility**

Cycle, Bike or **Bicycle Path** or **Way** Usually a protected facility for cyclists, physically separated and segregated from the main motorway by a verge, grass, planting line or gravel shoulder, a difference in level, and/or other physical barriers that prevent passage by motorized vehicles. These facilities must, nonetheless, preserve visibility, particularly at intersections. Cycle paths or ways may follow motorized traffic flows, move in the opposite direction (see Contraflow Cycle Paths), exist on both sides of roads, on one side, etc. according to the context into which they are inserted and the purpose for which they are used. A contraflow cycle path allows bicycle travel in the opposite direction to the flow of traffic. It can be used to allow two-way bicycle travel on a one-way street. Some planners divide cycle paths into three additional subcategories. *Bicycle Only Paths* are paths designated for the exclusive use of bicycles. They are generally designed for higher speed and longer distance travel. *Multiuse recreational pathways* are paths provided for joint use by two or more human-powered recreation activities including pedestrians. *Informal trails* are often found on public land along riverbanks and railway tracks. Some recreation activities can be restricted from some or all pathways. They are generally designed for slower speed traffic.
Note: typically segregated cycle paths are used to provide cyclists with safe passage through particularly complex, high-speed sectors of the city and are not required at every stage on a cycle route.

Cycle or *pedacycle* Every vehicle propelled exclusively by human power upon which any person may ride, having two tandem or more wheels, except scooters and similar devices. Some definitions incorporate all human-powered and power-assisted, wheeled vehicles (with no more than 200 watts total auxiliary power) within this definition, regardless of the number of wheels. See also Active Transport, above.

Cycle Parking facility A bicycle can be parked anywhere using a kickstand or by leaning it against a wall. To protect bicycles from being inadvertently knocked over, or stolen, cyclists usually prefer to lock their bicycle to something. Bicycles can be locked to trees or street furniture such as signposts. In most instances installing equipment specifically designed for bicycle parking is preferred. Various designs and options are available for bicycle parking facilities. Key terms: *Cycle stands*: mostly units for 1 or 2 bicycles. *Cycle racks*: mostly units for 6 or more bicycles. *Cycle lockers or boxes*: for individual or collective use. They can be opened by a conventional or an electronic key. An organisation is responsible for key distribution and administration. Requires a managed, operating system. *Automatic cycle parking facilities* (mostly paid): the cyclist hands in the bicycle at the entrance. The system registers and stores the bicycle. Upon return the cyclist has to use an electronic key to recover the bicycle. An organisation is responsible for key distribution and administration. Requires a managed, operating system. *Guarded cycle parking facilities* (mostly paid): collective cycle storage with supervision during most of the day and evening. These bicycle storage facilities or bicycle stations can be more profitable if they offer additional services, such as maintenance and repair, selling of accessories and bicycle rentals.

Cycle Planner Any planner, engineer, architect or other planning professional who, as part of her or his responsibilities deals with planning cycling-related facilities and activities. Usually not someone involved specifically in implementation of same.

Cycle Route or **Cycle Commuter Route** A cycle route is the total of consecutive road sections used by a cyclist between his/her origin and destination. Based on these road sections, planners designate cycle routes and cycle route networks: these are coherent selections of road sections and intersections which have been deliberately designed to accommodate cyclists. Some of these designated routes are specifically meant for recreational cycling, but in urban areas they usually serve mainly utilitarian travel needs. In many cities, these typically involve a combination of quiet roadways and major arterial thoroughfares, having high traffic volumes, speeds, bus or truck traffic, providing the most direct connections within a city and between the different neighbourhoods, boroughs, *comunas* and so on that make up metropolitan areas.

Cycle Trail refers to an undeveloped path suitable for use by all-terrain bicycles but may be unpaved and therefore harder work for typical urban commuter (or utilitarian) bicycles or inexperienced riders.

Cycle, bicycle, bike Lane: A lane marked on a road with a cycle symbol, which can only be used by cyclists. Cycling lanes are usually limited to one-way travel, in the same direction as the adjacent traffic flow. Where parking is permitted, the bike lane is usually between the parking lane and the through traffic lane (TAC, 1999). In some instances bicycles share a designated lane with other specified vehicles such as in a Bike/Bus lane.

Cycle, bicycle, bike Route or Way (US: a Class III bicycle facility) is an existing street, usually low volume, that is posted at intervals with a bike route sign. In some places, it may also be a roadway or shoulder signed to encourage cycle use when no preferential lane is provided. Some places also define a bike route or way as any cycle lane, cycle path, or cycle route, regardless of whether it is designated for the exclusive use of bicycles or is to be shared with other transportation modes.

Cycle, Bike or **Bicycle Parking Facilities, Guarded** (mostly paid) Collective cycle storage with supervision during most of the day and evening. These bicycle storage facilities or bicycle stations can be more profitable if they offer additional services, such as maintenance and repair, selling of accessories and bicycle rentals.

Cycle, Bike or **Bicycle Path** A cycling facility that is physically separated and segregated from motorized vehicular traffic by an open space or barrier or grade separation and either within the highway right of way or within an independent right of way. Note: often bikeway is used to refer to a segregated facility but some local authorities define a bikeway as any trail, path, part of the highway or shoulder, or any other travelled way specifically signed and/or marked for bicycle travel, including even a less formal facility such as a paved shoulder. It is important to specify in legislation, regulations, planning and other documents whether the facility is "segregated" from other, particularly motorized traffic.

Cycle, Bike or **Bicycle stands**: Parking units for 1 or 2 bicycles.

Cycle share or **sharing, public bicycles, bike share, Vélolib, etc.** short-term bicycle rental available at unattended urban locations; 2: bicycle transit (definition from the bike-sharing blog, http://bike-sharing.blogspot.com). The term bike share is used primarily in the US and Canada, and refers to services often offered on university campuses or by civil society groups at modest costs. More recently, in Europe and elsehwere, the idea of "public bicycles" has caught the imagination of residents and policymakers alike. While a rental service offers bicycles as a private transport mode, public bicycles form a vital part of the public transport system and are available to virtually everyone, typically for short-term usage to improve access to public transport nodes and destinations. This positions cycling where it belongs, as a crucial link in the sustainable transport policy chain. See Chapter 11 on multimodal transport systems for a more extensive discussion.

Cycling Advisory Group A group of stakeholder representatives that advises on improving cycling conditions. This may be a self-selected group, reflect cooperative individuals selected by local authorities, or a panel, carefully chosen to reflect different kinds of bike users, such as children, the elderly, parents with children, new users, experienced users, recreational users, and so on.

Cycling Network Plan or **Strategic Cycling Plan** A Plan, preferably developed through a participatory process, that includes objectives, promotional plans, and a map of the desired network of cycle routes, along with a budget and a schedule of the cycle infrastructure and other projects required to develop it.

Cycling Policy A general course of action relating to cycling to be adopted by the government or an organisation.

Cyclist, utilitarian, commuter or **urban** Terms often used to identify those whose transport mode is cycling, normally several days per week, from recreational, sports or occasional cyclists.

Deflector island Island in the carriageway located to deflect traffic normally at roundabouts or road junctions.

Demand management A set of strategies that promote increased efficiency of the transportation system by influencing individual travel behaviour. See also Transportation/Travel Demand Management.

Designated Shared Roadways *The Technical Handbook for Bikeway Design* (Vélo Québec, 2003) explains that a designated shared roadway one that is officially recognized as a bikeway. It consists of guide signs that indicate the proposed route for cyclists; and special signage to make motorists aware of the presence of cyclists. This is what the Canadian Institute of Planners (2004) refers to as a "Bicycle Route" in their *Community Cycling Manual*.

Desire Line or Air Line Line of desired route, most direct connection (as the crow flies) between between the origin and destination of a trip. Analysts map and use desire lines, with the width reflecting the intensity of trips along a given route.

Directness, see Five Main Requirements

District main roads: The roads that are meant to collect and distribute motorized traffic coming from and going to habitat areas or other places. In some countries, district main roads may also take the form of ring roads around a habitat area comprised out of a number of segments each with its own entrance.

Driver, motorist, operator Any person who is in actual physical control of a motor vehicle upon a highway, street, road.

Driveway means that portion of street, alley, or private property which provides access to, but not within, an off-street parking facility, from a curb cut. Portions of driveway may be shared with pedestrians.

Education Education is the process of teaching and instruction to develop knowledge and skills. Typically it occurs in formal settings, through the formal education system (primary, secondary, post-secondary) and informal settings (continuing education, municipal bike training courses, women's groups, and so on).

Elephants' footprints Non-continuous cycle lane markings to define cycle routes across carriageways.

Entry treatments Raised carriageway surfacing and/or carriageway narrowing at a side road junction.

Expected Intensity The expected level of use for a (human-powered) facility.

Expected Pedestrian Use Based on land use, population densities, site design, corridor usage and desired destinations, the number of people expected to use a pedestrian facility.

Expressway A divided arterial highway for through traffic with controlled access, the intersections of which are usually separated from other roadways by differing grades.

Facilities for Small Wheels Are facilities that are appropriate for skateboarding, roller skates, inline skates and scooters. Small Wheels users are usually restricted to hard surface pathways. As the wheel size increases, so does the ability use a greater variety of paths with different surface types, for example wheel chairs, walkers and wagons can also manoeuvre limestone or finely crushed gravel paths or well mowed trails.

