New Ways to Go

Public Investment in Cycling

Research, Analysis and Report

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i. Executive summary

The present document is an "Analysis of public investment costs, inhibitors and externalities" regarding cycling investment. The scope of the document is to investigate issues associated with the introduction of cycling in urban mobility management schemes. It is motivated by the recognition that in recent decades public administrations in many large urban agglomerations have initiated policies aiming at diverting urban commuting from motorized methods (such as automobiles) to cycling.

The present document is focused on the necessary infrastructure investment that have to be undertaken in order to facilitate uptake of bicycling by citizens. Such investment imply a substantial cost for the public budget and are associated to expected benefits. Therefore the objective of the present analysis is to explore three aspects related to cycling investment:

- The costs associated with cycling infrastructure investment. These costs can be the initial investment costs, as well as any additional maintenance and operation costs

- The benefits of the investment. These benefits can be direct revenue streams as well as indirect externalities resulting from increased bicycle usage and related to issues such as population health, quality of living and urban development.

- The possible drivers and inhibitors of cycling investment. Drivers are factors that facilitate and promote cycling friendly policies. On the other hand inhibitors are factors that impede efforts to improve cycling infrastructure. Among others, drivers and inhibitors can be related to public sentiments, preconceptions and misconceptions. They can also be related to political priorities and fiscal restrictions, as well as a variety of other factors.

In order to facilitate understanding, the present document includes an indicative typology of cycling infrastructure, with their characteristics. The approach of the present analysis is based on presenting methods for the quantification of costs, benefits and externalities, in an attempt to provide a meaningful cost/benefit comparison and highlight the expected overall gains from investing in cycling.

A Cost Benefit Analysis should ideally follow the nine steps of the *road map* for CBA's on cycling:

1. Problem Analysis
2. Formulating alternatives
3. Zero alternative (reference)
4. Naming effects
5. Scope of effects
6. Monetised effects
7. Making costs and benefits comparable
8. Sensitivity analysis
9. Use as a basis for decision making

ii. Abbreviations

BSC	Business Support Centre
SCBA	Social Cost Benefit Analysis
CBA	Cost Benefit Analysis
UMPC	Urban Master Plan for Cycling

iii. Distribution of work

The initial writing of the report was done by BSC. Besides some changes in the structure of the document, the following improvements were made by Decisio and Velo Mondial:

- Executive summary: added a road map for CBA
- Section 1: figures added and some minor adjustments to the writing.
- Section 2: minor adjustments
- Section 3: figures added, some minor adjustments to the writing and a somewhat larger effort on section 3.3.
- Section 4.1: figures added, indications on infrastructure costs, operational costs and promotion/training costs.
- Section 4.2: figures added and some minor adjustments to the writing.
- Section 4.3: improved the explanation of CBA methodology, added the bicycle kilometer and two CBA-cases; a bike bridge in Utrecht, the Netherlands and cycling investment on 2nd Avenue in Seattle, U.S.A.
- Section 4.4: some minor adjustments to the writing.
- Section 5: added figure, improvements to existing text, added future recommendations.

1. Introduction

1.1. Urbanization and the modern society

In the past 60 years world population has experienced a very fast population increase. Between 1950 and 2010 world population almost tripled, rising from 2.5 billion to 6.8 billion. The high pace is expected to continue in the coming decades. According to the United Nations[1], world population is expected to reach 8 billion in 2025 and pass the 9 billion mark by 2045[2].

This steep rise in global population is associated with a rapid urbanization of modern societies. The share of population that lives in urban agglomerations increased from 29.4% in 1950 to 51.6% in 2010 and is expected to reach 67.2% in 2050. This means that two thirds of the global population will be living in cities by 2050. In absolute numbers, this trend is even more compelling; urban population globally has risen from 750 million in 1950 to 3.5 billion in 2010 and will reach 6.2 billion in 2050[3].

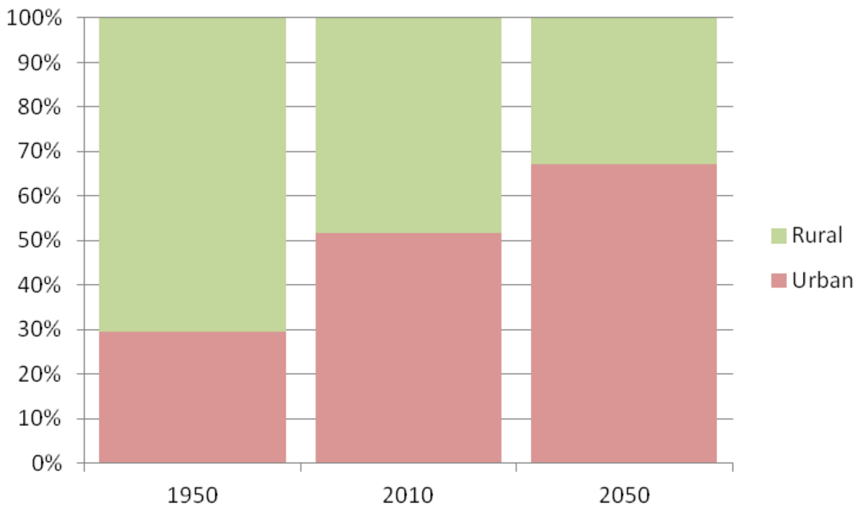

Figure 1.1 Share of world population living in urban and rural areas.

[1] UN (2012) World Urbanization Prospects: The 2011 Revision
[2] The UN estimates foresee that in 2050 world population will reach 9.3 billion. This means that within a century global population will almost have quadrupled
[3] It is interesting to point out that this means that in 40 years urban population is expected to be almost as large as total population in 2010.

European Union
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CYCLE CITIES

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This rise in global population is resulting in increasing size and number of large urban agglomerations. According to the same UN report in 1950 there were 177 cities with a population exceeding 500.000. The same number was 967 in 2010 and is expected to reach 1,418 in 2025.

The rise in the number of cities and in the size of urban agglomerations has a multitude of side effects. Increasing population densities affect the urban environment and degrade the population's quality of life. An important factor contributing to these adverse effects is associated with transportation within the city limits, and specifically the externalities created by motorized transportation. Another equally if not more important force degrading urban quality of live comes from the fact that most modern cities have been developed under the assumption that motorized transportation will be the primary method of transportation in cities.

The usage of automobiles as a primary method of transportation in turn is the result of two mutually reinforcing factors. On the one hand we saw rapid technological improvements of internal combustion engine technologies. This resulted in decreasing cost and rising numbers vehicles. Indicatively in the United States of America the number of vehicles in 1900 was approximately 8,000[4] implying an average of 0.11[5] cars per 1,000 inhabitants. In 2010 the number of vehicles per 1,000 inhabitants in the US had reached 797[6]. This trend is not confined in the US; there are many countries displaying similar characteristics. As mentioned earlier, a major contributing factor to this trend is the rapidly decreasing production cost facilitated by innovative techniques in industrial production. On the other hand we see an increasing GDP per capita (a commonly used indicator for wealth), also facilitated by the rapid industrialization of many countries and the ongoing digital revolution. The result from both factors (increasing wealth and decreasing cost) is the exponential expansion of the vehicle stock in almost every country around the world.

[4] http://web.bryant.edu/~ehu/h364/materials/cars/cars%20_19th.htm
[5] http://www1.eere.energy.gov/vehiclesandfuels/facts/2010_fotw617.html
[6] http://data.worldbank.org/indicator/IS.VEH.NVEH.P3

The coexistence of rapid urbanization and accelerating vehicle usage is behind the appearance of traffic related problems in modern cities. The latter, in many cases, are not designed to and do not have the necessary infrastructure to sustain the amount of vehicles occupying the streets. Therefore the car, which in the 19th century was promising more freedom in movement and improved quality of life, became one of the major problems in large cities within one century. The car is commonly blamed for problems such as traffic congestion, noise pollution, environmental pollution and so on.

At fault for this evolution in many cases are the policy planners, who for many decades viewed the car as the preferable method of transportation. This resulted in cities being planned around cars, with limited infrastructure for other forms of more sustainable transportation. However in the late 20th century, when the problems became pressing, a shift occurred away from the personal car. Initially efforts were directed towards public transportation; this includes buses, trains and subways. The results in some cases have been very promising, while in other cases less so.

In more recent years, another form of transportation is taking momentum both among policy planners and consumers; cycling is slowly becoming a very popular method for travelling and commuting. However, uptake is uneven among cities and countries. This variation in uptake is a reflection of diverging preferences and priorities among both public administrations and citizens. Another important factor is the differences in the availability of necessary infrastructure. This infrastructure includes for example the necessary cycling paths (tracks, lanes, etc.), end-of-trip facilities (parking infrastructure), and connections to other forms of public transportation.

Commuting cyclists in Copenhagen. Source: avenuecalgary.com (2014).

1.2. Scope of this document

The lack of suitable infrastructure in modern cities is indeed an important factor that inhibits uptake of the bicycle by citizens. Urban design in the past has focused on private and public motorized transportation, disregarding the advantages of sustainable transportation methods such as cycling. This resulted in insufficient funding for investment in cycling friendly infrastructure. However, it seems the public interest shifts in favor of cycling friendly mobility management schemes as well as the willingness and effort to implement the necessary infrastructure investment.

Public investment in cycling infrastructure can have a significant impact, by creating favorable conditions and significant incentives towards the uptake of the bicycle by the population. The scope of the report on public investment in cycling infrastructure is to investigate the following topics:

- Typology and characteristics of public investment in infrastructure and other facilities for the provision of services to cyclists.
- The costs and expected benefits that can be associated with those investment. These costs and benefits are related to the stakeholders making the investment, but more interesting to the society as a whole. A comprehensive analysis of the expected costs and benefits is therefore also within the scope of the final report.
- The reality that public sector initiatives might be facilitated or impeded by the existence or absence of several relevant factors. It is therefore crucial that the final report will incorporate such factors and propose policy initiatives that will improve the environment for public investment by providing the appropriate incentives.

1.3. The CycleCities context

CYCLECITIES aims to build and share knowledge and facilitate good practice transfer and experience exchange among European cities on the integration of cycling into urban mobility management schemes. It specifically aims to:

- Exchange experiences and make transferable good practices on mobility management and cycling available to European stakeholders.
- Establish consensus on policies towards sustainable European mobility management schemes.
- Establish a European, multilingual, freely accessible knowledge and experience base.
- Disseminate field experiences and project results as a means to enhance awareness on the integration of cycling in urban mobility management schemes.

Cyclecities addresses some critical challenges and opportunities for European cities that relate to a number of factors:

- **Traffic congestion**: 30% of car trips in Europe are under 3km and 50% are under 5km – a 15-minute bike ride (EEA Report No 5/2009). Reducing car use and increasing cycling will unclog roads and reduce congestion and associated delays, lost working hours and wasted fuel.
- **Cost reduction**: Motorised transport imposes high costs on individuals and society, both directly (road construction and maintenance) and indirectly (casualties, obesity, pollution, congestion, etc.). The European Commission (COM 2009/279)[7] estimates the external costs of road transport (mostly individual motorised transport) at 2.6 % of GDP. Other studies suggest as much as 4% and 8%. Shift from car to cycling provides an opportunity for huge cost savings.
- **Lower carbon footprint**: Some 40% of Europe's CO2 emissions from road transport and 70% of other pollutants are due to urban traffic. As recognised in EU Communication 2009/279, urban transport accounts for 40% of CO2 emissions, and 70% of other air pollution, in particular PM10 and NOx emissions, from transport. Tripling the modal share of cycling would save 5% of transport CO2 emissions by 2020. This would make a significant contribution to mitigating climate change and decreasing dependency on fossil fuels.
- **Health benefits**: Increasing the modal share of cycling enhances physical and mental health. Accidents involving cars are associated with cycling and walking, too. Nevertheless, on balance, the benefits to life expectancy of choosing to cycle are 20 times the injury risks incurred by that choice (WHO, 2000). Higher proportions of commuter cyclists are correlated with lower risks of casualties. Car drivers are used to the presence of cyclists and are more likely to be cyclists themselves.
- **Land use**: increased uptake of cycling leads to reduced land consumption: 10 bikes can be parked in the space required for one car. One lane of typical road can accommodate 2,000 cars per hour – or 14,000 bikes. Fostering of investment and neighborhood revitalisation: Cycle-friendly cities attract individuals & businesses

[7] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0279:FIN:EN:PDF

investment, encourage neighborhood revitalisation and can improve a city’s quality of life and environment.

In this context, the report on public investment has an important role. It will provide an overview of alternative options available to public administrations which can facilitate the proliferation of cycling friendly mobility management schemes. Furthermore the report will provide information regarding the associated costs and expected benefits; this includes both direct as well as indirect costs and benefits (externalities). The inclusion of quantified data (wherever possible) will provide comparable information on the cost and the expected impact of available policy alternatives. Finally the present report will investigate the existence of factors that might facilitate or impede public investment and/or the uptake of cycling as a method of transportation and commuting.

1.4. Investigation Analysis Questions

Taking into account the CycleCities objectives and the scope of this report it is possible to discern two investigation questions that should be addressed:

(1) Which are the costs and benefits that can be associated with public investment in cycling infrastructure and how can these be compared?