Facility, shared A structure (*i.e.* paving, signage, etc.) designed to facilitate human-powered transport, which is intended to be used by more than one form of transportation (*i.e.* cyclists and pedestrians).

Five Main Requirements Cycling experts in the Netherlands and elsewhere have defined five essential considerations when stakeholders work to create cycling-inclusive cities: these are attractiveness, coherence, comfort, directness and safety. ***Attractiveness*** refers to how cyclists perceive their surroundings and usually involves the presence of trees, suitable illumination, and in general a lively urban landscape with plenty of room for cyclists to advance, good natural surveillance by a diverse group of people (especially women and children), and clear signage that does not block the view. ***Comfort*** refers to routes (sections, intersections, networks) that allow cyclists to travel along smoothly paved surfaces with a minimum of interruptions and limited contact with motorized transport. It typically involves routes that avoid bends, prevent lost time, and minimize slopes and hills, traffic nuisance and weather nuisance (sun or rain). ***Coherency*** refers to an easily read route with clear but not excessive signage consistent throughout that allows cyclists new and expert to navigate the city with relative ease and a minimum of confusion. ***Directness*** refers to both distance (the shortest reasonable distance between origin and destination) and time (avoiding roundabout routes due to one-way streets and other barriers). ***Safety*** refers to safety from physical hazards, traffic accidents, theft, assault, rape and so on. Usually it is dealt with by avoiding conflicts — with cross traffic, oncoming traffic, between vehicles of vastly different weights and/or moving at very different speeds, and so on. Ensuring recognisable road categories and unambiguous traffic situations is another part of safety, as is reducing speeds at conflict points and avoiding cyclists being forced off the road. See Chapter Five for a detailed discussion of these requirements and the CROW Design manual for bicycle traffic.

Fixed Route A system of transporting individuals (other than by aircraft), including the provision of designated public transportation service by public entities and the provision of transportation service by private entities, including, but not limited to, specified public transportation service, on which a vehicle is operated along a prescribed route according to a fixed schedule.

Footpath An informal travel way for pedestrians created by repeated use and usually separated from the roadway.

Freeway, Highway, Expressway, Carriageway A divided arterial roadway designed for the unimpeded flow of large traffic volumes, typically at high speeds. Access is rigorously controlled; grade separated intersections are the rule.

Geographic Information System (GIS): A computer system capable of assembling, storing, manipulating and displaying geographically referenced information, *i.e.* data identified according to their locations. A computer based mapping system. In some communities, participatory mapping forms part of cyclists' and walkers' contribution to active-transport planning.

Governance Governance is the ecology of actors and actions that together define how a specific territory, large or small, is governed. Typically it comprises the traditions, institutions and processes that determine how power is exercised, how citizens are given a voice, how decisions are made on issues of public concern and how they are monitored and subsequently modified to better fit practical experiences.

Grade Separation The vertical separation of cyclists by a bridge or underpass across a roadway, railway line, etc. It contrasts with an at grade intersection or level crossing.

Greenway An area of green space that surrounds and stretches into cities, linking parks and squares to form a continuous park environment. Often associated with (biological) corridors designed to preserve vegetation. Sometimes these are integrated into pedestrian and cycling pathways, routes, networks. They are an excellent way of mitigating heat, wind and other weather conditions that sometimes make cycling difficult in some places.

Ground Truthing Verifying information through actual site visits. This can be done for existing information or new potential sites for future development. Date of verification along with any changes noted should be recorded with the information for future reference.

Groups, User, Focus, Cyclists', Bicycle/Bike User, Organisations, see also civil society. When studying, designing, planning or implementing cycle policies, regular consultations and indeed permanent cooperation with different kinds of current and potential users is vital to success. The marketing technique, using focus groups, can be useful, particularly when sounding the opinions of potential or non-bicycle users, but is limited since the groups consulted/formed is usually temporary in nature and any learning is promptly lost when the meeting ends. Working with panels that represent different kinds of current or potential users (children, women, men, shoppers, commuters, students, etc.) can be very helpful and can create a varied and permanent source of input throughout the planning-implementation-evaluation cycle. In Europe cyclists organisations played a vital role in the renewed appreciation of cycling by public and governments. Some cities, such as Toronto (Canada) have pioneered the creation of permanent bicycle user groups or BUGs (see http://www.toronto.ca/bug/index.htm). These, in cooperation with local, regional and national associations of cyclists, pedestrians and other human-powered road users, can become permanent sources of wisdom, cooperation and knowledge that will reduce risks and enhance the likelihood of success.

Habitat area An area of public space in which priority should be given to social life and human-powered traffic and motorized traffic is of secondary importance. These areas are sometimes referred to as 'Residential-areas'. We prefer the term habitat area to emphasise that such areas can contain much more than just dwellings. They can comprise all sorts of functions that make a district thrive, such as shops and markets, small offices, workshops, public buildings, sporting grounds and other recreational facilities, etc.

HGV Heavy Goods Vehicle.

High Accident Location/Black Spots A location that has experienced a higher than average number of accidents within the previous three years and that has a "critical rate" of accidents greater than 1. "Critical rate" is a statistic that compares the accident experience among similar locations. A "critical rate" greater than 1 indicates a higher than average rate of accidents for the location given its traffic volume and other characteristics. It is useful to map these places, analyse their causes and propose solutions as part of developing better cycling and walking networks.

High Capacity Transit An American term that refers to a public transit system, such as rail and bus rapid transit (BRT), that can accommodate large volumes of riders.

High Occupancy Vehicles (HOVs): Generally applied to vehicles carrying three or more persons. Freeways, expressways and other large volume roads may have lanes designated for the exclusive use of HOVs (carpoolers, vanpools, and buses). The term HOV is also sometimes used to refer to high occupancy vehicle lanes themselves.

High Pedestrian Use More than two people travelling at a given time, in the same or in the opposite directions.

Highway, freeway, express way This term applies to roads, streets, and parkways, and also includes rights-of-way, bridges, railroad crossings, tunnels, drainage structures, signs, guard rails, and protective structures in connection with highways.

Highways, metropolitan Roads designed for a smooth flow of motorized traffic. Their purpose is to shield District main roads from flows of motorized traffic that won't fit into the set of conditions for District main roads.

Home Non-Work (HNW) A trip for a purpose other than employment (*e.g.* shopping, recreation, social, school, etcetera), with either trip end being at one's home.

Human-Powered Transport (HPT) Travel by means other than a motorized vehicle. As transport planning seeks increasingly integrated approaches to planning and implementation, this typically includes walking, cycling (bicycle or tricycles used by taxis, recyclers and other small businesses in Asia and Latin America), wheel chairs, skating, skateboarding and other means.

Human-powered Transportation Plan A document containing the goals, policies, design standards and implementation strategy to provide a continuous network of human-powered facilities that make human-powered travel a viable alternative. Many cities are now using this term, rather than "Non-motorized" (See, for example, Bainbridge Island, Washington, US).

Impacts The effects of a transportation project, including a) direct (primary) effects; b) indirect (secondary) effects; and c) cumulative effects.

Informal Trails Informal trails come into existence through use, turning into dirt trails, trampled grass or packed snow. They are often cut by people walking, cycling or cross-country skiing / snow shoeing along the same route.

Infrastructure Refers to the physical underpinnings cities, usually including roads, bridges, transit, water systems, public housing, sidewalks, utility installations, parks, public buildings, and communications networks. May also refer to the natural (environmental) infrastructure of land, water, air, and life-forms.

Injury Bodily harm to a person as a result of an accident of some kind, usually (in the context of this handbook) involving a collision with a motor vehicle.

Injury Severity Typically classified in one of three categories: ***Fatal Injury*** (Death): Any injury that results in the death of a person within 30 days of the collision in which the injury was sustained. ***Serious Injury***: Any injury, other than a fatal injury, which prevents the injured person from walking, driving, or normally continuing the activities the person, was capable of performing before the injury occurred. ***Visible Injury***: Any injury, other than a fatal injury or incapacitating injury, which is evident to observers at the scene of the collision in which the injury occurred. ***Possible Injury***: Any injury reported or claimed which is not a fatal injury, incapacitating injury, or non-incapacitating, evident injury.

Intelligent Transportation Systems (ITS): Encompasses a broad range of communications-based information, control and electronics technologies. When integrated into the transportation system infrastructure, and in vehicles themselves, these technologies help monitor and manage traffic flow, reduce congestion, provide alternate routes to travellers, enhance productivity, response to incidents, adverse weather and other road capacity constricting events.

Intermodal Facilities Transportation facilities that provide for seamless links between travel modes, such as rail or bus stations at airports.

Intermodal: A term that refers to connectivity between modes as a means of facilitating linked trip making. It emphasises connections (transfers of people or freight in a single journey), choices (provisions of transportation options to facilitate trip making), and coordination and consolidation (collaboration among transportation organisations).

Junction or **Intersection Table** or **Platform** Raised carriageway surface across a carriageway at a junction used as a speed control measure.

Land Use The way specific portions of land or the structures on them are used. Basic land use categories are: single family residential, multi-family residential, retail, commercial/office, industrial, agricultural, recreation, and so on. There is much debate about exactly how land use and transportation facilities influence each other, but they are closely connected, with higher density locations tending to be better suited to public transport and other collective solutions. See also sprawl, smart growth. See chapter three on urban form for a more complete discussion of the relationship between land use and transportation systems.

LEED$_{TM}$ certification (Leadership in Energy & Environmental Design): A rating system developed by the United States Green Building Council (USGBC) that sets definitive standards for what constitutes a *green* or *environmentally preferable* building. The certification system is self-assessing and is designed for rating new and existing commercial, institutional, and high-rise residential buildings. It evaluates environmental performance of the entire building over the building's life cycle. LEED certifications are awarded at various levels (certified, silver, gold, and platinum) according to a point-based scoring system. Where countries are considering developing systems of this nature, they should provide for cycle parking and other relevant facilities as part of their requirements.

Level of Service (LOS) For motor traffic it mainly assesses interruptions to free traffic flow. For cycling, other factors such as perceived safety, comfort, and directness of route are more important. In the US, the six levels of service range from LOS "A" to LOS "F". LOS A: free-flow conditions; delays are minimal or nonexistent; LOS B: stable flow, but motorists begin to experience some delays; LOS C: flow is still stable, but delays lengthen and manoeuvring within the traffic stream is noticeably more difficult; LOS D: flow is still stable, but speed and manoeuvrability are severely restricted; moderately long delays (25 to 40 seconds per vehicle) at intersection; LOS E: road is at or near capacity; speeds are reduced to low, uniform flow; delays at intersection of 40 to 60 seconds per vehicle; LOS F: roadway is operating under "breakdown" conditions; intersection delays of more than 60 seconds per vehicle. There are several researches going on to define appropriate LOS categories for cycling.

Limited Access: A street or highway especially designed for through traffic and to which owners or occupants of abutting land or other persons have no right or easement of access.

Limited Shoulder A restriction of the standard shoulder width (of less than three feet).

Liveable Community: A neighbourhood, community or region with compact, multidimensional land use patterns that ensure a mix of uses, minimize the impact of cars, and promote walking, bicycling and transit access to employment, education, recreation, entertainment, shopping and services.

Local or **residential road** or **streets** means streets defined as land service streets and are generally limited to providing access to abutting property. They are tributary to the major and secondary thoroughfares and generally discourage through traffic.

Local Street: A street intended only to provide access to abutting properties. Also defined as routes that provide access to local property owners and which connect property to the major thoroughfare or other collector street networks. Some local authorities define two types: Local A: Daily traffic volumes range between 500–1000 vehicles per day (vpd); Local B: Daily traffic volumes range from 1,000–4,000 vehicles per day (houses fronting) and 4,000–8,000 vehicles per day (no houses fronting). In the case of this handbook we define them as all streets within a habitat area.

Maintenance The work of keeping a building, road, machinery, etc. in a state of good repair. Specifically, the regular clearing of gravel from bicycle facilities to promote safe bicycle travel.

Marginal Strip see **Safety Strip**

Markings Pavement markings are a significant element for traffic regulation on bikeways. Pavement markings are used to define messages in the form of words and symbols, designating bicycle lanes, lane usage, etc. In most cases, pavement markings supplement signage. As with signage, pavement markings should be uniform, easily recognized and understood. (Canadian Institute of Planners, 2004) Vélo Québec (2003) does not recommend the use of pavement markings on multi-use paths: … because they reinforce the roadway aspect of the trail to the detriment of pedestrians and other users who travel more slowly than cyclists. For the benefit of both cyclist and pedestrians on very wide and popular paths, the footpath can be delimited by markings (lane lines). These markings will have greater meaning for users if they extend or connect sections where cyclists and pedestrians travel on separate paths. Each country has its own legal context, approach and measures in this sense, so it is well worth surveying experiences elsewhere, when national standards, policies and regulations are under review.

Minimum Of Vehicle, Pedestrian And Bicycle Interaction The ability for safe multi-modal transportation to occur simultaneously.

Minor arterial means defined as routes which serve lesser points of traffic interest within a city; provide communication with outlying districts in the same degree or serve to collect and distribute traffic from the major arterials to the local streets.

Mixed-Use Development Defined by the Urban Land Institute (US) as developments with three or more significant revenue-producing uses, such as office, retail, residential, hotel/motel, entertainment, cultural, recreation, etc., which are mutually supportive in well-planned projects.

Mobility Impaired A descriptive, non-regulatory definition that generally applies to those persons who, for one reason or another (*e.g.* age, physical, economic, or other), do not have personal access to or the ability to use an automobile in a transport system that is (almost) exclusively car based. In general, these persons are elderly, disabled, youths, children, many women, people who are economically disadvantaged. The term "differently abled" may also be used to refer to people with different abilities to interact with the physical environment, underlining the need to consider not only wheel chair users but also people with Parkinson's, back problems and other physical disabilities that affect their access to the goods of the city and their right as citizens to participate fully in social, economic, leisure, cultural and political affairs.

Mobility The degree to which the demand for the movement of people and goods can be satisfied. Mobility may be measured by the quantity, quality, accessibility and utilization of transportation facilities and services. This is also defined as the ease with which desired destinations can be reached.

Modal Interface The interaction between two or more modes of transportation (*e.g.* the ability to change from the pedestrian to bicycle to bus modes in order to complete a trip).

Mode Any means of moving people or goods: typically aviation, bicycle, highway, paratransit, pedestrian, pipeline, rail (commuter, intercity passenger and freight), transit, space and water.

Mode Choice Model A mathematical model used as part of the transportation modelling process to determine what mode of transportation (principally automobile or mass transit) a specific trip is inclined to use. May also be referred to as "mode or modal split". These models may suffer from highly significant bias, as they often measure or report only trips made in motorized vehicles, ignoring huge proportions (in some countries as high as 40% or more) of daily trips made on foot and by bicycle.

Mode or Modal split Usually expressed as a percentage, this term refers to the distribution of the different transport modes, usually at peak periods on work days, and refers to the number of trips made by single or multiple passenger private vehicles; bus; rail; bicycle; and pedestrian modes. Modal split (sometimes referred to as modal balance) can be influenced by such factors as price, speed, ease of access, demographics (age, economics, education, occupation, etcetera), and land use composition. In the best cases, it adequately represents political, social and environmental priorities of urban communities.

Model A mathematical and geometric projection of activity and the interactions in the transportation system in an area. This projection must be able to be evaluated according to a given set of criteria which typically include criteria pertaining to land use, economics, social values, and travel patterns. The transportation planning process relies heavily on the use of travel demand models that predict travel behaviour in order to assess the feasibility, effectiveness, and efficiency of current and future transportation alternatives.

Moped A light motor bicycle, especially one with an engine capacity of 50 cc or less.

Multi-modal (i) A planning process, capital improvement, or transportation system which takes into account all available modes of travel, including vehicle, mass transit, rail, aviation, bicycle, and pedestrian activity. (ii) Projects which contain multiple traffic elements (*i.e.* traffic lanes, cycle lanes, bus lanes, sidewalks, bus pads, bus pull outs). (iii) Increasingly users also define themselves as "multi-modal" or "multi-modals", meaning they choose the simplest, cleanest transportation mode according to the length, distance and other characteristics (number of people and their capacities, cargo, etc.) of their journey, usually preferring to combine different sustainable modes to minimize their negative environmental impacts. In this sense, a businessman who cycles to a subway station and then commutes to and from work by train, is an example of a "multi-modal".

Multi-modal transportation system A transportation system that includes affordable, alternative modes of transportation such as public transit, and infrastructure and access for alternative fuelled vehicles, bicycles and pedestrians, in addition to standard vehicular transportation.

Multi-Purpose Trail A trail designed by location or construction to accommodate different modes of human-powered transport, such as pedestrian and bicycle travel.

Multi-stakeholder approach An approach in which a problem is defined and dealt with based on the concerns of the different stakeholders potentially affected by any decisions or changes in the current situation.

Multi-Use Paths Depending on the season, location and type of surfacing, these trails are used for a variety of purposes, such as cycling, walking, in-line skating, horseback riding, cross-country skiing, snowshoeing, and snowmobiling. (Vélo Québec, 2003)

Negotiation The process whereby interested parties resolve disputes, agree upon courses of action, bargain for individual or collective advantage, and/or attempt to craft outcomes which serve their mutual interests. It is usually regarded as a form of alternative dispute resolution.

Neighbourhood Character The (historic) design and personality of a location as defined by those that live in the area.

Network A graphic, mathematical or physical representation of multimodal paths in a transportation system, the total of coherent connections between origins and destinations. Networks can be analysed at different levels of scale; *e.g.* at metropolitan level origin and destination will be defined as complete neighbourhoods, whereas on neighbourhood level origin and destination will be defined as individual addresses.

Network, cycle An integrated network of both on- and off-road routes to facilitate an easier and safer journey for cyclists between all relevant origins and destinations.