Investment that promotes cycling friendly mobility management schemes can be associated with costs and expected benefits. Both these categories can be specific to the entity making the investment; however they can also have a more general economic and social impact. Direct costs and benefits are usually related to monetary expenditures and income associated with the investment. On the other hand the wider impact (also known as externality) will affect entities that are not involved in the investment. The effect can be positive or negative (positive and negative externalities). For example cycling friendly investment create an environment that enables people to adopt bicycles as their primary mode of transportation for certain trips. Adopting cycling implies that these people are increasing their levels of physical activity resulting, among others, in all illnesses connected to a sedentary lifestyle being reduced. This externality has a significant impact on the quality of life for individuals and the society-wide expenditures for health. This kind of effects can be monetized in order to compare costs and benefits of cycling investment.

(2) Which are the drivers and inhibitors that can facilitate or impede private investment?

Another investigation question that is also addressed in the report on private investment concerns the potential existence of drivers and inhibitors affecting investment decisions. There is a variety of sources that could either facilitate or impede investment. The most prominent among them is the official public policy. Specifically the attitude of public administrations towards cycling, as expressed by the investment and other policy decisions, can have a significant impact (positive or negative) on private attitudes towards using the bicycle or investing in cycling. Although public policies are the most common factor, other social or technical/technological factors can also play an important role. For example public investment is more widespread in areas where the local society has a positive attitude towards cycling, giving additional incentive to elected representatives in the pursuit of cycling friendly policies. On the other hand in some cities, due to the characteristics of the existing road network, it is technically difficult to implement cycling friendly mobility management schemes. Drivers and inhibitors like these are investigated more thoroughly in section 4.

1.5. Structure of this document

Taking into account the thematic scope of the present deliverable in particular and the CycleCities project in general; the remainder of this document is structured as follows:

- Section 2 will provide an overview of the methodology used for searching for the necessary information, selecting the appropriate sources and evaluating the collected data.
- Section 3 will provide a typology of investment in cycling friendly infrastructure. The investment that will be presented refers to infrastructure that can be constructed by the public sector. On the contrary this report does not include solutions that can be undertaken only by the private sector; this also refers to cases where there is no public sector interest or jurisdiction.
- Section 4 will provide an economic impact analysis of investment in cycling infrastructure. This includes the costs and benefits from investment in cycling friendly mobility management schemes. The cost benefit analysis methodology is illustrated with an example.
- Section 5 will summarize the findings of the report and provide conclusions and suggestions.

2. Methodological Approach

The methodology that has been followed during the development of the present report identifies three stages for the collection, evaluation and assessment of relevant information and data[8]:

(1) Identification

(2) Quantification of Indicators

(3) Assessment

2.1. Identification

Assessment of policy decisions and projects' effects requires identification of:

- Thematic areas of influence;
- Parameters per thematic area;
- Indicators per parameter or thematic area.

The report is a synthesis of information and data collected through desk research. Indicative sources that have been used include:

- European Union official policies;
- Academic research papers;
- Reports written by public authorities in their effort to design and implement cycling friendly policies and/or investment;
- Economic evaluations and feasibility reports of cycling investment written by private companies for specific investment;
- Positions expressed by interest groups such as cyclists' federations and bike industry representatives.
- Data bases and/or research projects offering quantitative data that can be used for the purposes of the report.

[8] The present document is based on a methodology report developed for the purposes of the CycleCities project by a different consortium partner; the Technical University of Athens.

As a result the report is a product of secondary research and represents a synthesis of state of the art opinions and primary research results regarding public investment in cycling friendly mobility management schemes. Among the sources priority has been given to studies that are aligned with the geographic and thematic scope of the CycleCities project and/or provide empirical data. Furthermore academic papers and other in-depth analyses where preferred.

2.2. Quantification of Indicators

After identifying the areas of interest, the objective is to provide a quantification of the appropriate indicators[9], wherever the appropriate data are available. The term quantification implies the calculation of the monetary value of each indicator. This will create unit prices that can be used for comparisons for example with the investment costs. Such unit prices are available in sources such as feasibility studies and cost-benefit analyses. In some countries (e.g.UK) some extensive studies have already been carried out, which are the sources of quantitative data for a variety of indicators related to cycling.

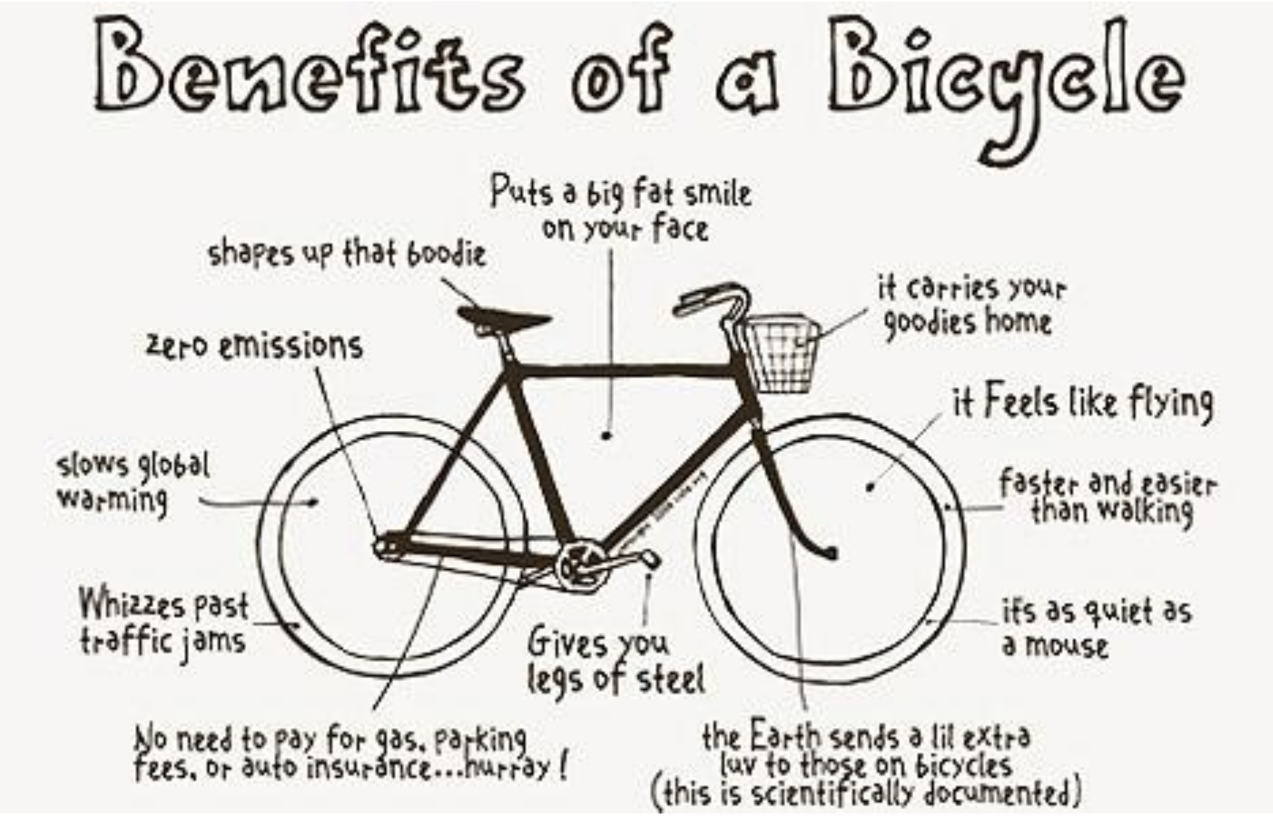
2.3. Assessment

The most commonly used tool for performing comparisons between the expected cost and the anticipated benefits of every project and policy is the Cost Benefit Analysis (CBA). The CBA is also the officially suggested assessment tool for infrastructure projects other than in cycling when (co)-financed by EU funds.

Since there is a long history of evaluation of major transport projects such as motorways, railways, etc., CBA may also be proven a helpful tool to demonstrate cycling's potential. A CBA attempts to measure the positive and/or negative consequences of a project, which may include:

[9] See also section 0

1. Effects on users or participants
2. Effects on non-users or non-participants
3. Externality effects
4. Option value or other social benefits.



3. Investment in Cycling Infrastructure

This section includes a non-exhaustive typology of cycling infrastructure that can be the subjects of investment undertaken by public administrations[10]. On this subject it is possible to classify them into three major groups of infrastructure[11]:

- Travel-related infrastructure for cycling
- Bike-parking and end of trip facilities
- Integration of bicycling with public transport (transit synergies)

3.1. Travel-related infrastructure for cycling

These include infrastructure upon which bicycles can travel and other measures (through infrastructure) that facilitate the flow of cycling traffic. We first give as much forms of physical cycling infrastructure as possible with their associated costs (when available). We then point out some other bicycle friendly physical adjustments to infrastructure (like traffic signals and way finding signals). Finally we sum up measures that can be taken by public authorities in order to create a better, safer environment for cyclists.

3.1.1. Travel Infrastructure

This category includes all infrastructure that cyclists can use when travelling. Within this category we can distinguish two subcategories; the differentiating factor will be the existence of a physical separation of the cycling path from the rest of the road used by other vehicles. As a result it is possible to distinguish two categories:

- **Mixed traffic:** Paths where cycling traffic is mixed with motorized traffic, or where there is no physical obstacle for crossing over between normal street and cycling path.

[10] Investment costs feature great variations depending on the existing local conditions. However additional information are available in Section **Napaka! Vira sklicevanja ni bilo mogoče najti.** and Section **Napaka! Vira sklicevanja ni bilo mogoče najti.**

[11] Pucher et. al (2010)

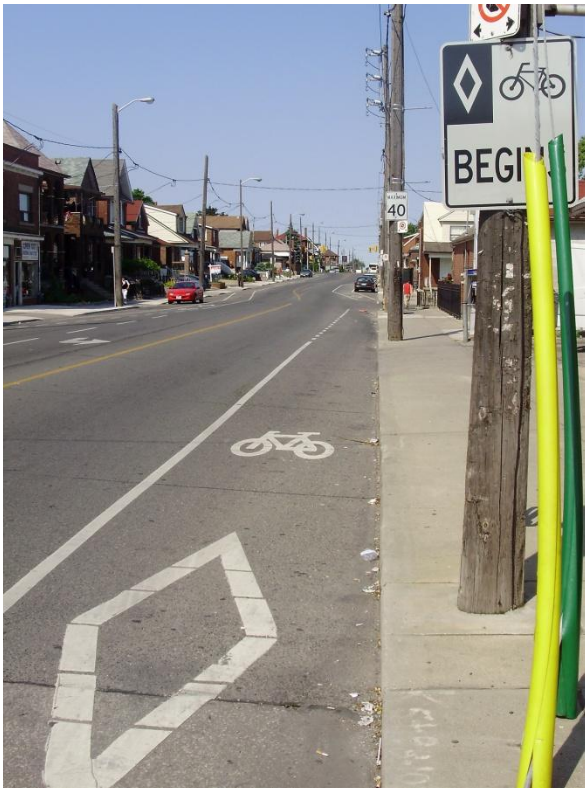
- **Seperated infrastructure:** Paths where cycling traffic is completely separated from motorized traffic. This implies a physical obstacle that cars cannot cross easily or at least without noticing it.

Mixed Traffic

Solutions of this type do not provide a physical separation for cyclists from vehicular traffic. This does not necessarily imply that vehicles and cyclists are mixed, however this type of measures does not create a distinct physical obstacle preventing crossover traffic. Indicative infrastructure are included in the following box:

- On-road bicycle lanes
- Two-way travel on one-way streets
- Shared bus/bike lanes
- Bicycle Boulevards
- Colored lanes
- Shared Lane markings
- Advanced Stop lines

__On road bicycle lanes:__ These are lanes that occupy part of the existing roadway. Usually there is a stripe separating bicycles from other vehicles. The stripes can be solid or with breaks depending on whether other vehicles are allowed or not to enter the bicycle lane.



<u>*Two-way travel on one way streets:*</u> In this case bicycles can travel in the opposite direction in one-way streets. These are also known as "contra-flow" lanes. Bicycles can travel in both directions on the one-way street. A variant of this approach are roads that are two-way streets and barriers prevent car from entering on one side, while cyclists can enter. In those cases, although two-way travel for vehicles is not prohibited it is severely restricted through the entry barriers.

<u>*Shared bus/bike lanes:*</u> In order to improve traffic flow of buses, many cities have introduced bus lanes in their downtown areas, where traffic is dense and problematic. Bus lanes are a

part of roadways just for public transportation vehicles to access. The existence of such a network can be combined with cycling traffic. In this case, bicycles can be allowed to travel on bus lanes. This is a measure that has relatively low cost (given that existent network of bus lanes) and can facilitate bike usage. However cyclists still face the danger of accident, although diminished compared to travelling in regular roads.

<u>Bicycle Boulevards:</u> These are signed bicycle routes. They are usually located on low-traffic streets. While motorized traffic is not prohibited on bicycle boulevards, it is severely discouraged through traffic-calming features, such as speed bumps and traffic circles. This creates negative incentives to automobile drivers, and reduces the traffic, making cycling traffic safer and more enjoyable.

<u>Colored Lanes:</u> This is a type of bicycle lanes mentioned earlier. Colors are used to make cycling lanes more visible. A common approach in this case is to use intense colors although this is not the only option.