New Mobility This term, closely associated with but not identical to sustainable transportation, refers to a complex bouquet of overlapping mobility arrangements in an attempt to offer a high quality alternative — or complement — to the mostly car-based transport system of the city. Services most often incorporated into this multi-level alternative transport system include (Wikipedia): Bus lane, Car diets/reduction plans, Congestion charging, HOV, Intelligent transportation system, LOV (Low-Occupancy Vehicle), Shared space, Park and ride, Parking, Road diets, SOV, Single Occupancy Vehicle, Toll roads, Traffic Calming, Transportation Demand Management, Bus rapid transit, Car rental, Car Free Days, Carpooling, Carsharing, Cycling, utility cycling, e-work, flexible working, flextime, Hitch-hiking, Human-powered transport, Jitney, Midibus, Mini-bus, Pedestrianization, Promenadology, Public space management, Public transport, Ride sharing, road pricing, Roller skating, Self-Organizing Collaborative Networks, Share taxis, Taxicab, Telecommuting, Telework, Vanpooling, Walking (Wikipedia, http://en.wikipedia.org/wiki/New_Mobility_Agenda). Also a magazine for wheel chair users.

Node These are points such as intersections or places where some change in the characteristics of a roadway occur, within a network. They may also reflect points where specific or multiple types of activity occur, in both transport network and land use senses.

Node, transit/public transport or **intermodal** Typically, a public station on a bus or train corridor that offers connections to buses, taxis, cars, bicycles and walking facilities. In some cities, particularly in Germany, may also offer car-share arrangements, bike repairs, tourist information and other additional services, as part of "new mobility" initiatives.

Non-governmental organisation (NGO): A wide range of groups and organisations created by citizens' groups, which do not belong to the governmental or private sector. Usage varies widely, but the term has frequently come to mean more established organisations of like-minded individuals, as opposed to grassroots or **community-based organisations (CBOs)**, such as neighbourhood associations. For the purposes of this Handbook, we have therefore opted for the broader term, **civil society organisation (CSO)**, which refers to groups organised along both thematic (*e.g.* cycling) and territorial (*e.g.* specific community or neighbourhood) bases, thus incorporating both NGOs and CBOs.

Operating Cost The costs of actually operating a transportation system. These are separate from capital costs, and include such items as: wages, fuel, oil, maintenance, etc.

Operating Revenue Money received from users of a transportation system such as fares, tolls, charter fees, etc.

Origin The point or locale where a trip begins.

Origin-Destination Survey (O-D Survey) A survey typically undertaken of travellers (motorists, cyclists, walkers or public transport passengers) to identify travel patterns, habits and needs.

Parallel road Road on the side of the main road serving local traffic only. Sometimes referred to as a service road or alley.

Parallel Routes Roadways suitable for cycle travel, or off-road bikeways, within a reasonable distance and along the same general corridor.

Paratransit service (US and Europe) Demand-response transportation provided in lieu of fixed route bus service, including taxi and wheelchair van transportation. For some users, this kind of service may not be necessary where bus rapid transport systems have been implemented that allow ramp access to stations and access to buses by platform, as occurs in Bogotá, Colombia, for instance. This type of service has many names world wide: *Share taxis* (*taxi collectif* in French; *taxi colectivo* in Spanish; *Kombi* or *taxi-bus* in parts of Africa; *Auto-rickshaw, Phata-a-Phat* or *Polaamboo* in India; *tuk-tuk* or *Songthaew* in Thailand; *shuttle*, *poda-poda* in Sierra Leone; *Dala-dala* in Tanzania) and *jitneys* provide similar services. (For more terms, please see: http://en.wikipedia.org/wiki/Share_taxi)

Park-and-Ride Lots, Kiss-and-Ride Commuter parking lots, usually located on the periphery of urban area adjacent to major travel corridors, where commuters may park their cars and ride on public transport to the central business district or other destinations. Kiss-and-Ride refers to drop-off facilities suitable for cars to drop off passengers, who continue their journey by public transport.

Passenger Any occupant of a motor vehicle other than the driver.

Path, shared use A path provided for use by both cyclists and pedestrians. These are common in mid-sized European cities, such as Salzburg, or in rural and semi-rural areas.

Peak Hour-Peak Direction The travel direction which, during the sixty minute peak hour, contains the highest percentage of travel.

Peak or **Peak Hour** The period observed in the morning or evening, during which the most people are travelling at the same time. In North America this may also be referred to as "rush hour" and is often defined as a specific 60-minute period/hour.

Peak Period The two consecutive AM or PM sixty minute periods which collectively contain the maximum amount of AM or PM travel. Peak period can be associated with person-trip movement, vehicle trip movement, or transit stops.

Peak-Hour Factor The fraction of the average daily traffic volume occurring during the highest volume sixty minute period during the day.

Pedestrian Access Plans (or Travel Access Plans) These plans are increasingly used in Canada, the US and Australia to reduce parking needs and encourage healthier transport modes for users of offices, industries, businesses, educational and other facilities to maximize walking and HPT to access sites.

Pedestrian facilities According to some definitions typically consist of three subfacilities: ***i) Off-Street Path:*** Paths and trails in areas not served by the street system, such a parks and greenbelt corridors. Off-street paths are intended to serve both recreational uses and other trips, and may accommodate other human-powered travel modes in addition to walking. ***ii) Connector Pathway:*** A walkway, trail, stair or other pedestrian facility not situated along a street. This may occur as a pathway within a public right-of-way where no street has been built, in a public walkway easement on private property, or as a path in a park or other open space. ***iii) Alternative Pathway:*** A design for a pedestrian facility along a roadway that is an alternative to an urban standard sidewalk with curb. (*Portland Pedestrian Design Guide*, 1998), *e.g.* ***Widened Shoulder Pathways:*** A pedestrian facility provided immediately adjacent to the roadway (Portland Pedestrian Design Guide, 1998). This is similar to a shoulder bikeway. These complement the most common (although all too often forgotten) sidewalk, normally adjacent to streets, designed mainly for pedestrian and other similar (prams, wheelchairs, etc.) uses. Other local authorities use a more general definition, referring to any infrastructure that exists to facilitate pedestrian travel, which typically include at least sidewalks and crosswalks. Other facilities increasingly used as part of tempting people to walk more and drive less, include walkways, trails, curb ramps (especially to include parents with strollers, wheel chair users, skaters, etc.), grade separations (especially underpasses and overpasses), and above all pedestrian-friendly furnishings such as benches, urban trees and streetscaping. Traffic calming devices may also be considered pedestrian facilities. For more see, Traffic calming, in this glossary.

Pedestrian In the US, this term officially refers to any person afoot and any person operating a wheelchair or motorized wheelchair. Elsewhere usage varies, but always includes walkers.

Pedestrian street Usually refers to a street for pedestrian use only, a popular measure to encourage more use of central streets, shopping and service areas, often combined with urban heritage preservation or revitalization of deteriorated down town or business districts.

Pedestrian walkway means a surfaced walkway, separated from the roadway, usually of crushed rock or asphalt concrete, and following the existing ground surface (not at permanent grade).

Person-Trips The sum of trips made as passengers of an automobile, bus, taxi, truck, and the like, plus as an automobile driver. Auto person-trips are trips made as a passenger or driver in an automobile.

Pinch point Part of the carriageway where width is reduced, sometimes used as a speed control measure or Location on the network where traffic capacity is frequently exceeded resulting in congestion.

Plain Link A link with no cycle specific facilities such as cycle lanes or cycle tracks.

Planner Professionals involved in urban and/or community planning measures whose purpose is to seek a balance amongst the different users, needs and possibilities of a location. Increasingly, planners and others must seek "sustainability", in the environmental, social and economic senses, as part of plans to deal with rising fossil fuel costs, global warming, noise, air pollution and other externalities arising from 19th and 20th century urban developmental patterns.

Planting Strip A contiguous area within a right-of-way, along a curb, cycle way or sidewalk, used to provide landscape features, separation of uses and, increasingly, to improve comfort, attractiveness and environmental benefits of a particular piece of mobility infrastructure.

Point closure Closed access to a street (one way or two way)

Preferred alternative A recommended course of action included in many transport plans, which defines a hierarchy of transport alternatives, usually to achieve a specific goal such as the implementation of alternative multi-modal strategies to reduce potential traffic congestion resulting from infrastructure or land use patterns, local transport policies, regulations, or environmental imperatives.

Primary Cycle Network The cycle facilities expected to receive the highest concentration of use, often at greater speeds, designed for longer distances from suburbs to city centres or central business districts, between city neighbourhoods, or connecting residential areas with the main destinations, particularly schools, employment or shopping centres.

Principal arterial These are streets defined as transport arteries that concentrate large volumes of traffic and/or connect major destinations within a city, between peripheral areas and city centres, between suburbs, and so on.

Priority junction Junction where priority is indicated by give-way lines or occasionally stop lines or, in a small number of cases, no road markings at all. Represents the majority of junctions.

Private road Refers to roads that are not within the public domain.

Provider Some countries, such as the US, distinguish between public instances that provide services, such as public transport, and those providing funding for specific programs. Elsewhere these functions may be mixed, or the government may provide guidelines and tender contracts among private transport operators.

Public Authority A national, federal, regional, state or provincial, municipal or city, county, town, township, Indian tribe, municipal or other local government empowered to finance, build, operate, or maintain toll or toll-free transportation facilities. Enabling legislation typically defines the actions that these different bodies may and may not carry out with regard to transport.

Public or **Citizens' Participation** Many countries, such as the US, the UK, Canada, the Netherlands, Sweden, Switzerland and Australia now have a wide range of instruments for ensuring that transport plans and improvement programs include substantial input from citizens. In the US, national transport laws (ISTEA) require that state departments of transportation "provide citizens, affected public agencies, representatives of transportation agency employees, private providers of transportation, and other interested parties with a reasonable opportunity to comment on the development of the long-range plan …"

Public Road Any road or street open to public traffic, which is under the jurisdiction, ownership, and maintained by a public authority.

Rail trails A term coined in Australia to describe shared-use paths recycled from abandoned railway corridors, which can be used for walking, cycling and horse riding. They link country towns, large and small, and many offer scenic routes "just as railways did in the past" ('Railtrails Australia' 2005).

Raised Pavement Bicycle Path Developed by the Danish, this refers to a special bike way referred to as a "cycle track" in the design guide published by the Roads Directorate in 2000. It involves a tiered system in which raised, paved lanes flowing in the same direction as traffic along roads with large volumes of cars and/or high speeds, separate cyclists from other road and sidewalk users.

Recreational Cyclists The division between recreational versus commuter or utilitarian cycling can often lead to locating vital cycling infrastructure in parks and away from the main urban centres that cyclists — like everyone else who lives and works in cities — need to be able to access. It is more useful to treat cycling as a continuum, ranging from occasional, often recreational, use by a wide range of people (children, the elderly, women and men), through to daily or constant use of the bicycle as (the only or at least the main) transport mode. All users require infrastructure that meets the five requirements defined by the Dutch in their CROW and other manuals: comfort, safety, attractiveness, directness and cohesion.

Recreational Use Sometimes transport planners distinguish between commuter/utilitarian and recreational use, but again, the division can be misleading. The gap between new users and experienced ones, for example, is often more relevant to on-the-street conditions and users' needs from a comfort or safety perspective. Distinguishing between people who use (human-powered) facilities for pleasure rather than for work is odd, to say the least. Everyone, including non-cycle users who often share facilities with cyclists, prefers to move along comfortable, attractive, tree-lined facilities where they feel safe and comfortable. Recreational cycling is only asking for different application of quality requirements in so far as that more emphasis is put on 'attractiveness' and less on 'directness'.

Residential Streets A non-arterial street that provides access to residential land users and connects to higher level traffic streets. See *Collector*.

Restricted Roadway A form of bikeway where the roadway is closed to most motor vehicle traffic but open to bicycles and other types of human-powered use. Selective closures of roadways may occur, such as the Sunday closures of streets used in Winnipeg, Canada, Bogotá (Colombia), Rio de Janeiro (Brazil) and many other cities worldwide. Roads may also be closed regularly at specific hours or on specific days, as occurs in many urban centres as they attempt to restrict private car use in favour of buses, bicycles and other designated vehicles. A specific example of restricted roadways are so called '**bicycle streets**' in Germany and the Netherlands: designed for cycling, but accessible for cars that have their destination along that street.

Ridesharing or **car pooling** A common instrument in North America, where the car holds a high percentage of the daily transport modes, this involves sharing a ride (and related costs) to an employment or other destination, with others in a car or van. Ridesharing tends to refer to long-distance trips, whereas car-pooling tends to refer to daily commutes.

Right-of-Way (R/W or **ROW)** This US term (which is extended to other countries in the world, such as India, among others) refers to the width available for the construction and operation of transprot facilities. It can also refer to priority use of a facility granted to one user over other(s), which requires that other users yield.

Roads/streets, feeder Smaller less developed roadways, sometimes not providing for connectivity. See *Collector*.

Roadway In many countries, national or other legislation defines road or roadway to mean that portion of a road or street improved, designed, or ordinarily used for vehicular travel and parking, exclusive of the sidewalk or shoulder. Where there are curbs, the roadway is the curb to curb width of the street. Elsewhere roads may be treated as spaces to be shared by the different transport modes. Increasingly, this kind of definition forms the basis for restoring or achieving a better balance among the different kinds of users and to give priority to the more sustainable, environmentally friendly transport modes (walking, cycling and public transport, especially bus rapid transit or BRT).

Roadway, shared While some countries' legislation considers roads specifically for cars and other motorized vehicles, others establish that all roadways must be considered shared. This is more realistic, since cyclists typically use all streets within a city, whether or not they have specific facilities. The Transportation Association of Canada describes a shared roadway as follows: Bicycles share the roadway with other vehicles, usually on the right side portion of the travel lane. On a shared roadway, the shared travel lane could be a normal travel lane (standard width or wider than a normal travel lane, wide curb lane). Some transport authorities recommend that as motor vehicle traffic volumes and speeds, and truck traffic increase, the width of the travel lane should be widened to permit motorists and cyclists to pass without changing lanes. This may work in some contexts, but could lead to more speeding and therefore increase hazards for walkers and cyclists, so is very context dependent. Both motor vehicle traffic and bicycle traffic on a shared lane travel in the same direction. The presence of a bikeway is usually indicated by road signs or specific pavement markings. (Transportation Association of Canada, 1999) The *Technical Handbook for Bikeway Design, V*élo Québec

(2003) specifies that "a shared roadway is a street or road shared by cyclists and motorists when vehicle traffic is not too heavy" and it often does not have any special features, since paved roadways are suitable for bicycle traffic.

Safe Free from danger, injury or damage. Often users distinguish between "safety", referring to freedom from the risk of accidents, and "security", referring to concerns about aggression, theft, rape, etc. For either, the design and maintenance of human-powered transportation facilities, particularly in terms of surfaces, lighting, connections, and so on, is vital to users' wellbeing.

Safe Roadway Crossing A crossing that gives the human-powered traveller the advantage, often in visual terms. This may include raised crosswalks, flashing lights, streetlights, signs or specific locations (in front of cars stopped at a traffic light, but not blocking pedestrian crossings, for example) reserved for cyclists.

Safety, see **Five Main Requirements**

Safety or **shy Zone** This term may be used to refer to markings on the road surface that define additional space between cyclists and cars or other motorized vehicles, providing extra space along curbs or on bridges, underpasses and overpasses. They may also provide extra space to ensure cyclists are not slammed by car doors as they open, particularly where lines of cars park along streets.

Safety Strip A safety gap between cycle track and carriageway, sometimes called a "marginal strip"

Scenic Byway Many countries designate specific roadways, typically secondary roads, with significant cultural, historic, scenic, geological, or natural features as "scenic byways" or some other term. These typically offer additional facilities (see Quebec's Route Verte, for example) to encourage cyclists and other HPT users and form part of economic development and/or tourism policies. Ideally, these kinds of routes are integrated into train, subway and BRT systems to provide city residents and visitors with a seamless route for reaching access points with bicycles and/or other necessary equipment (strollers, wheelchairs, etc.).

Segregated or **separated path** or **bike way** A path where the section for cyclists' use is physically separated from the section for pedestrians' or car use, to prevent mixing modes.

Shared use pavement (UK) A footway (pavement) on which cyclists are also permitted to ride. There are two kinds: **unsegregated**, where cyclists and pedestrians both share the whole space of the footway. These are indicated by a sign with a white cycle and pedestrians, one above the other, on a blue circular background, and usually a white cycle painted on the pavement; **segregated**, where cyclists and pedestrians are separated by a white line. These are indicated by a sign with a white cycle and pedestrians side by side separated by a white line (note the subtle difference) and a cycle symbol painted on the side for the sue of cyclists. Occasionally the pedestrian side may have a pedestrian symbol painted on it, though this is unusual in Cambridge. On this type, cyclists are obliged by law to keep to the side allocated to them (though limited widths for passing oncoming cycles often make this impossible in practice), though pedestrians are technically allowed use the whole width if they are determinedly suicidal. Shared-use is also now often delimited by corduroy slabs laid at the start and end which are designed to help people with sight difficulties distinguish pavements where cycles are likely to be present. It should be noted that these shared use pavements usually don't meet high quality standards.

Sheffield stand Common type of cycle parking stand; an inverted 'U' shape.

Shoulder (North America), verge (European) Terms that typically refer to the presence of a strip of earth, gravel or pavement alongside an established roadway, usually reserved primarily for use in emergencies by private vehicles with problems or emergency service vehicles such as police or ambulances. Sometimes these are adapted for cycle facilities of some kind, although obviously the degree of users' vulnerability to adjacent motorized traffic is a key safety issue. These terms do not normally refer to pedestrian facilities, such as sidewalks or pavements.

Shoulder, paved The paved area between the (striped) motor-vehicle lane and the edge of pavement. Many local authorities have a defined width for this facility, which may or may not provide for pedestrian, bike, emergency vehicle or other use. This does not normally refer to facilities for pedestrians, which are normally called sidewalks or, sometimes, more generically as pavement.

Shuttle This refers to a small scale bus-type service, usually involving vehicles suitable for 20 passengers or less and covering relatively short distances, for example between a parking lot and an access point to an airport. Shuttles may offer feeder service to main transit routes, operate in point-to-point, or in a circular fashion. Sometimes motorized shuttles could be replaced by bicycle taxi and other similar services, to reduce noise, air and other pollution over the short distances many of these vehicles cover.

Sidewalk or **path** A walkway separated from the roadway with a curb or other protective barrier and constructed of a durable, hard and smooth surface, designed for preferential or exclusive use by pedestrians. Usually, but not always, located in the public right-of-way adjacent to a roadway.