<u>Shared Lane Markings:</u> This type of signage is used in lanes where both automobiles and bicycles can travel. There is a variety of reasons why this type of mixed traffic solution can be chosen. One example could be areas where due to physical constraints (e.g. limited space availability) no separated bicycle lane can be constructed. In such cases shared lane markings intend to alert drivers to the possibility of encountering a bicycle. Furthermore it intends to manage cycling traffic in a way that reduces danger.

Advanced Stop Lines: Usually this is a marked “box” where cyclist can wait when traffic lights are red. They are place in front of motor vehicles. This makes cyclists more visible to drivers, while giving them a head start through the intersection when the lights turn green.

Separated Traffic:

This group includes infrastructure where motorized and cycling traffic are completely separated. This is in contrast to the previous group where although both types of traffic could be separated, there was no physical obstacle preventing vehicles from crossing over. Separating traffic modes means no crossing between cycling lane and road or the other way around. Indicative types of such infrastructure are:

- Cycle tracks
- Off-street paths

Cycle tracks: Cycle tracks bear many similarities with cycle lanes. They are adjacent to existing vehicle roadwork and its traffic management arrangements. The difference is that there is a physical separation between motorized traffic and cyclists, instead of a simple stripe. This separation could take the form of a curb. It is also very common that the cycle track is more elevated compared to the rest of the roadwork. Another solution adopted by city planners is to put parking spots between the cycle track and the rest of the traffic. Although in many cases cycle tracks are adjacent to the pavement, pedestrians are usually not permitted to use them.

Off-street paths: These are also tracks that are completely separated from motor vehicle traffic. They are paved and usually pedestrian travel is not allowed on them. The main difference from cycle track is that their design and planning can be independent from motor vehicle roadwork. Furthermore off-street paths usually accommodate both directions of cycling-traffic.

3.1.2. Other infrastructure

The infrastructure examined so far were the various types of lanes/tracks that facilitate the usage of bicycles by citizens. However, those routes are not the only measures that can have an impact on the usage of bicycles, their effectiveness and (as a result) the potential for a shift for citizens from motorized traffic to cycling. There is a class of other infrastructure investment that can affect significantly cycling traffic by increasing ease of use and improving traffic management. Indicative examples of this type of investment are:

- Bicycle phases – Traffic signals
- Way finding signals
- Techniques to shorten cyclists' routes

__Bicycle phases – Traffic Signals:__ Investing in traffic signals dedicated to cyclists can be an important facilitator of bicycle usage. They can manage and coordinate traffic (motorized and non-motorized) and increase safety. Investment in traffic lights can also allow for the introduction of bicycle phases in traffic management. These phases can improve the flow of traffic, by giving cyclists time to cross an intersection and/or prioritizing cycling traffic over to motor vehicles.

__Way finding signage:__ Using signs it is possible to manage cycling traffic and improve both its flow and safety. Furthermore it can help cyclists by giving them directions for prominent destinations (taking into account the availability and quality of other cycling infrastructure) as well as distance information and approximate time estimations. All this infrastructure can facilitate the uptake of cycling, by providing current and prospective cyclists with necessary and relevant information.

Techniques to shorten cyclists' routes: This category includes traffic arrangements that facilitate cycling traffic especially in intersections and involves the construction of cut-throughs that provide cyclists with more direct ways than motor vehicles. On intersections where certain bicycle movements do not interfere with car movements it is possible to create a bicycle by-pass. A good example is right-turn shortcuts that allow cyclists to turn before they reach an intersection. This increases cycling speed, and reduces accidents. Another example is a free pass for straight going cyclists on T-intersections; this movement does not interfere with any car movement and therefore it is not necessary to let these cyclists wait for the green light.

3.1.3. Other measures facilitating cycling traffic

Finally one cannot forget the various policies regarding traffic management that can also have a large effect on the uptake of cycling. These policies include

- Traffic calming
- Home zones (Traffic Calming in residential zones)
- Car-free zones (Both permanent or temporary restrictions and bans to motor vehicle traffic)
- Complete Streets (Streets were all types of traffic are allowed, after having implemented the appropriate precautions)

From the above discussion it can be understood that the last type of policies are more a subject to traffic regulations and city planning rather than infrastructure investment. They have been included here because they have a (small) infrastructure investment aspect, since each of these policies requires some sort of investment (for example signage).

A UK study carried out by the Transport Research Laboratory (2011) gives a wide overview of possible traffic management measures that better facilitate cyclists. The study investigated 48 measures on their effectiveness of improving junctions in favor of the bicyclist. Some examples are colored cycle lanes on intersections, priority for cyclists (during bad weather) at traffic light intersections or so called 'green waves' for cyclists and two green periods per cycle for cyclists at traffic light intersections.[12]

3.2. End-of-trip facilities

The existence of the necessary lanes and routes examined in the previous sections is of significant importance when individuals consider using a bicycle for their trips (both work related commuting as well as leisure). They are not however the only factor. Of similar

[12] For more measures and the ranking of effectiveness see Transport Research Laboratory (2011), Traffic Management Techniques for Cyclists: Final Report.

importance are the so-called “end-of-trip facilities”. These are infrastructure that cyclists can use when they have reached their destination.

3.2.1 Bicycle parking

The most important of this type of investment are bike-parking infrastructure, where cyclists can leave their bicycles. The main differentiating characteristic among various types of bike-parking infrastructure is the level of security they provide for the owner of a bike. In this vein a categorization of bicycle storage that can be made is the following:

- Unsheltered
- Sheltered
- Guarded
- Bike lockers
- Bicycle Stations

The above categorization has been sorted from the least safe to the safest solutions. Safety here is considered not only in terms of reducing the possibility of theft and/or vandalism, but also taking into account the protection from weather conditions. Obviously the most common but least safe solution are unsheltered parking facilities. They offer limited protection from theft and bicycles are exposed both to weather conditions and vandalism. An improvement to this are sheltered parking infrastructure that protect bicycles from weather phenomena. A significant difference in terms of safety is achieved with guarded parking infrastructure and bike lockers. The first are sheltered/unsheltered infrastructure where attendants protect bicycles, while the latter are places where the bicycles are stored inside a locker. Both solutions reduce the dangers of the theft and vandalism, and offer a variable protection from weather conditions.

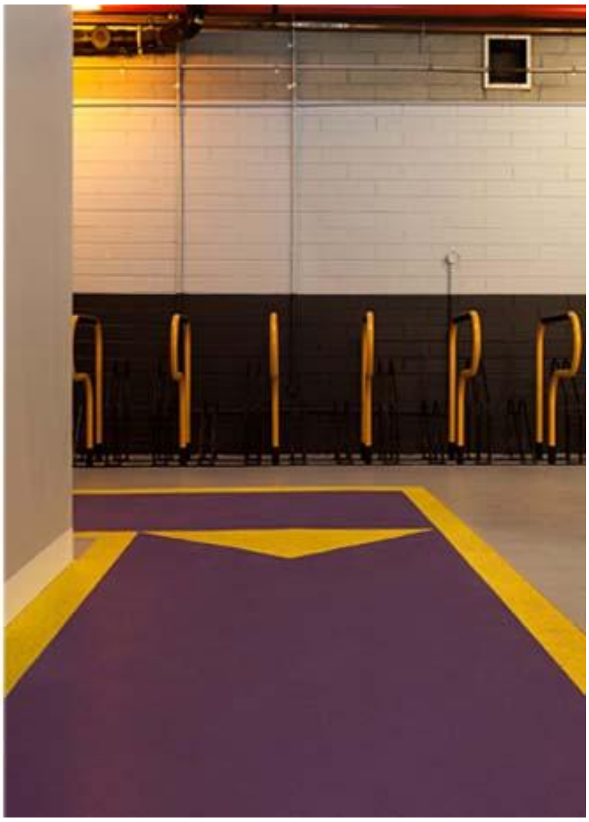
Bicycle stations are full-service facilities that can offer secured, sheltered bike parking in addition to bicycle rentals, bicycle repairs, showers, accessories, bicycle washes etc. To some degree these are services also related to and provided by "end-of-trip" facilities; the latter will be explored below. Bicycle stations are a form of infrastructure that is generally expected to be a result of private initiative. However there are no limitations against public involvement.

3.2.2 Other end-of-trip facilities

Although bike parking is very important and can be a significant factor affecting the uptake of the bicycle, the existence of additional and more complex facilities can also be important. Cycling necessitates the usage of certain equipment (apart from the bicycle); for example cyclists have to use helmets for protection from accidents. Additionally cycling requires significant physical effort, which raises issues related to personal hygiene after using the bicycle. This is not a major problem for leisure activities; however it can be an important factor when the bicycle is used as a method for commuting to and from the workplace. In this vein, amenities related cycling could be provided to employees. Such amenities could be showers and lockers in the workplace, possibly in combination with parking infrastructure[13]. In this case employees would not be disinclined from using the bicycle to

[13] Bicycle stations and "end-of-trip" facilities provide very similar services and amenities to cyclists. A distinction that can be made is that "end-of-trip" facilities are usually provided by employers for their staff

commute, as they would be able to shower, use fresh clothes in their workplace and store all additional equipment in lockers.



Amenities of this type are mostly a subject for private investment. However, governments can provide employers with incentives to invest in these facilities. In the Netherlands for instance, it was possible for small and medium sized enterprises (SME's) to get a subsidy for mobility advice by a specialized mobility advisor.[14] Public policies like this can create awareness on the benefits of employees cycling to work and make employers invest in end-of-trip facilities in the end. Providing inside in these benefits – being productivity gains, better quality of work, less sick days – could also be of great impact on employers' investment in cycling facilities. Besides that, public investment for such amenities in public

(free of charge or for a fee), whereas bicycle stations are independent businesses and provide services to customers for a fee.

[14] The "SME Mobility voucher project" gave SME's a voucher which they could exchange for mobility advice. Decisio gave a lot of advices to SME's and collected data on the mobility management from these companies. Some figures from this data are presented in the report on private investment.

buildings might affect the altitude of public sector employees towards using the bicycle and "giving the right example" could stimulate private companies to invest as well.

3.2.3 Bike-sharing systems

A different type of infrastructure investment is Bike-sharing systems. They consist of a network of stations placed at various points in a city. At these stations citizens can rent a bicycle and use it to cycle to a next station in the network. The big advantage is that consumers can pick-up the bicycle from one station and drop it off at another. This facilitates one-way trips and increases the attractiveness of such systems. Bike-sharing systems are comparable to regular public transport systems with the difference of driving yourself inducing all additional benefits like an increased health and more certainty of arriving on time.

Bike-sharing systems are often initiated by municipalities but most times partly financed by a private company. The public authority in this case "uses" the commercial interest of a company in some way; by allowing the company to advertise in public space (on the bikes and the bike-stations) they are able to demand for an investment in the bikes and the infrastructure for the Bike-sharing system.

3.3. Integration of cycling with public transportation

Parking infrastructure, end-of-trip facilities and bike-sharing systems, such as those described so far, can play a key role in achieving a shift towards cycling. Their role can be further enhanced through other intervention in urban policy planning. This includes policies that integrate cycling with various forms of public transportation. Policies pursuing such integration will have an accelerating effect on the uptake of the bicycle. These policies can be through investment in parking close to public transportation hubs (such as railway and metro stations), or can be related to creating opportunities for cyclists to take their bicycle with them whenever using public transportation. To this end many cities have used parking infrastructure extensively; as a result they have built an extensive network of parking spots for bicycles close to metro and railway stations as well as central bus hubs[15]. The number of installed parking spots depends on the estimated cycling traffic and resulting parking demand.

Bicycle parking at Amsterdam Central train station

[15] It is also common to put Bike-Sharing systems in proximity to those hubs.

Additionally some cities have introduced measures and infrastructure that allow cyclists to take their bicycle with them whenever they use public transportations. An indicative example for infrastructure of this type is a special bicycle wagon which is part of a train or a tram[16]. Similarly many urban or regional buses offer bike racks, where passengers can load their bicycle for the duration of the trip[17]. Another option is to reserve some space *within* buses, metros, trams or trains to store a bicycle.

These facilities that somehow improve the "transit synergy" between one mode (bicycle) and another (public transport) is particular important when encouraging cycling. The bicycle is useful for short trips up to about 15 kilometers. When people live further away from their workplace the bicycle alone would not be an obvious choice as commuter mode. However, a combination of public transport an bicycle can be a very comfortable alternative for the car – especially when the destination is somewhere in the city where congestion is high and parking space for cars are scarce and expensive.

Academic studies[18] point out that the bicycle as transport mode is often a substitute for public transport on short trips, but public transport and cycling are complementary on longer trips. These studies strongly recommend policies for transit synergies between cycling and public transport because these can have a very positive impact on cycling rates. Besides that, cycling is a much cheaper solution to 'feed' the public transport system. A meshed public transport system with buses or trams in all neighborhoods of a city is a very

[16] http://cyclingresourcecentre.org.au/post/204/public_transport_integration/zahnradbahn_bicycle_wagon
[17] http://www.postbus.ch/pag-startseite/pag-kundenservice/pag-velotransport.htm
[18] Singleton, P.A. & J.C. Kelly (2013), Exploring Synergy in Bicycle and Transit Use: Empirical Evidence at Two Scales. ; Witte, A. (2009), The Role of Bike Centres in the Urban Transportation Environment.

expensive way of bringing people to a train station or on to a metro network compared to cycling. We will explore the costs of infrastructure for different modes in the next section. A broader view on costs per mode is given in section 4 – where a wider view on societal costs and benefits is presented.