Signage Typically, signage falls into three categories, although this is very country-dependent (Vienna Convencion on Road signs 1968; CIP, 2004; Drdul, 2004; Vélo Québec, 2003; Transport Association of Canada, 1999): Above all, it is a tool to communicate with road users: What to expect (type of road/intersection); What to do (obligation, recommendation); What to avoid (ban); What dangers to be alert to (warning); Where to go (signpost). To do this well, signage needs to be understandable and in accordance with the road design in order not to confuse the road users. Signage will often define the legal context of road use (responsibilities, liabilities). Many countries categorise signs as follows: i. Regulatory Signs — indicate a regulation (obligation or restriction) that applies to road users; ii. Warning Signs — indicate a danger that is significant or difficult to see. For example, *Share the Road* and *Bicycle Crossing* signs remind drivers to look out for cyclists on the road; iii. Information Signs — provide direction and information. These may indicate cycle routes, major destinations, parking locations. The Canadian Institute of Planners (2004) has a fourth category, classified as "Other Signs", which are usually temporary signs used to indicate roadwork and other similar situations. Vélo Québec (2003) adds "Tourist Facility Signs", which they recommend be smaller versions of tourist facility signs used on roads. In its most advanced use, good signage can turn the city itself into a map that can easily be read by every user, whether walkers, cyclists, drivers or public transport users. The historic centre of Paris works well in this sense, and could serve as an example for other cities.

Single Occupant Vehicles (SOVs) A SOV, usually a car, is a motor vehicle used to move a single individual to a destination. Since these require parking at their point of origin and destination, and often at intermediary points, and take up a disproportionate amount of space, many countries are applying incentives to discourage SOVs. In Toronto, Canada, for example, some roads come with express lanes that can be used by any vehicle (bus, car, taxi) carrying more than three or more individuals.

Smart growth, see also **Sprawl.** This term enjoys considerable popularity in the US and Canada, where it is often associated with movements such as new urbanism. It describes a strategy for metropolitan development policies that favours compact, *mixed-use* districts, efficient land use (usually with higher densities than typical suburban development), and infrastructure to encourage public transport, bike and other sustainable transport modes. It often involves explicit protection for the environment, public spaces and other community resources. See, for example, http://www.smartgrowth.org, http://www.smartgrowth.bc.ca, http://www.smartgrowth.ca, http://www.epa.gov/smartgrowth, and books by the popular urban writer, J. Howard Kunstler, such as The Geography of Nowhere, Home from Nowhere, The City in Mind, and The Long Emergency. For a useful encyclopaedia on these and other concepts, http://www.vtpi.org/tdm/tdm38.htm.

Smart Lights A lighting system embedded in the pavement along crosswalks that, when activated, flashes to alert drivers to the presence of pedestrians.

Social Equity, Justice: The provision of affordable, efficient and accessible transportation services to all people regardless of race, ethnicity, income, gender, or disability. A socially equitable transportation system provides all people with convenient access to meaningful jobs, services and recreational opportunities.

Social marketing The use of marketing principles and techniques to sell ideas rather than products to a target audience, social marketing is particularly common in the developed world. The objective is to people to change their behaviour, usually to benefit other individuals, groups or society as a w convince hole. It often overlaps with techniques used in popular education, such as those developed by Miles Horton (The Highlander School, US) or, in developing countries, by Paolo Freire (Brazil), but does not embrace the full range of citizens' initiatives, poverty, empowerment and governance issues raised by the latter.

Speed Cushion Raised speed control measure that does not lie across the full width of a carriageway or lane.

Splitter island Centrally located traffic island at roundabouts and junctions, which can be used to protect the cyclist from motor vehicles.

Sprawl This term usually refers to a car-centred model of urban development, involving low-density, dispersed activities versus traditional concentration of activities in city centres (central business districts) or smart growth (see definition). The Victoria Transport Policy Institute offers the following comparison chart, from Ewing and Galster *et al.*, comparing smart growth and sprawl. See *Table 3 in Chapter 2: Smart Growth versus Sprawl,* Comparing Smart Growth and Sprawl (Ewing, 1996; Galster, *et al.,* 2001)

Street furniture Refers to fittings and fixtures on streets, such as benches, recycling systems, lamp posts, fire hydrants, street signs, and other structures. In a well-planned, integrated transport system they should also include bike racks, multiple publication news racks, water fountains, pedestrian scaled lighting, planters, and other elements essential to quality public spaces.

Street improvement Refers to an improvement in the public right of way, whether above or below ground, such as pavement, sidewalks, or a storm water drainage system, that increase its present or future value. In south Africa the concept of 'dignified space' is used to underline that street improvements can play an important role to give dignity to to (poor) people using it. A similar approach has been at the basis of policies in Bogotá (Colombia) to improve the quality of public spaces.

Street or road, Refers to a right of way intended to provide for general circulation, providing the main means of vehicular access to abutting properties, and including space for utilities, sidewalks, pedestrian walkways and drainage.

Street tree Refers to a tree planted within a public right of way.

Street, arterial See arterial street or road.

Street, commercial access means a non-arterial street for providing access to commercial and industrial land uses and providing localised traffic circulation.

Street, existing means any street which is not a new street.

Street, private These streets are on private property or are privately controlled.

Street, residential access Means a non-arterial street providing access to residential land uses.

Streetscape Means the appearance or view of a street.

Surface Transportation Program (STP) In the US, a funding program created by its Intermodal Surface Transportation Efficiency Act (ISTEA, 1999) to finance roadway construction, reconstruction, resurfacing, restoration, and rehabilitation; roadway operational improvements; capital costs for transit projects; highway and transit safety improvements; bicycle and pedestrian facilities; scenic and historical transportation facilities; and, preservation of abandoned transportation corridors.

Sustainability, ecological Based on the principles of ecology which recognize the connectedness and interrelationship of all living things. Long-term survival (sustainability) of any species in an ecosystem depends on a limited resource base. See Sustainable Society, below.

Sustainable society This term, coined by the Brundtland Commission, led by former Norwegian Prime Minister Gro Harlem Brundtland, defined sustainable development as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (see http://www.un.org/documents/ga/res/42/ares42-187.htm for the original report). In this sense, a sustainable society seeks to apply this principle to its current environmental capacity, social and economic needs, working to reinforce cycles of energy, materials, and other elements, rather than models producing high levels of "waste" that then become dangerous pollutants of air, soil and water. This is often defined in terms of combining population, capital, and technology to provide adequate living standards for all; the usage rates of renewable resources does not exceed their regeneration rates; the usage rate non-renewable resources does not exceed the rate at which substitutes are developed; and pollutants generated remain within the environment's ability to assimilate.

Sustainable Transport Modes In line with the previous definition, the main sustainable transport modes are generally considered to be walking, cycling and public transport, although some researchers, such as Richard Gilbert (Toronto, wttp://www.richardgilbert.ca) argue that animal traction will regain importance in many countries as part of sustainable transport strategies.

Sustainable transport system Toronto's Centre for Sustainability defines this as one that (a) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; (b) is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy; (c) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.

Tactile paving Paving with raised surface textures for the guidance of blind and partially sighted people. Though primarily used at crossings specifically for pedestrians and/or cyclists, they are also increasingly used simply at uncontrolled points where a sighted pedestrian would naturally cross the road.

Traffic Calming A combination of measures (mostly changes to the road environment) aimed at altering driver behaviour, primarily by reducing speeds and improving conditions for pedestrians and cyclists. The objective is to create an environment favourable to the peaceful coexistence of different transport modes, primarily in residential, recreational and commercial areas. Traffic calming is based on the fact that traffic speeds of under 20 mph or 30 km/h substantially reduce fatal or serious accidents and injuries. They may aim to improve public space, social equality, safety or security, social relationships, quality of life (See Box 18, for a list of measures from around the world).

Trail Facility A facility provided for the benefit of (recreational) trail users, often through an urban ravine, wilderness or other natural area, typically including signs, a boardwalk, benches, washrooms, etc.

Transit In the US and Canada, refers to mass transportation by bus, rail or other conveyance providing general or special services to the public on a regular and continuing basis. It does not include school buses, charter services, or sightseeing services. Elsewhere in the world this is referred to as public transport or collective transport (Latin America, where services are often provided by private companies rather than state- or city-run agencies).

Transit Lane In the US, a lane for exclusive use by public passenger vehicles, motor cycles, bicycles and motor vehicles carrying a specified minimum number of passengers.

Transport disadvantaged Those persons who, because of physical or mental disability, income status, or age are unable to transport themselves or to purchase transportation and are, therefore, dependent on others to obtain access to health care, employment, education, shopping, social activities, or other life-sustaining activities.

Transport Plan, Green Plan by public authorities, businesses or other organisations which defines the steps they are taking to ensure that specified levels of travel by employees and customers are made by walking, cycling, bus and rail.

Transportation Control Measures (TCMs) This term refers to local actions aiming to influence traffic patterns, particularly to reduce car use, and thereby improve air quality and reduce congestion. Typically they include: transportation system management (signal optimization, ramp metering, incident detection, special events planning, etcetera), transportation demand management techniques (reduced transit fares, preferential parking, telecommuting, compressed work hours, etcetera), facilities development (high-occupancy vehicle lanes, on-site child care facilities, etc.), or growth management policies (mixed use developments, transit corridor s, job/housing balances, etc).