4. Economic Impact Analysis

In the previous section we have provided an indicative list of cycling infrastructure that can be the target of public investment. It becomes apparent from that list that there is a variety of alternative routes that can be followed by each public administration to improve cycling infrastructure, each with a different price tag. The selected solutions will be a reflection of their policy objectives and priorities in conjunction with the limitations set by financial, political and public preference constraints. In order to do that each public administration wants to consider all expected costs and benefits associated to an investment, taking into account all other pertinent factors.

Performing a Cost Benefit Analysis (CBA) provides public administrations with such an overview. In this section we introduce the CBA methodology and give an overview of costs and benefits cycling investment can cause. Furthermore this section will examine other factors that also affect the assessment and decision making process, which function as drivers or inhibitors of investment in cycling friendly infrastructure.

4.1 Costs of cycling infrastructure

Infrastructure costs consist of the construction costs of a cycle lane or other peace of infrastructure (4.2.1) but also contains the maintenance costs (4.2.2) and operational costs (4.2.3). These different types are discussed in this section. Besides these 'hard' infrastructure costs public organizations can also invest in cycling in another, more 'soft' way; these kind of investment are discussed as promotion and training costs (4.2.4).

4.1.1 Infrastructure costs

These are the costs associated with the initial construction of an infrastructure and are expenses that occur only once. They can range from relatively low (e.g. the installation of signs and traffic management equipment) to intermediate (e.g. construction of bike lanes on the existing road network) to high (e.g. construction of bicycle tracks and off-road paths). All these costs are highly dependent on the cost for resources, the labor wages and other organizational/implementation overheads. Usually costs are proportional to investment complexity and scale[19].

However costs for cycling infrastructure differ largely between countries we want to give some insight in the costs of the cycling infrastructure introduced in section 3.1. We will give the costs for some types of cycling infrastructure for Belgium (3.4.1), the U.S. (3.4.2) and the U.K. (3.4.3). Finally, we evaluate the differences between these numbers from three different countries (3.4.4). The presented costs in this section are just an indication of the costs of cycling infrastructure. In the end, costs will be very much case specific.

Infrastructure costs in Belgium

For Belgium we found an overview of cycling infrastructure costs made up by the cycling association (*Fietsersbond*).[20] The costs were derived from numerous tenders for the construction of cycling infrastructure in Belgium in 2009. We translated those prices to 2014-price values. The costs are given for separated bicycle lanes and on-road bicycle lanes in a per meter-price for lanes of 1,5 meter wide.

[19] See also Section **Napaka! Vira sklicevanja ni bilo mogoče najti.** for some comparative data on infrastructure costs

[20] http://www.fietsersbond.be/sites/default/files/Finalekostenfietspadcontrole2.pdf

Table 4.1 Costs of bicycle lanes in Belgium in 2014.

	Seperated bicycle lane	On-road bicycle lane
Asphalt	€ 55,52	€ 49,18
Red asphalt	€ 66,71	€ 60,37
Concrete	€ 54,32	€ 54,32
Red Concrete	€ 63,84	€ 63,84
Concrete (better foundation)	€ 64,14	€ 64,14
Red Concrete (better foundation)	€ 73,65	€ 73,65
Bricks	€ 71,79	€ 65,44
Red bricks	€ 77,94	€ 71,60

Infrastructure costs in the U.S.

In the United States an extensive database on costs of cycling infrastructure was built by the Active Living Research organization.[21] This database consists of costs of a variety of pedestrian and cycling infrastructure ranging from bicycle parking facilities (lockers, racks etc.) to bicycle lanes and different kind of infrastructure at junctions. The table below gives an overview of the average costs of some types of infrastructure.

Table 4.2 Costs of different types of infrastructure in the U.S. in 2013.

Type	Dollars	Euros	Unit
Bicycle lane	$65,53	€ 51,93	per meter (1,5 meter wide)
Pavement marking	$9,58	€ 7,59	per meter
Traffic light	$5.611,40	€ 4.447,30	each
Bike route signage	$160,82	€ 127,46	each

The database contains costs of much more types of infrastructure. However, these are much more diverse in terms of units measured and therefore less useful in this case.

Infrastructure costs in the U.K.

The UK figures are derived from the London Cycling Design Standards 2005 costs.[22] Amounts are translated to 2014 Euro prices in order to compare them with the costs in other countries. As we can see in the table below the combined bicycle-bus lane seems to be much cheaper than the other bicycle lanes. With this type of infrastructure the consisting infrastructure (bus lane) only has to be adjusted where the other types are newly constructed.

[21] http://activelivingresearch.org/costs-pedestrian-and-bicyclist-infrastructure-improvements-resource-researchers-engineers-planners

[22] http://www.sustrans.org.uk/sites/default/files/images/files/migrated-pdfs/17%20costs%5B1%5D.pdf

Table 4.3 Costs of different types of infrastructure in the U.K. in 2014.

Costs per meter	UK Pounds	Euros
Bicycle lane with major junctions[23]	£746,75	€ 950,82
Bicycle lane with simple junctions	£271,52	€ 345,72
Bicycle lane on bus lane	£40,74	€ 51,88
Traffic calmed / managed area	£271,52	€ 345,72
White line	£2,91	€ 3,71
Raised white line	£13,39	€ 17,05
Cycle logo (each)	£30,56	€ 38,91

Comparing national figures

As we can see from the costs for cycling infrastructure in Belgium, the U.S. and the U.K. these costs can vary very much between countries. It is also important to notice that costs can be given on different levels – being total costs for the construction of a bicycle lane including working hours, planning and so on (as in the British figures), or being just the cost price of the material (as in the Belgian and American figures).

When performing Cost Benefit Analysis - as we will introduce in the next section – it is therefore important to trace the real costs of a certain project or to make an educated guess based on accurate local figures.

Comparing costs of different modes

If one were to compare the costs of constructing cycling infrastructure, she would encounter some very interesting facts. Take for example the area of Queensland (Australia). The construction of cycling infrastructure - even if built to the highest standard - is relatively inexpensive compared to other transport infrastructure. Thus choosing infrastructure that increase cycling can have a positive effect on the resources that have to be spent for developing other transportation infrastructure. Assuming an average cost of $1.5 million per

[23] Notice that the junctions have a major impact on the costs of the bicycle lane. The costs per meter are more than ten times higher than the Dutch and American figures.

km to plan and construct a separated bicycle path, it is possible to make the following comparisons[24]:

- 1km of Rail costs the equivalent of 29 kms of bikeway
- 1km of Motorway/Road costs the equivalent of 110 kms of bikeway
- 1km of Busway costs the equivalent of 138 kms of bikeway
- 1km of Road Tunnel costs the equivalent of 324 kms of bikeway
- 1km of Underground Rail costs the equivalent of 533 kms of bikeway

4.1.2 Infrastructure Maintenance Costs

After constructing any infrastructure and releasing it for public usage, the continuous and gradual degradation of its properties begins. This degradation can be a result of the usage, it can also be the result of other environmental factors. For example after having constructed a bike track, its erosion begins. This erosion is partially a result of bicycles travelling on the track and partially a result of its exposure to physical elements. It is obvious that erosion is proportional to the bicycle traffic and is accelerated if exposed to severe weather conditions (therefore maintenance costs are very much country specific). In order to ensure that all physical and qualitative properties of an infrastructure maintain an acceptable level, it is necessary to periodically repair the damages and possibly undertake preventive repairs that will slow down degradation and prolong its usability. These periodic costs are the maintenance costs. Their height depends also on the initial value/complexity/extent of the infrastructure and pose a long term commitment of resources from the authority making an investment. If these costs are not available we use a percentage of the investment costs to estimate the maintenance cost in Cost Benefit Analyses.

4.1.3 Operational costs

Some types of investment do not only have maintenance costs, but also have operational costs. These are not related to the physical degradation of the investment, but are related to its normal operations. A good example would be the salaries of personnel operating bike-sharing system, the energy consumption of lights install above an off-road bike path and the energy consumption of traffic lights for cyclists.

[24] *Cycling Resource Centre: Comparative Infrastructure Costs (Australia)*

Operational costs for traffic lights, street lights and the like are marginal compared to initial infrastructure investment and maintenance costs. In a Cost Benefit Analysis a percentage of the investment costs or the maintenance costs will be an adequate guess for this when real figures are not available.

To give an idea of the operational costs of a bike sharing system we use the example of the Philadelphia bike-sharing system that has started its first phase of implementing in the summer of 2014. The city of Philadelphia made a business plan for the system (see table 4.4)[25]. The system is planned to count 1800 bicycles in the summer of 2017, with a total investment of $11.102.00 between 2014 and 2018.

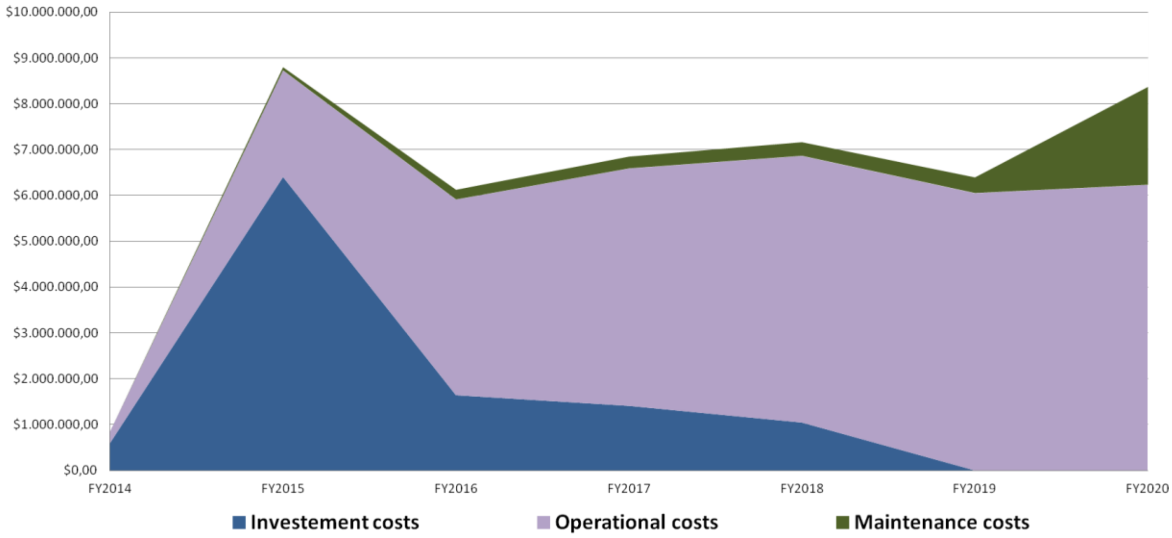
Table 4.4 Operating costs of the Philadelphia Bike-sharing system in Fiscal Year 2014 – 2020.

	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020
Operations	$0	$1.869.000	$3.868.000	$4.764.000	$5.389.000	$5.609.000	$5.777.000
Administration	$150.000	$242.000	$180.000	$186.000	$191.000	$197.000	$203.000
Marketing	$100.000	$206.000	$212.000	$219.000	$225.000	$232.000	$239.000
Utility fees	$0	$5.000	$11.000	$13.000	$15.000	$15.000	$15.000
Total	$250.000	$2.322.000	$4.271.000	$5.182.000	$5.820.000	$6.053.000	$6.234.000

The largest share of operational costs is formed by the system; it includes functions such as maintenance of all equipment, rebalancing of bicycles, customer service operations and website and IT support. The operational costs grow in every period since the city has planned to implement the system in five different phases – within every phase the system is enlarged by a number of bikes (and stations).

[25] The Pennsylvania Environmental Council (2013), Philadelphia Bike Share Strategic Business Plan.

Figure 4.1 Investment costs, operating costs and maintenance costs of the Philadelphia Bike-sharing system in Fiscal Years 2014 – 2020.

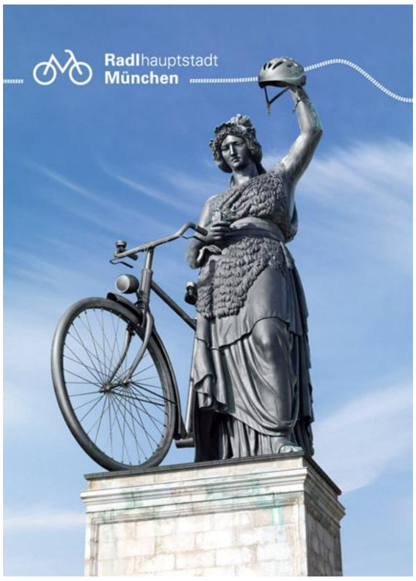


From figure 4.1 we see that operational costs are a substantial part of the investment in the Philadelphia Bike-sharing system. Most of the investment is done in Fiscal Year 2015 where most of the infrastructure such as rental stations are build. The operational costs getting higher every year because the number of bikes grows every year. However, this growth is stabilizing after Fiscal Year 2018 when the maximum number of bicycles (1800) is reached.

4.1.4 Promotion / Training Costs

A different type of cost is related to the resources spent in order to ensure that the efficiency and effectiveness of an infrastructure is maximized. A good example would be the resources spent in order to increase public awareness and mitigate common misperceptions. In order to achieve that a promotion campaign is necessary, the extent of which depends on the priorities and the objective of the public authority in charge. A different cost which is peripheral to an infrastructure investment and has to be taken into account regards the training of personnel; a good example are bike-sharing systems, where there is staff required to operate them, which needs to have the appropriate training. Similarly in many cases, it is the public that has to be trained in order to be able to use the infrastructure with safety and efficiency (e.g. training seminars related to traffic regulations).