Transportation/Travel Demand or **Mobility Management (often abbreviated as TDM)** Some planners define TDM as "measures to reduce traffic congestion" from the demand side, focusing on reducing the number of cars (ride-sharing, mass transit, "flex" time, telecommuting, employer incentives to use alternative modes, and restriction on the amount of free or cheap parking, among others). Increasingly, however, TDM is often used to refer to mobility management, a broad set of strategies that boost transport efficiency by combining different modes in ways that make the most of the strengths of each mode. For an excellent on-line resource, see the Victoria Transport Institute's Online TDM Encyclopaedia http://www.vtpi.org/tdm/.

Transportation Modelling, travel demand model Typically this involves a computerised procedure to predict future trip making. The traditional model has four steps: trip generation, trip distribution, mode choice, and assignment to a simulated transportation network (*e.g.* highway or transit); **Trip Distribution:** The process by which the movement of trips between zones is allocated in a travel demand model. Trip distribution is generally based on a gravity model.

Transportation System Management (TSM) A program involving the implementation of traffic control measures, such as high-occupancy vehicle (HOV) lanes, signal timing adjustments, median closings, and access management strategies to increase the operating efficiency of the traffic circulation system.

Travel route A formal or informal path for motorized or human-powered transportation.

Travel time The total time taken to complete a trip from origin to destination.

Tricycle A three-wheeled, human-powered vehicle typically used to transport children, passengers, recycled materials, working tools and materials. These typically are key components in efforts to build urban sustainability through transport, recycling and socially-inclusive measures. (Cycle) rickshaw is the term used In India for tricycles.

Trip Generation The process by which the number of trips within each analysis zone are estimated in a transportation model. Trips are generated on the basis of demographic (number of households, household size, income, etcetera) and economic (number and type of employers, commercial activities, etcetera) attributes, and are given in the form of attractions and productions.

Trip Length Frequency Distribution The array which relates the trips or the percentage of trips made at various time intervals or various trip distances.

Truck (heavy) A motor vehicle exceeding 8,000 pounds gross weight, has two or more wheels per axle or has more than two axles, and is designed, used, or maintained primarily for the transportation of property.

Urban Defintiions for what actually constitutes the urban vary widely. The US Census Bureau defines urban as: (a) the population living in urbanised areas; plus (b) the population in other incorporated or census designated places of at least 2,500 population at the most recent national census. Wikipedia defines an urban area as one with "increased density of human-created structures in comparison to the areas surrounding it. Urban areas may be cities, towns or conurbations, but the term is not commonly extended to rural settlements, such as villages and hamlets… Measuring the extent of an urbanised area helps in analyzing population density and urban sprawl…" It notes that European countries define urbanised areas on the basis of land use, employing satellite photos rather than census blocks to determine boundaries, and provides definitions used by different countries, primarily in the developed world.

Urban, utilitarian or **commuter cycling** This refers to cycling mainly as a transport mode, rather than a recreational or sporting activity.

Vehicle Hours Travelled (VHT) A measure of motor vehicle use over some period of time, usually a day or a year. It represents the total time spent on the roadway system by all vehicles combined, over the specified period of time.

Vehicle Location System (VLS) Information Technology enabling the ever-changing locations of vehicles to be monitored at a central location. For public transit, VLS enables passengers waiting for rides to continuously be informed of the status of service.

Vehicle Miles/Km Travelled (VMT) An area-wide measure of motor vehicle use. VMT is calculated by summing data on a link basis or by multiplying average trip length (in miles) times the total number of vehicle trips.

Verge, see **shoulder.**

Visibility Splay A clear area for visibility at junctions, defined by x and y dimensions.

Vulnerable road users A collective term (Europe) used to refer to pedestrians and cyclists, in the context of road safety.

Walkway A pedestrian facility, whether in the public right-of-way or on private property, which is provided for the benefit and use of the public. In some cities, this refers to covered facilities (underground or skywalks linking two buildings) that allow pedestrians to move around without having to go outside. These are used a great deal in Canadian cities, subject to extreme winter weather conditions.

Widened Curb Lane A relatively inexpensive way to create more cycling-friendly streets, a Widened Curb Lane typically involves adding a metre or so to standard road widths, to allow motor vehicles and cyclists to share a lane, ideally providing them with room to pass without having to change lanes. These are typically designated by re -striping the road surface, narrowing the inside travel lanes and widening the curb lane, or by rebuilding (narrowing) the median, boulevard or sidewalk area. Because this kind of solution is mostly applied in response to financial limitations, rather than technical best practices, it is often questioned, particularly where cycling-inclusive streets are the policy goal.

Widened Travel Lane Like the widened curb lane, the widened travel lane involves adding extra width to standard city road width to facilitate human-powered vehicles.

Zone The smallest geographically designated area for analysis of transportation activity. Zones vary greatly in size depending on such factors as: homogeneity of land use, amount of transportation network, level of analysis desired, and physical geography. Zones can range in size from a city block to very large rural areas (census tract size).

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Co-authors biographies *)

André Pettinga

Born in 1951, André enjoys living in Utrecht, in the heart of the Netherlands. He is a founding member of I-CE, Interface for Cycling Expertise (1995), in response to rapidly growing demand from abroad for cycling policy action plans, which required a more professional response. Today he sees himself as a Dutch cycling policy ambassador. In his daily life, he uses a bicycle as much as possible for a variety of destinations. His educational background includes both civil engineering and urban planning & design. Working as a civil servant during the 1970s and 1980s for the city of Delft, he learnt that experimenting with urban traffic was very important. He formed part of the teams developing a series of experimental 'woonerf', a highly successful and now very famous traffic calming concept, which has been copied all over the world. Similarly, he has worked on experimental bicycle networks, pedestrian facilities, combined bus-tram-tracks, etc. This all was done as part of early urban housing renewal projects and integrated into newly built residential areas, including city centres. Since 1989 he has worked as a traffic and transport consultant for Grontmij Consulting Engineers (The Netherlands). Both for Grontmij and for I-CE, he has led projects on cycling planning and engineering in the Netherlands (Utrecht, Amersfoort, Eindhoven), in Europe (Dublin, Bordeaux, Budapest) and in developing countries (Bangkok, Dar-es-Salaam, Morogoro, Nairobi, Eldoret). My main skills are: project-in-process management, interactive workshops, training-on-the-job, public space analyses, cycle manual developing, small conferences, etc. He sees cycling as part of the solution to aggressive private car dominance. He is highly motivated to raise awareness of the unsustainable and unjust impact of ongoing motorization in urban areas. The democratic use of public space is at stake in many rapidly urbanising areas. His ambition is to continue working as a 'non-motorized transport' professional, maintaining an integrated and human approach, along with training young talented people in the unique impact of cycling.

*) In alphabetical order by first name

Anke Rouwette

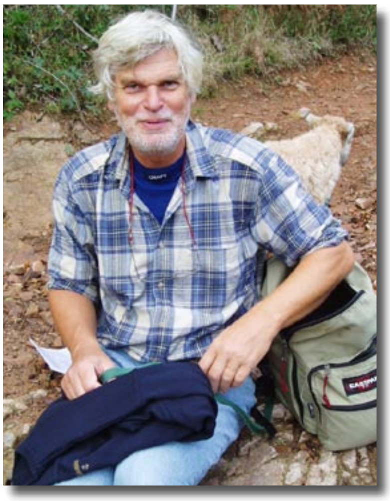
Anke Rouwette studied at the University of Twente, the Netherlands, from 2001 to 2008. She finished a Bachelor in Civil Engineering, a Master in Transport Engineering and Management and a Master in Applied Mathematics. During her study period she worked part-time at the traffic consultancy, Keypoint. For her internship, she studied the integration of BRT and NMT in Dar Es Salaam, Tanzania. Since August 2008 she is employed at the consultant company of Witteveen+Bos, where she works as a traffic consultant.

Bas Braakman

Born in 1972 in Hengelo, the Netherlands, Bas studied traffic and transport planning at the Breda University of Applied Sciences. He worked from 1996 to 2005 as a traffic planner for Grontmij consultants in the Netherlands. In his role as project leader and consultant, he advised a variety of local and regional governments in traffic planning and traffic engineering projects. Since 2005, Bas Braakman has worked as a civil servant for the city of Eindhoven, the fifth largest city in the Netherlands with 200,000 inhabitants. As a project leader, he is in charge of major road reconstruction projects and development of cycle policies. Since 1998, Bas Braakman has served as a cycling expert in several cycle projects abroad, representing Interface for Cycling Expertise (I-CE). He has worked on cycle network studies and cycle planning and design studies in different cities, such as Bogotá (Colombia), Quito (Ecuador), Santiago (Chile), New Delhi (India), Dublin (Ireland) and Paris (France).