The costs of this kind of campaigns of course vary widely from campaign to campaign. The starting situation in terms of cycling numbers and infrastructure are of great influence on these costs. An example of a promotion campaign to increase cycling numbers is the *Radl hauptstadt Munchen* (bicycle capital Munich) campaign.[26] It was a diverse campaign in the German city of Munich with all kinds of promotion material, advertisements and contests. The costs were **€0,70 per inhabitant** and according to the city the cost-value ratio was good. However, they also acknowledge that 'soft' measures cannot replace 'hard' investment in cycling infrastructure, but it can enhance the impact of infrastructure investment. Some form of activation of citizens along infrastructure investment might even be necessary to make it successful.



[26] Fietsberaad (2011); http://www.fietsberaad.nl/library/repository/bestanden/Wigand.pdf

4.2 Benefits

4.2.1 Accessibility

A major aspect of externalities related to the deployment of a network of cycling infrastructure is related to the transportation needs of urban populations. As discussed in the introduction, current urban agglomerations are increasing in every possible index; this includes population size, geographic extent, population density etc. This results in an ever-increasing number of automobiles using the existing road infrastructure. This approach is not sustainable in the long term. Especially in already developed cities, the capacity of the road network is used to the maximum and there is not an option for further expansion, at least not in the commercial city centre (the destination of the majority of commuters). As discussed earlier, efforts so far have been directed towards public transportation, however this has a limit regarding their maximum capacity too.

The adoption of cycling can have significant impact in mitigating a variety of the costs associated both with the usage of public and private transportation methods. Indicatively it is worth considering the following aspects where cycling can play an important role in saving time and money[27]:

- Time Costs:
  - **In London 20% of commuters spend more than two hours a day travelling** to and from work, which adds up to one working day a week. In **Germany, 37% spend one hour per day** commuting.

[27] *Roadmap to a Single European Transport Area, Facts and figures*

    - In London, Cologne, Amsterdam and Brussels, car drivers spend more than **50 hours a year in road traffic jams**. In Utrecht, Manchester and Paris, they spend more than **70 hours stuck on roads**.
- Congestion
    - **Congestion costs Europe about 1% of Gross Domestic Product** (GDP) every year
- Vehicle Operating Costs
    - **13.2% of every household's budget is spent on average on transport** goods and services.
- Transit synergies
    - **Cycling should be treated as a complement to public transportation rather than a competitor**. To this end measures that facilitate the integration of both methods of transportation can have an important role. A successful policy in this case would have significant impact on the effectiveness and efficiency of both methods of transportation. Short trips would become faster, while the ability to use public transportation would allow for the bicycle to be used for more distant destinations, thus increasing its flexibility. This complementarity would elevate the profile of both transportation methods and make them more attractive to a larger part of the population, especially the youngest segments.

4.2.2 Health

In earlier sections it was mentioned that modern societies are becoming increasingly urbanized. This means that a significant portion of the population lives in urban agglomerations. This is a side effect of the fact that technological advances are gradually transforming production processes. The production of commodities is becoming increasingly automated. This is also visible through the shift in economic activity from the primary (agricultural) and secondary (manufacturing) sector to the service sector; in most advanced economies a significant portion of GDP is generated by the service sector. This shift implies that work related physical activity is reduced.

At the same time economic growth and technological advances have increase per capita income and decreased the cost of manufactured goods, among them automobiles. Currently in advanced economies the majority of households have access to at least one private vehicle; this results in automobiles being used in every aspect of everyday life (commuting,

leisure etc), further reducing physical activity. Households that do not own a private vehicle (either by choice or due to insufficient income) have easy access to the extensive networks of public transportation in cities.

It becomes apparent that in modern societies, physical exercise to a great degree has been reduced, both in the work place and in the free time. Both forces in conjunction with the increased wealth and the resulting access to relatively cheap (but unhealthy) food, have resulted in an increasing portion of the population suffering illnesses related to a sedentary lifestyle such as diabetes, obesity and cardiovascular diseases. In recent years these issues are becoming increasingly popular in public debate. The arguments raised relate to their negative implications both at personal and societal level. The aforementioned potential health problems can lead to a significant deterioration of quality of life and a reduction in life expectancy. Furthermore they increase the health costs for the public (and private) health systems, putting a strain on their sustainability[28].

Cycling can be part of the solution to these problems. Frequent use of the bicycle for commuting as well as leisure activities is a very good way to have regular physical activity. This reduces symptoms of a sedentary lifestyle, increases fitness and improves overall health. Therefore it is not a surprise that various stakeholders are recommending the adoption of cycling for everyday activities. Such an adoption can be significantly facilitated

[28] If one were to take also into account the changing demographics and the gradual increase in the average age of the population and the prolonged life expectancy, these problems are even intensified.

by public investment in cycling infrastructure. **The gains for society come in form of reduced healthcare costs**, which can mitigate most of the investment costs if a significant modal shift is achieved[29].

The approach in this section so far was to review the health benefits from physical activity for the population segment that adopts cycling. However this is not the only channel of positive externalities on health issues. A modal shift in favor of cycling can be beneficial to the rest of the population as well. Increased usage of bicycle will be resulting in decrease usage of other motorized transportation methods. This is particularly important if cycling kilometers are substituting car kilometers. The reduction of vehicular kilometers traveled poses a **significant improvement in the air quality of the urban environment**, since emissions are reduced. This is a positive externality for the entire society[30], since a variety of health problems in modern cities are related to the bad air quality. These benefits are very important both for individual quality of life as well as the economic performance and sustainability of public health systems.

Finally another aspect contributing to the positive health related externalities is the **reduction in noise pollution**. High levels of traffic in general and congestion in particular elevate the noise levels in an urban environment. This can result in hearing loss, cognitive impairment in children, sleep disturbance or annoyance and can contribute to cardiovascular diseases. This can significantly reduce quality of life, and can result in a variety of physical and mental illnesses, increasing social costs. Adoption of cycling and the resulting reduction in traffic can have a positive impact on those aspects.

The Health Economic Assessment Tool (HEAT) for cycling[31] is an online tool designed by the World Health Organization. It aims at providing quantitative information regarding the

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[29] Quantitative data for these effects are provided in Section 4.3

[30] This remains true even if we take into account the possible health effects to cyclists from their exposure to the exhaust fumes because of their travelling among or in close proximity to motor vehicles. Studies have shown that these adverse effects are relatively minor and easily overcompensated by the positive effects from increased physical activity and overall quality of air improvements.

[31] World Health Organization: Health Economic Assessment Tool for Cycling, http://www.heatwalkingcycling.org/

health benefits of active transportation (cycling and walking). The HEAT tool is a result of two research projects coordinated by the World Health Organization (WHO) aiming at developing guidance and practical tools for economic assessments of the health effects from cycling and walking. It is a free on-line tool which allows economic assessment of the health benefits of cycling and or walking by estimating the value of reduced mortality that results from specified amounts of cycling or walking. The tool has just been adjusted to 2014 key figures on mortality, traffic accidents and values of statistical lives (VSL). HEAT for cycling estimates the maximum and mean annual benefits, in terms of reduced mortality as a result of cycling, by answering the following question: "*If X people cycle a distance of Y kilometers on most days, what is the economic value of the health benefits that occur as a result of the reduction in mortality due to their physical activity?*"

HEAT can be used to evaluate the reduced mortality from present and future levels of cycling, at the city, regional or national level. It is designed for assessments on a population level (i.e. among groups of people, not individuals), for habitual behavior (such as cycling for commuting, or regular leisure time activities, not for one-day events), and for adult populations (aged approximately 20-64 years), in a number of different situations. Furthermore it is worth pointing out that the model used by HEAT is based on studies on the benefits of physical activity that have been conducted in the general population, where very high average levels of physical activity are uncommon. Thus, the exact shape of the dose-response curve is uncertain for groups that on average have relatively high levels of systematic physical activity; in such a case the tool may not be suited for assessment on the benefits of cycling since these populations already have activity levels beyond the common in an average adult population.

Finally the tool is a reflection of scientific knowledge on the health effects of cycling at a given time. The model used for all calculation reflects the consensus on a harmonized methodology. It is a result of expert judgements made by the advisory group based on the best available information and evidence. Therefore, the accuracy of results of the HEAT calculations should be understood as estimates of the order of magnitude, much like many other economic assessments of health effects.

4.2.3 Safety

The construction of an extensive network of cycling infrastructure can have a significant impact on the actual and perceived safety of cyclists. Of particular importance in this area is investment that separate cycling traffic from vehicular traffic; such a separation can contribute significantly to a reduction in accidents. Statistics from the UK[32] show that every year around 19,000 cyclists are killed or injured in reported road accidents, including around 3,000 who are seriously injured. It is likely that these figures understate the actual accident toll, since minor accidents often are not reported to the police and are not treated in hospitals. This would imply that the actual number of cyclists injured (severely or slightly) is probably larger.

These statistics outline a significant societal cost related to cycling. Accidents result in economic cost directly, through the expenses necessary for treating accident injuries. It also creates a negative externality through the cost of lost production and income due to the inability to work. The construction of high quality infrastructure and the adoption of necessary traffic management policies can reduce accidents. This would have a dual positive effect.

- A reduction in accidents **reduces also the accident related costs to society.**
- Most importantly **the reduction of accidents will improve the attitude towards cycling.** People that were discouraged by the increased danger of using a bicycle

[32] *The Royal Society for the Prevention of Accidents: Facts and Figures*

would be more probable to use it for commuting purposes. This trend would be accompanied with all other positive externalities related to cycling adoption that are mentioned here.

A final aspect that has to be mentioned is the fact that increased cycling usage can by itself result in improvements in safety for cyclists. Increased presence of cyclists on roads makes drivers more accustomed to them and can result in the modification of their driving behaviour. Being aware that cyclists also occupy the road makes them more careful and alert regarding to them and thereby improves safety for cyclists[33].

4.2.4 Cycling Tourism

The creation of a cycling network can also have a positive impact on economic activity resulting in economic growth. Cycling Tourism is a good example. The existence of appropriate cycling routes can be attractive to a specialized and growing segment of tourism activity. This can have a positive effect on the urban environment. Tourists would be able to use bicycles for moving between touristic attractions. However, more importantly cycling infrastructure could increase tourism and result in economic growth in areas that are not traditional touristic destinations. Cycle routes in rural areas and/or small communities would make them attractive to cyclists and would increase direct spending in local economies. This would support local businesses, maintain and create new jobs and increase local income.

It is estimated that there are over 2.2 billion cycle tourism trips and 20 million over-night cycle trips made every year in Europe. These have an estimated economic impact of €44 billion[34]. See also Section 4.3.1 for further details.

The benefits of cycling tourism must be dealt with carefully in a CBA. The main question to be asked is what would the new tourists do in a situation *without* the cycling investment. If tourists would go and cycle somewhere else in the same region, the effect is only a *shift* in the spending, not an *increase.*

[33] TemaNord (2005) and Jacobsen (2003) develop the argument and provide evidence that cities with increased bicycle usage feature lower injuries and fatalities per km travelled.
[34] http://www.ecf.com/advocary/cycling-tourism/

4.2.5 Sports and Leisure

Cycling infrastructure would increase cycling as a sport and leisure activity. The organization of events could become an attraction to a large number of cyclists. The economic benefits to the local economy would be very important, in a way similar to the one propose for cycling tourism. Again, these benefits could be a *shift* from economic benefits from another place in the same region or country to the project area; therefore these benefits must be dealt with carefully in a CBA. Furthermore systematic usage of the bicycle for leisure and sports would provide a steady clientele to businesses of the local economy. For instance in France there is an extensive market for leisure rentals of bicycles comprised of more than 1,000 hire firms and having an annual turnover of more than €25 million. Rentals cover a number of very different segments including holiday rentals on coasts and cities and rentals of highly sophisticated mountain bikes in the mountains[35].

4.2.6 Cycling Industry

Previous sections explored the impact of cycling on local economies through tourism, leisure and sports. This impact can be invigorating to local businesses of many kinds. Beneficiaries can be hotels, restaurants, coffee shops and in general any enterprises providing services to cyclists. However this is not the only way the increased adoption of cycling can increase economic activity and income generation.

Economic activity can increase through businesses offering specialized services to cyclists. This includes retail shops, and bicycle service stations. A good example would be also bicycle stations mentioned earlier offering end-of-trip services and amenities to daily commuters. Furthermore in proximity to large urban centers with significant number of active cyclists businesses could appear that provide higher added-value services and commodities. This could provide an important boost to local economy and increase employment[36]. Furthermore these businesses could expand operations and become a hub for manufacturing, wholesale/distribution, retail and services related to bicycling. In such a case they would become a significant factor in local economic activity, contribute to the increase

[35] Grand Angle (2009)

[36] Quantitative data are available in Section 0

of local GDP and help maintain and increase employment. Again, these benefits must be researched with care. The benefits do only count in a CBA if they come from new cyclists. When a new bicycle lane ensures higher sales for a local business along this lane, while another business a few blocks away sees its sales decreasing due to a shift of bicycle traffic – the *benfit to society as a whole* is zero. Therefore the geographical scale of measuring costs and benefits in a CBA is of major importance. A project could have benefits on the local level which are actually shifted benefits from another area. On a higher geographical scale the outcomes of the CBA would be very different in such case.

Bicycle manufacturers obviously benefit from public investment in cycling as well. When more people start cycling on a more regular basis they will need a bicycle to start a and once in a while they would need a new one. People will replace there bike sooner if the cycle more. Therefore, increased cycling numbers means a bigger market for bicycle manufacturers. However the total bicycle sales has not grown substantially between 2000 and 2012 – the bicycle market represents a substantial economic value: almost 20 million bicycles are sold in the EU-27 every year with an average value of €250. The total market for bicycles comes to a little over €5 billion.[37]

[37] Colibi (2012), European Bicycle Market.
http://www.colibi.com/docs/issuu/European%20Bicycle%20Market%20&%20Industry%20Profile%20-%20Edition%202013.pdf

4.3 Cost – Benefit Analysis

Assessing any investment proposal involves the attempt to estimate the costs and benefits associated with it; this is a complex task, where multiple factors have to be taken into account. Furthermore it is possible that not all costs and benefits can be predicted exactly, and thus this assessment has to rely on estimates based mainly on scientific methods.

A systematic process for calculating and comparing gains (benefits) and costs of projects, decisions and policies is the Cost-Benefit Analysis (CBA), which is used world-wide and is the official assessment tool for investment financed by EU funds. A CBA is used:

- to determine if it is a sound investment (justification / feasibility);
- to see how it compares with alternative projects (ranking / priority assignment).
- to compare different solutions/alternatives to solve a problem;
- to optimize investment plans (make them more cost effective);
- to show in what extent different parties profit from the benefits.

Since there is a long history of evaluation of major transport projects such as motorways and railways, CBA may also be a helpful tool to demonstrate cycling potential. A CBA on cycling should follow the same methodology as regular CBAs. Therefore, here we first give a short introduction on how this method is used for other infrastructure than cycling, such as road infrastructure for cars. The methodology of the CBA for infrastructure has developed more and more towards Social Cost Benefit Analysis, including ‘soft’ factors besides ‘hard’ effects reflected by real behavior and real economic value.

Social Cost Benefit Analyses (SCBA) is used in many western countries as an evaluation tool for infrastructure projects ex ante.[38] Making a SCBA gives insight to policy-makers and the public into the costs and benefits of an infrastructure project or several alternatives. Not only are the simple costs of building a road, bridge or rail track included but also the ‘soft costs’ such as damage to nature, pollution and accidents. On the benefit side a SCBA

[38] Mouter, N., J.A. Annema & B. van Wee (2013), Ranking the substantive problems in the Dutch Cost–Benefit Analysis practice. Transportation Research Part A: Policy and Practice 49, Pp. 241–255.

calculates the gains of a certain infrastructure project to society in terms of welfare. These benefits stem from all kind of aspects such as travel time gains, better accessibility, safer traffic environment and agglomeration effects.

In the academic spheres as well as in public policy the Societal Cost Benefit Analysis can count on some critics as well.[39] Those critics mainly focus on the problems of quantifying 'soft' factors due to an infrastructure project, such as effects on nature. However, translating these soft factors into money makes it possible to involve them into the analysis so that a decision is far better justified. An important methodological issue when performing a CBA is the type of data in terms of revealed or stated preferences. Revealed Preference (RP) shows the real effect of a certain investment or project on consumer behavior. It is the preference of people shown by hard data on their actual behavior. For the many effects we want to include in CBA's it is not easy (or impossible) to get data on revealed preferences. The value of nature or biodiversity in the case of building a road near a forest for instance, cannot be measured out of real consumer behavior. In these cases we can ask people how much they think this piece of nature or biodiversity is worth. This is called Stated Preference (SP).

In summary, a CBA attempts to measure the positive or negative consequences of a project, which may include:

1. Effects on users or participants;
2. Effects on non-users or non-participants;
3. Externality effects;
4. Option value or other social benefits.

Below we give a *road map* for the assessment of a Cost Benefit Analysis on investments in cycling.

[39] Beukers, E., L. Bertolini & M. Te Brömmelstroet (2012), Why Cost Benefit Analysis is perceived as a problematic tool for assessment of transport plans: A process perspective. Transportation Research Part A: Policy and Practice 46:1, pp. 68–78.

Cost Benefit Analysis road map

1. Problem Analysis

Why is investment in cycling necessary? What problem will it solve? It could be that cyclists don't have a safe place on a certain street and therefore suffer from many accidents. Or because of the absence of cycling infrastructure cycling numbers are low and thereby pollution of other transport modes is higher than desirable.

2. Formulating alternatives

Probably there are several solutions to think of. To stay with the example of low cycling numbers caused by the absence of cycling infrastructure, we could think of building such infrastructure. But cycling promotion would be an alternative investing less money. A cost benefit analysis provides the tool to compare such alternatives in terms of societal and economical costs and benefits besides the plain investment costs.

3. Zero alternative (reference)

Here we define the future situation without the intervention. In the end we compare all alternatives from step 2 with this situation. In this way it is possible to tell the relative costs and benefits compared to the same reference situation.

4. Naming effects

In the next phase we make a list of effects we expect to happen as a result of the formulated alternatives. To do so, we look at the long list in section 4.2, where we defined all possible effects of investments in cycling.

5. Scope of effects

Quantitative data or key figures are then used to determine parameters for all affects. For example, the WHO gives an average number for days cycled per year in the HEAT model. Combined with the length of a new designed bike path and expected number of users we can calculate the extra kilometres cycled due to the construction of the path. Many of these parameters may be location specific.

6. Monetised effects

For all the effects, it is possible to calculate the effects in Euros. With parameters on traffic accidents and the value of preventing a deadly victim of an accident for example, we can calculate the societal benefits of building a safer cycling path which means less victims in traffic accidents.

7. Making costs and benefits comparable

In order to make alternatives comparable we transfer all costs and benefits to Net Present Values (NPV). An overview of all NPV's for different alternatives is very useful in the decision making process of weighing different interventions such as constructing a new bike path versus a cycling promotion campaign.

8. Sensitivity analysis

In the last step we 'play' with some parameters to give insight in the effect of specific parts of a measure. You could think of changing the length of bicycle paths to be constructed or the sum of money invested in a promotion campaign.

9. Use as a basis for decision making

In the end, the results of the CBA are to be used as a basis for decision-making. It is important of course to use the results in the most effective way. In many cases this includes the 'buying in' of the decision makers. They must understand the method and analysis and ideally adopt it. In general this means that the decision makers should participate in the analysis, so they really get a good sense of the costs and benefits of the projects.

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4.3.1 Quantification of indicators

Key Figures

In order to be able to perform a cost benefit analysis, it is necessary to quantify the impact from cycling and establish "key figures" for the effects of cycling activities. The result is a monetization of actual effects; these figures are subsequently comparable to the costs related to an investment. A good example for this is a Danish study which developed a methodology and used available data to determine unit prices for cycling.[40] The latter were then used to perform a cost benefit analysis and assess two cycling investment (a bridge and an intersection). In order to calculate the unit prices in this study they took into account the following parameters related to cycling (although not all of them are relevant for unit price calculations):

Effect of cycling	Methodology to quantify effects	Data requirement
Vehicle operating costs	Change in vehicle kilometre by mode, i.e. for different motorized vehicles, public transportation and bicycles.	Traffic counts and/or modelling.
Time Costs	Change in transport time by transport mode	Traffic counts and/or modelling.
Accident Costs	Change in the number of accidents with and without bicycles involved.	Accident registrations, traffic counts and/or modelling.
Pollution and externalities	Change in vehicle kilometres for each mode of transportation.	Traffic counts and/or modelling.
Recreational Value	Change in cycle kilometres and cyclists' statements.	Interviews and traffic counts and/or modelling.
Health Benefits	Change in cycle kilometres (or people cycling/ cycling trips)	Traffic counts and/or modelling.
Safety	Change in the number of accidents, cyclist statements and change in cycle kilometres.	Accident registrations, interviews and traffic counts and/or modelling
Discomfort	Change in cycle kilometres.	Traffic counts and/or modelling.
Branding Value	Qualitative effect	-
Value for urban open spaces	Qualitative effect	-
System Benefits	Change in cycle kilometres.	Traffic counts and/or modelling.

[40] Source: Economic evaluation of cycle projects – methodology and unit prices, 2009, COWI, City of Copenhagen

Using data collected on those parameters the Danish scholars were able to calculate average costs (benefits) per kilometer for cycling. They separate cycling costs into internal and external. The distinction is similar to the distinction between direct and indirect costs. Therefore, internal costs are the ones that affect the cyclist's decision process, because they directly affect him/her. Examples are vehicle operating costs – which are way higher for a car compared to a bicycle – thereby influencing the decision of the individual in a positive way towards cycling. On the contrary external costs are the ones creating externalities to third persons. It is assumed that these costs (benefits) do not enter the cyclists' decision process[41]. The average **unit cost per kilometer for cycling and driving a personal car** estimated using this methodology is shown in the following table.[42]

	Cycling (16 km/h)			Car (50 km/h) in city			
	Internal	**External**	**Total**	**Internal**	**External**	**Duties**	**Total**
Time Costs	5.00	0	5.00	1.60	0	0	1.60
Vehicle Operating Costs	0.33	0	0.33	2.20	0	-1.18	1.02
Prolonged life	-2.66	0.06	-2.59	0	0	0	0
Health	-1.11	-1.80	-2.91	0	0	0	0
Accidents	0.25	0.54	0.78	0	0.22	0	0.22
Perceived Safety	?	0	?	?	?	0	?
Discomfort	?	0	?	?	?	0	?
Branding/Tourism	0	-0.02	-0.02	?	?	0	?
Air Pollution	0	0	0	0	0.03	0	0.03
Climate Changes	0	0	0	0	0.04	0	0.04
Noise	0	0	0	0	0.36	0	0.36
Road Deterioration	0	0	0	0	0.01	0	0.01
Congestion	0	0	0	0	0.46	0	0.46
Total	1.81	-1.22	**0.60**	3.80	1.13	-1.18	**3.74**

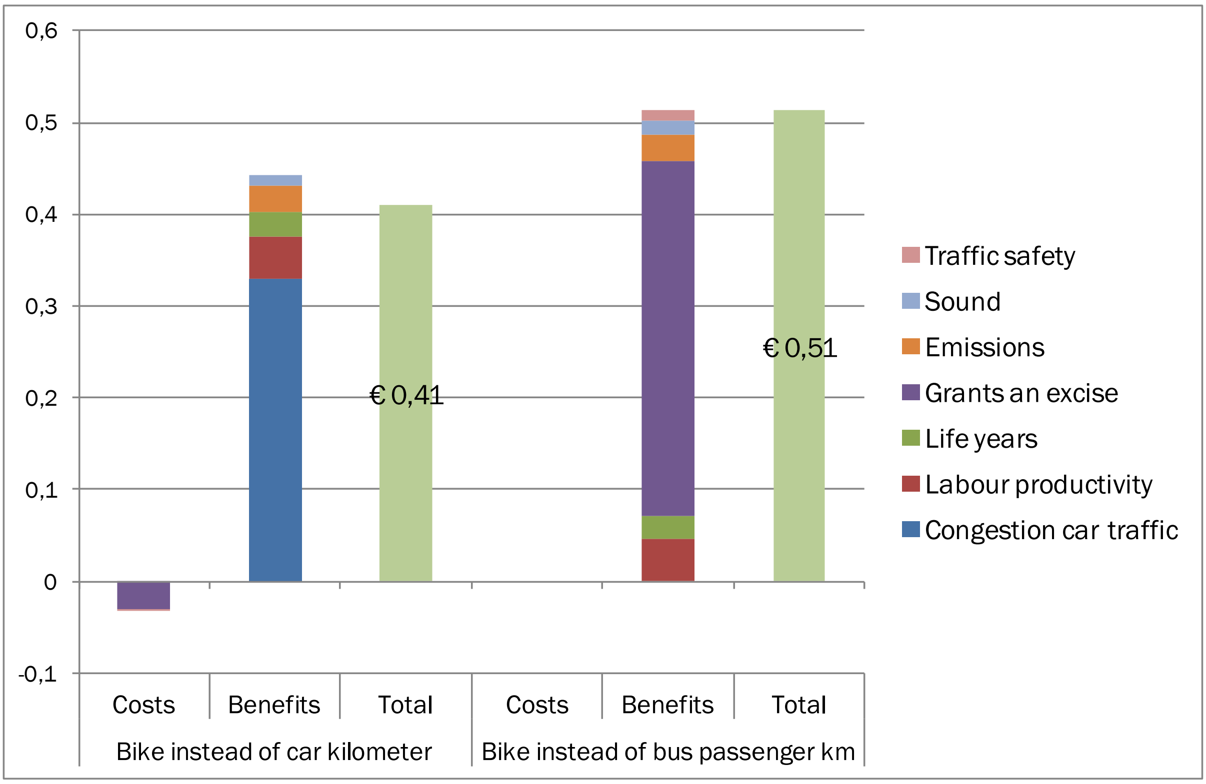
[41] This may not be entirely true. For example, although environmental change does not affect cyclists directly, the environmental benefits of cycling might be a deciding factor.