Carlosfelipe Pardo

A Colombian psychologist, Carlos Felipe has worked on transportation issues from the organisational, advocacy and policy perspectives, with several projects in his country and abroad. He worked with a foundation in Bogotá as mobility coordinator in 2002–2004, and as an assistant to the Institute for Transport and Development Policy (ITDP) and others. Since 2005, he has coordinated the GTZ Sustainable Urban Transport Project in Asia and Latin America (http://www.sutp.org) and served as a steering committee member for Sustran LAC. He has taken part in the development of training courses on Bus Rapid Transit (BRT), non-motorized transport, sustainable transport and public awareness in Indonesia, Thailand, Uruguay, Brazil, Mexico and elsewhere around the world. He authored two chapters in the Bus Rapid Transit Planning Guide (published by ITDP, UNEP, Hewlett, GTZ) and a module and training document on public awareness and behavioural change for GTZ. He has edited a document on gender and urban transport. He spends some of his time on research and applying initiatives to raise public awareness and change urban transport-related behaviour and at the time of writing is finishing his MSc in Contemporary Urbanism at the London School of Economics.



Hans de Jong

Hans (1950) has a degree in traffic engineering and is a freelance consultant/sustainable transport specialist with I-CE, as well as lecturer and module leader for the road safety module in European Traffic and Transportation Master of Science (MSc.) programme of EUROconnect which is a co-operation between several European Universities. From 1977–1980 he was a traffic engineer at the Dutch Pedestrian Organisation and from 1980–2006 he was a road safety engineer and later a policy maker at the Dutch Ministry of Transport, Public Works and Water Management. As a road safety engineer he was involved in the first 'Shared Space' projects. Later he became involved in the National Mobility Plan. During the 90's he was a member of the national project group that developed the Netherlands' master plan for the bicycle (Ministry of Transport). He has extensive experience with multi-disciplinary mobility & transport projects; integrated traffic-policy projects, cycling policy, urban planning, sustainable transport and the involvement of user groups.

Ineke Spapé

Ir. Ineke Spapé (1958) is (part-time) associate professor at the International Professional University (NHTV) in Breda in the areas of integrated urban and transport planning. She is also a senior consultant in the field of mobility and urban-spatial planning and a managing director of SOAB Consultants. She has degrees in both transport and urban planning. For more than two decades, she has worked on pedestrian, cycle and infrastructure planning, specializing in the issues implicit in creating quality public space and developing spatial networks for vulnerable people (children, seniors), plans for sustainable mobility and implementing safe routes to schools and other destinations for children (in co-operation with child-related partners). As a project manager, Ineke has worked for many Dutch city councils (Ede, Eindhoven, The Hague, Gorinchem, Rotterdam, Amsterdam, etc.), for national knowledge institutes (CROW, KpVV) and regional and national government (Short Trips Plan, Pedestrian Crossing Survey). On behalf of I-CE (Interface for Cycling Expertise), Ineke was also involved in introducing integrated city and cycle planning, cycle parking strategies and school safety and education plans for Cape Town, Quito (Ecuador) and Melbourne (Australia). Besides being a consultant, Ineke is a member of the Commission for Road Transport of the National Board for Transport Safety (Ongevallenraad voor Veiligheid, OVV). She was a member of the Dutch National Board for Cycling (Fietsberaad). She is an expert in the international network of I-CE (Interface for Cycling Expertise) in the area of cycle parking, safety and education plans for vulnerable people and urban planning. She is also involved in a Dutch network for a more child-friendly design of streets (IKS-CROW).

Lake Sagaris

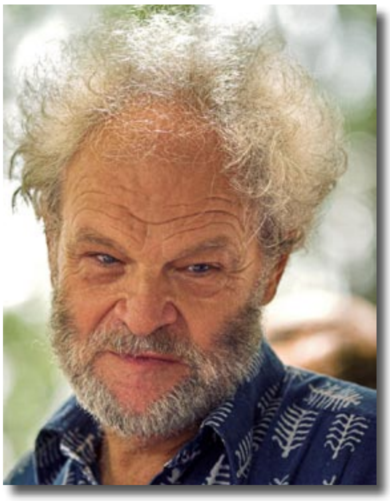
Lake Sagaris (b. Montreal, Canada) has worked as a journalist (London Times, CBC, CTV, Miami Herald, Newsweek, among others) and bilingual editor for most of the 30 years that she has lived in Santiago Chile. A happy traveller (through time and space), she is also author of five books. Her book on the demise of the Pinochet regime, After the First Death, was short-listed for the Governor General's Award of Canada (1996). After getting involved in community organizing to save a large swathe of central Santiago from an urban highway project, she went on to study planning. Today she holds a Master of Science in Urban Planning and Community Development. She is co-founder of Ciudad Viva (Living City), a community-based organisation active in sustainable and especially human-powered transport, citizen-led urban planning, participatory mapping, heritage and other issues. She is currently working on a doctorate (University of Toronto, Department of Geography and Planning) to develop tools and prototypes for improving citizens' participation and research in urban transport planning.

Mark Zuidgeest

Dr Mark Zuidgeest (1974) is a civil engineer by training. Currently he is assistant professor urban transport at ITC International Institute for Geo-Information Science and Earth Observation in the Netherlands. Much of his teaching and research involves the use of Geographical Information Systems (GIS) and Remote Sensing in urban transport planning in countries that are economically and/or technologically less developed. Much (though not all) of this work has been related to transport sustainability (incl. role of non-motorized transport, public transport, environmental and social impacts) in urban regions in for example India, Indonesia, Tanzania, Ghana, Rwanda, etc. Mark received his doctorate from the Netherlands Research School on Transport, Infrastructure and Logistics (TRAIL) in 2005. Before that he was a lecturer in transport engineering at UNESCO-IHE Delft and served as a consultant on the Non-Motorized Transport component of the World Bank Sub-Sahara Africa Transport Policy Program (SSATP) in Tanzania and Kenya. Currently Mark is also secretary of the Cycling Academic Network (CAN), which is part of the Bicycle Partnership Program of I-CE Interface for Cycling Expertise in the Netherlands.

Roelof Wittink

Drs Roelof Wittink (27-07-1948) is executive director of I-CE, Interface for Cycling Expertise. He is a specialist on traffic behaviour with a Masters in Psychology. He has published on behavioural modifications, traffic education, attitudes on road behaviour, social marketing, institutional strategies, the promotion of non restrictive safety measures for cycling and walking and the economic significance of cycling. He was the program manager of LOCOMOTIVES, a four-year support program from 2003–2006 on low cost mobility that operated in nine developing countries and is currently the manager of the Bicycle Partnership Program, a four-year support from 2007–2010 on cycling inclusive planning that operates 15 developing countries. As such he is involved in the application of expertise on the integration of cycling in a wide variety of local context and in building partnerships between civil society organisations, governments, experts and the private sector.



Steven Schepel

Steven Schepel (born in 1944) started his professional career as a town planner at the municipality of Delft in the 1970's. In that period Delft was well-known for the develepment of the 'woonerf' (a street for children, where cars can be allowed within restrictions, called Home-zone in the UK) and the preparation of the Cycle Route Plan (realised in the 1980's as the first comprehensive cycle route network in an existing town. He wrote the first manual on the layout of a woonerf, and.drafted the official 'Traffic-Livability in Towns and Villages' report, introducing the concept of vast, comprehensive Habitat-areas (traffic calming in combination with a friendly layout) complemented by traffic-arteries bundling the streams of motorized traffic. Later he was hired by Spijkenisse to empower the future residents during the design of their housing estate. At the same time he was president of 'Stop de Kindermoord', an NGO advocating the rights of children to move around safely, and independently on streets and roads. In the 1980's Steven Schepel was director of public works at the borough of Amsterdam-Osdorp, responsible for policy development, design, construction, maintenance, and daily care of public space and other facilities. In the 1990's he entered the Ministry of Transport, Public Works, and Water Management (dep. Traffic Safety). He was member of the national team for the Masterplan Bicycle. Later he was responsible for the national Sustainable Safety programme Nowadays, Steven Schepel is an independent consultant, working for VVN (the national organisation for traffic safety), and I-CE (Interface for Cycling Expertise).

Tom Godefrooij

Tom Godefrooij was born in 1950 in Eindhoven, the Netherlands. He studied architecture at the Technical University of Eindhoven, and worked subsequently as an architect for 3 years. In 1981 he was employed by the Dutch Cyclists' Union for the writing of a book on Traffic Calming measures. After that he became the policy director of the Dutch Cyclists' Union. In this position he dealt with the various aspects of cycling like road safety, cycle planning, the integration of cycling and public transport, vehicle standardisation and so on. In 1991 he joined the management committee of the European cyclists' Federation, a federation of national and local bicycle user groups. From 1996 to 1999 he was president of this ECF. The ECF has been making a substantial contribution in putting cycling on the transport agenda through Europe, amongst others by the organising of the worlds premier bicycle conference series Velo-City. Tom Godefrooij was also the main organiser of the second world bicycle conference Velo Mondial 2000 in Amsterdam. From 2001 to 2006 he worked as a civil servant for the provincial government of Noord-Brabant. There he was in charge of the drafting of the Provincial Traffic and Transport Plan. This plan is defining the roles of the various modes of transport in the transport system and provides a framework the transport policies of the municipal governments in the province. The plan was approved in 2006. From 2006 on Tom Godefrooij is working for Interface of Cycling Expertise (I-CE), a Dutch NGO that is promoting the inclusion of cycling in urban and transport planning processes as a contribution to sustainable development. In 2007 I-CE started its Bicycle Partnership Program to assist cities in developing countries to make their urban and transport planning more cycling inclusive.

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