[42] Source: Economic evaluation of cycle projects – methodology and unit prices, 2009, COWI, City of Copenhagen. DKK 2008 Prices

Bicycle kilometer[43]

A second example of an effort to generate key figures for the “bicycle kilometer” instead of the “car kilometer” is a Dutch webtool for making simple Cost Benefit Analyses for investment in cycling. Besides the comparison with car traffic these Dutch figures also allow us to compare the bicycle with travelling by public transport.[44] Behind this tool lies a rich database with key figures on time values, health effects, environmental effects, accidents and so on. When we translate all these figures to a per kilometer value, we are able to compare the costs and benefits of the bicycle to those of driving a car or travelling by public transport (see figure below).

Social effects modal shift in urban area with relatively dense car traffic.



[43] Decisio (2012), Social costs and benefits of investments in cycling. Commisioned by Ministry of infrastructure and environment in the Netherlands.

[44] Notice that the societal costs and benefits from travelling by public transport are very much country specific due to differences in subsidies or even private versus public exploitation. The figures presented in this section are therefore only relevant for the Dutch case, but indicative for other countries as well.

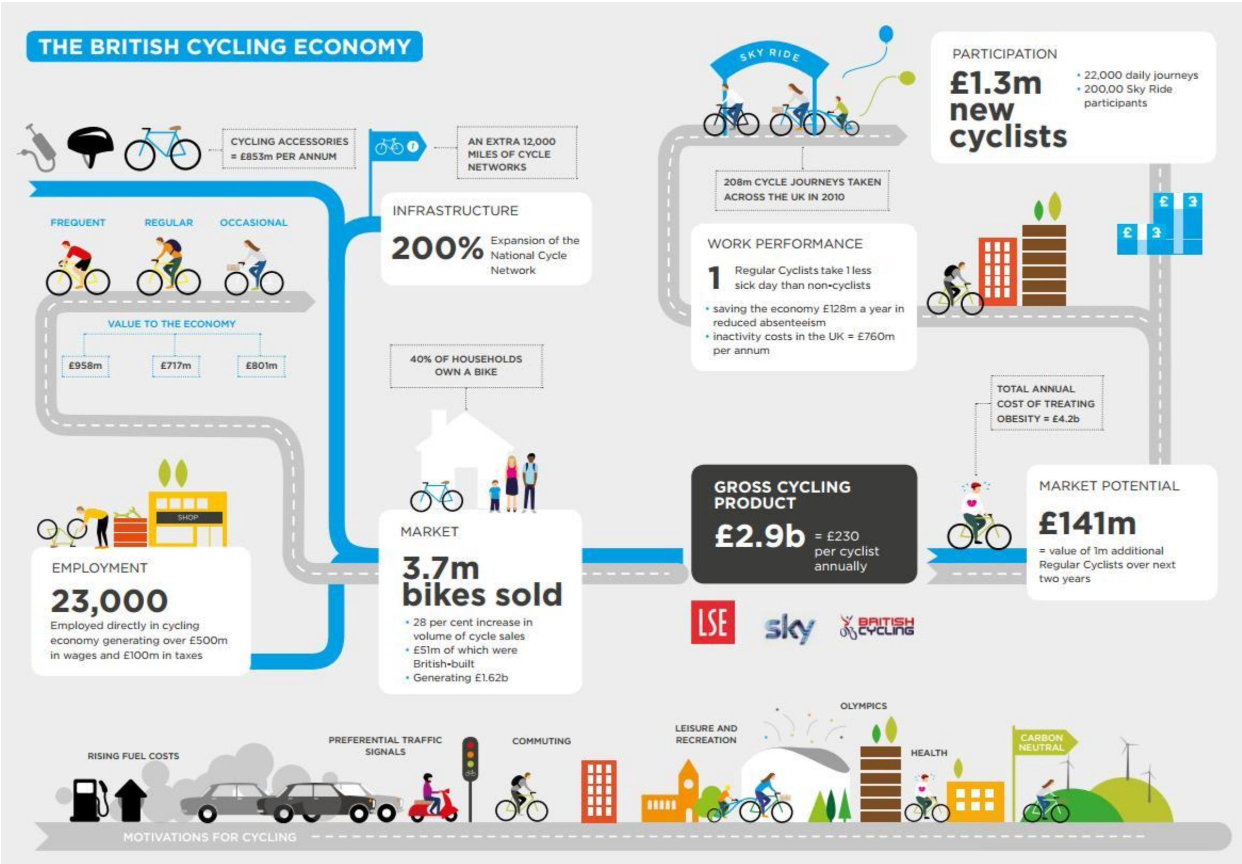
As we can see from the figure above, driving a bicycle is **€0,41 more beneficial to society than driving a car per kilometer.** So every kilometer that is driven on a bike instead of in a car has 41 cents of benefits to society. The effect of lower congestion due to less car kilometers is the largest part of this.[45] Health effects (life years) are relatively low in this case but we must notice these figures are applicable to the Dutch case where physical activity is already relatively high.

The societal benefits of driving a bike instead of travelling by bus are even larger; **every kilometer on a bike instead of in a bus brings €0,51 of societal benefits.** Hereby we must also notice these figures are very much country specific; in the Netherlands public transport receives relatively high grants and subsidies. Note that the example assumes that the extra cyclists leads to an adaption of the public transport supply. This will not be true for small number of travellers shifting from public transport to bike. But it may be true when a rise in traffic demand is expected and an investment in cycling can replace extra expenditures on public transport. When performing a CBA it is therefore important to collect key figures on the national or even regional (city) level.

GDP and Tourism Performance Indicators

Apart from the per kilometer costs and benefits from using a bicycle there is a wider economic impact of increased bicycle usage. Cycling can be a driving force to an entire business sector and can increase GDP and employment. Indicative in this direction are the figures from the cycling sector in the United Kingdom[46]. The number are very illustrative:

[45] Note that this example is located in an urban area with relatively dense car traffic.
[46] The British Cycling Economy, 'Gross Cycling Product' Report, 2011, LSE



And the expectations for future benefits are also very promising. The study states that in the coming decade the projected gains could be:

- Frequent and Regular cyclists could further save the economy £2b over a ten-year period in terms of reduced absenteeism
- A 20 per cent increase in current cycling levels by 2015 could save the economy £207m in terms of reduced traffic congestion and £71m in terms of lower pollution levels
- Latent demand for cycling could amount to around £516m of untapped economic potential for the UK

This study had a general point of view towards the effects of increased cycling on GDP in general and the bicycle industry in particular. There are also other studies that are more specialized and explore the significance of cycling on tourism. Indicative in this direction are studies that estimate the impact of cycling tourism in Scottish GDP.[47] Similar to this study there are other studies that highlight the importance of cycling to local tourism.

In a more general context the EuroVelo[48] project conducted extensive research and provides data on various aspects related to cycling. Among them are tourism statistics for a wide range of European countries. In Europe (EU-27 plus Switzerland and Norway) the revenue of the cycling tourism sector is almost 44 billion euros in total. This revenue comes from 2,3 billion overnight and day trips.

Size of the cycling tourism sector in the EU-27 (+ Switzerland and Norway).[49]

	Daytrip	**Overnight**	**Total**
Trips	2274 million	20,36 million	2294 million
Revenue	€ 35 billion	€ 8.94 billion	€43,94 billion

[47] The value of Cycle Tourism, Opportunities for the Scottish economy, Ivan Zovko, June 2013 and Economic Value of Mountain Biking in Scotland EKOS, April 2009

[48] The European Cycle Route Network Eurovelo, Challenges and Opportunities for Sustainable Tourism, ECF 2012

[49] Sources: Expert estimates plus Eurostat (2008), Peeters et al. (2004), The Gallup Organization (2011).

4.3.2 Assessment

In section 2.3 we explored the characteristics of a Cost-Benefit Analysis (CBA). It is worth mentioning that the CBA, although it is mainly used in order to assess the feasibility and justification of an investment proposal, it can also be a powerful tool for assessing the importance and impact of cycling in general.

In this section we will present an online tool that can be used for free in order to provide a very indicative CBA to potentially interested stakeholders and individuals. Furthermore this section will present the results from an analytic cost benefit analysis for a variety of cycling friendly infrastructure investment performed by the Austrian central government and published in the form of guidelines to interested stakeholders. In the end we present a recently performed CBA for an investment in a safer cycling environment on 2nd Avenue in Seattle, US.

Decision making tool from the Austrian Government

In 2011 the Austrian Government published guidelines regarding investment in cycling infrastructure[50]. The guidelines were primarily directed towards municipal authorities. The objectives of the guidelines were:

- To make an extensive list of possible interventions and investements that can be undertaken by municipal authorities. This would allow them to have a complete list of possible solutions, from which they would be able to choose those that are a better fit to their needs and in accordance with their priorities.
- To provide information of a cost/benefit relationship for each investment. This is particularly important if we take into consideration the fact that municipalities have a very limited budget, and only a small portion of it can become available for investment in cycling infrastructure. The CBA would assist them in making the optimal decision.

The guidelines included information on four different factors of interest:

- Expenses. This category includes the costs for the implementation of the investment. It includes every expense, including raw material, labour costs etc. The numbers were a result of desk research and interview with relevant stakeholders.
- Benefit for cycling traffic. This indicator describes the benefits for cycling traffic due to the implementation of the investment. This is measured by the resulting increase in the share of regular cyclists in the community.
- Administrative Effort: This indicator provides information regarding the effort that is necessary by public administrations in order to implement the investment (or action).

[50] Benefits and Costs of Cycling Infrastructure Investment

- Public Acceptance: This is an indicator measuring the responses from the public to the implementation of an investment. It is obvious that this indicator depends strongly on public attitudes towards cycling at a give point in time.

The scales that were used for depicting the information in the guideline are presented in following Table 1.

Table 1

Score	Expenses	Benefit for Cycling Traffic	Administrative Effort	Public Acceptance
1	Less than €3,000	Very low	Very low	Very Negative
2	€3,000 - €10,000	Low	Low	Negative
3	€10,000 - €50,000	Average	Average	Neutral
4	€50,000 - €100,000	High	High	Positive
5	Over €100,000	Very High	Very High	Very Positive

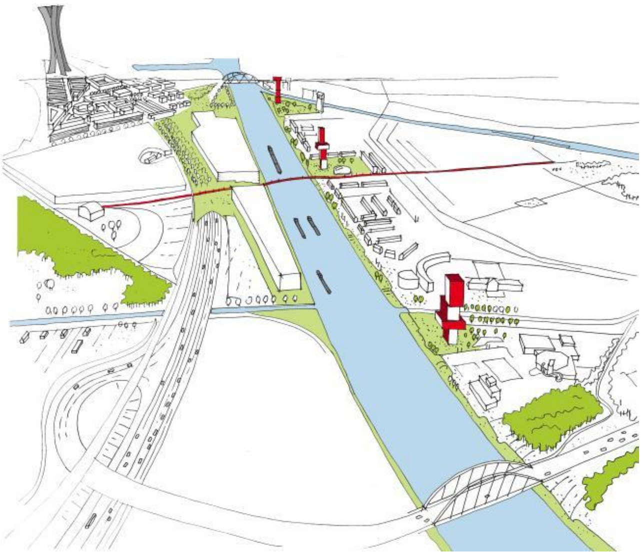
Indicative results from the guidelines are included in following Table 2

Table 2

Measure	Expenses	Benefit for Cycling Traffic	Administrative Effort	Public acceptance
Cycle Path	5	3	5	4
Cycle Lane	2	5	2	5
Advanced Stop Line	1	3	1	4
Cycling traffic Guidance System	3	5	3	5
Phazed Traffic lights for cyclists	3	2	3	3
Opening one-way streets to cycling traffic	2	5	2	4

One conclusion that might be drawn from this guideline is that it is not always necessary to make big investment in order to achieve significant positive results. Take for example advanced stop lines. They have a very low cost and administrative effort combined with positive results and significant public acceptance. This tool could be useful to make a quick comparison between different types of investment in cycling infrastructure. However, it is not a fully developed CBA; effects from investment are not monetized. The following two examples explain CBA on cycling investment by discussing two different cases.

Cost Benefit Analysis on a Bike bridge investment in Utrecht, the Netherlands[51]



In 2012 a Social Cost Benefit Analysis was carried out on a possible investment in a bike bridge spanning the Amsterdam-Rijn canal linking Leidsche Rijn and Oog in Al. The SCBA compares the situation without a bridge (reference situation) to the situation when the bike bridge is built, and thereby schools and a sporting facility have to be demolished and rebuilt. (This is the scenario chosen by the Board of Aldermen and the City Council in 2011). The bridge would offer a faster way across the canal for cyclist from the suburban area on the west of the canal towards the center of Utrecht on the east of the canal.

As there is no information about the benefits (energy savings, a more pleasant building, etc.) of the new school buildings, several different scenarios were designed. In these scenarios different values are used when estimating the valuation of travel time by cyclists and the number of cyclists using the bridge. Thus, the scenarios cover the extreme range of the cost effectiveness of the project.

[51] Decisio (2012), Social costs and benefits of investments in cycling. Commisioned by Ministry of infrastructure and environment in the Netherlands.

Scenarios used in the SCBA

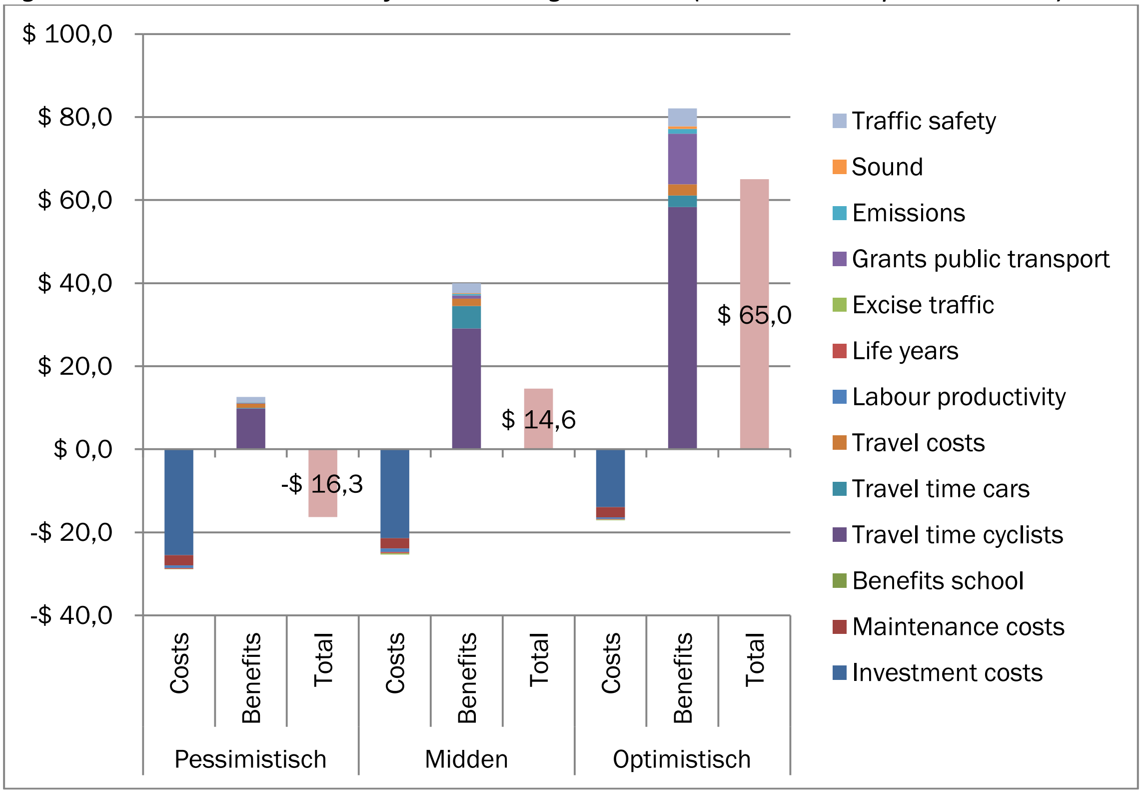
Pessimistic	Middle	Optimistic
Relocating school	Relocating school in the future (when buildings are at the end of depreciation term)	Relocating school not included
665 meter shorter distance	750 meter shorter distance	800 meter shorter distance
4.600 cyclists	7.300 cyclists	10.000 cyclists
195 new cyclists	674 new cyclists	1912 new cyclists
85% previously in car	85% previously in car	15% previously in car
15% previously in public transport	15% previously in public transport	85% previously in public transport
2,8 minutes saved per cyclist	3,1 minutes saved per cyclist	3,3 minutes saved per cyclist
€ 6,65 value of time per hour	€ 10,70 value of time per hour	€ 14,03 value of time per hour
-€ 0,03 congestion effect per km	-€ 0,33 congestion effect per km	-€ 0,33 congestion effect per km
€ 0,02 health effect per km	€ 0,02 health effect per km	€ 0,03 health effect per km

As Figure 1 shows, the social cost is higher than the social benefits only in the most pessimistic scenario. It should be noted that in this scenario the cost of demolition and rebuilding of the schools are included, but not the benefits (nor the savings in maintenance and energy costs). Moreover, in this scenario we went with a low valuation of travel time by cyclists and low usage of the bike bridge. In the other two scenarios, the bike bridge has a very positive score in the SCBA.

Besides, the health effects in this case are measured using Dutch indicators (where cycling numbers and rates of physical activity are already high). Performing such an analysis in any other country in the EU would probably result in much higher health benefits. The WHO uses per kilometer figures of about 80 cents per kilometer[52] for health effects; in this case the health benefits per kilometer were set at 2 to 3 cents per kilometer.

[52] World Health Organisation (2008), Health Economic Assessment Tool for Cycling (HEAT for cycling). User guide, Version 2.

Figure 1 Social costs and benefits Bike Bridge Utrecht (millions € net present value)



When we look at the distinct effects, it is obvious that in this case the biker's gain in travel time is by far the most important benefit. It is, therefore, particularly important to have a clear picture of the number of cyclists benefiting from new bicycle connections and of the travel time valuation to be used for the cyclists.

The travel time elasticity and the related modal shift is another important aspect that should be clarified. If the bike bridge leads to a shift from car to bicycle, the benefits are relatively high (saving travel time for the other cars), and if the project leads to a shift from bus to bicycle, the benefits can also be high (savings in subsidies as a result of the adjustment of the timetable and the equipment to the reduced demand).

Quick Scan social cost benefit analysis 2nd Avenue Seattle[53]

In order to show the basics about Social Cost Benefit Analysis on cycling infrastructure investment we present a *Quick Scan* SCBA on a recently constructed bicycle lane on 2nd Avenue in Seattle. Before the project there was no separated bicycle lane and the crossings with Pike Street and Yesler Way were not adjusted to cyclists. As a result of this poor cycling infrastructure there were 61 collisions in the past 4,5 years. Half of those, including one fatality, were from left-turning vehicles. The project includes separated left turn signals for cyclists, which will be of positive influence on the safety for cyclists. The investment in the cycle lane at Second Avenue was between $1.2 and $1.5 million.

The average daily volume was measured to be 1.100 in one week, three times higher than before the project, but it is not expected that the volume stays that high. For the current analysis the number of cyclists is not of great importance, because we don't expect any modal shift or travel timesavings. In a sensitivity analysis we did 'play' with the assumption that there would be a modal shift from car and public transport to cycling due to the project. The total modal share of the bicycle in the city is included; 3,3% in 2012. In the different scenarios we assumed a different growth rate of this modal share.

We give three different scenarios that are called negative (high investment, low growth of modal share, low reduction of traffic injuries), positive (low investment, high growth of modal share, no traffic injuries on 2nd Avenue) and middle - which uses the average of indicators from the negative and positive scenario. Notice that the change in modal share is

[53] Decisio (2014), Quick Scan Social Cost Benefit Analysis 2nd Avenue Seattle. Memo behind a presentation for the visit of the American delegation of PeopleForBikes on September 25th, 2014.

not due to the 2nd Avenue project, but based on predictions by the 2012 Center City Commuter Mode Split Survey. All the input factors are given in the following table.

	Negative	Middle	Positive
Costs			
Investment costs	$1.500.000	$1.350.000	$1.200.000
Maintenance costs (annually)	5% of investment	2% of investment	1% of investment
Cycling numbers			
Current number of cyclists	400	400	400
Modal share bicycle	3,3% in 2012, 10% in 2041	3,3% in 2012, 10% in 2031	3,3% in 2012, 10% in 2026
Safety			
Fatal accidents before project (annually)	0,2	0,2	0,2
Cyclists injured before project (annually)	6,6	6,6	6,6
Reduction accidents	30%	60%	100%
Value of statistical life (fatal accident)	$9.200.000	$9.200.000	$9.200.000
Value of traffic injury (average)	$336.628	$336.628	$336.628

With these figures we were able to calculate the costs and benefits using American indicators as much as available, complemented with Dutch indicators from earlier CBA's performed in the Netherlands (like the Bike Bridge SCBA presented earlier). To monetize traffic accidents we use the value of statistical life (VSL) set by the U.S. Department of Transportation (2014). For non-fatal accidents we calculated an average of five stages of severity, running from 'minor' to 'critical'. The monetary value is based on the VSL for fatal accidents.

Net Present Value (NPV)

We calculate all costs and benefits for the 100 years to come and express these values in Net Present Value (NPV). This means that all amounts are brought back to what the worth would be today. To calculate NPV's we use a discount rate of 5,5% per year. The basic idea behind this calculation is the following: an amount of $1000 dollars today is worth more than the same amount 5 years later. You could earn interest from the bank or by investing this $1000 (e.g. 2%) so that your $1000 today will be more than $1100 five years later. In the same way a benefit due to better road safety in 2020 has to be calculated back to its value today. This step in the CBA is especially important when comparing different alternatives – for instance a separated bicycle path versus a mixed traffic solution. Effects of both alternatives can come up at different moments during those hundred years. To make them comparable we have to express them in comparable values which is NPV.

Results

The CBA model we used for this analysis is based on the free webtool for CBA on cycling investment in the Netherlands.[54] We changed indicators and economic growth figures to the U.S. situation and then calculated the costs and benefits in NPV. The table below shows the results for three scenarios.

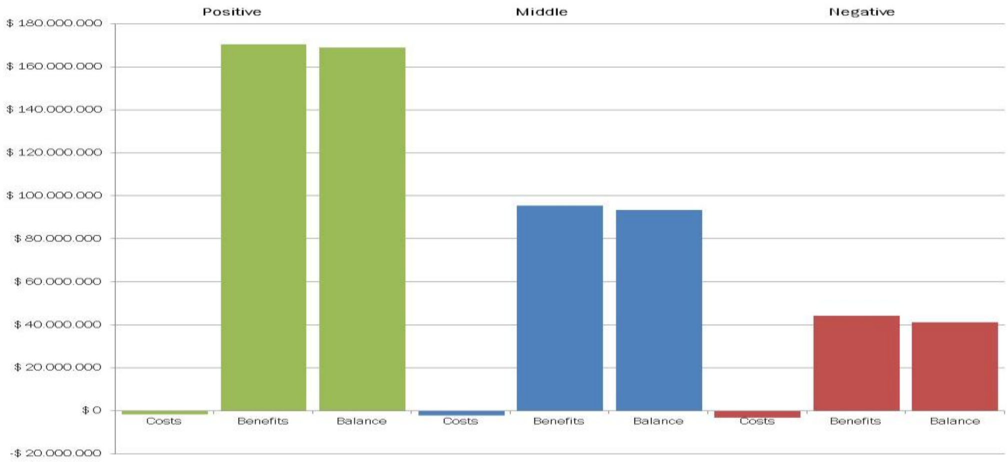
	Negative	**Middle**	**Positive**
Investment costs	-$1.500.000	-$1.350.000	-$1.200.000
Maintenance costs	-$1.356.500	-$488.300	-$217.000
Safety	$44.091.700	$95.297.100	$170.388.600
Balance	**$41.235.200**	**$93.458.800**	**$168.971.500**
Cost/Benefit ratio	**15**	**52**	**120**

All three scenarios have a very positive balance of costs and benefits. The investment of $1.2 - $ 1.5 million and maintenance costs between $0,2 and $1,3 million gives us between $41 and $169 million in safety benefits. Even in the most negative scenario the benefits due to the adjustments on Second Avenue are 15 times higher than the investment and maintenance costs (cost/benefit ratio). Even though this project only ensures one type of

[54] In Dutch, available via http://www.fietsberaad.nl/mkba-fiets/index.cfm?action=nieuweinfrastructuur

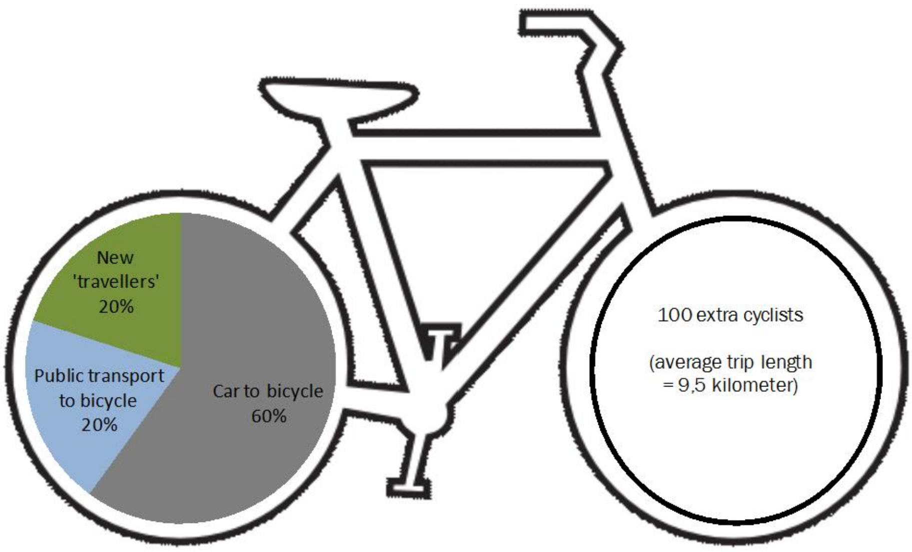
benefit – an increased safety – the benefits outweigh the costs by far (also see figure 2 below).

Figure 2 Costs, benefits and balance of costs and benefits due to the adjustments on Second Avenue in three scenarios (all Net Present Values)



Sensitivity analysis: Including changes in modal shift

There is no change in travel choice mode expected due to the Second Avenue project. Therefore only benefits from an increased safety were included in the CBA above. In order to give an idea of other potential benefits (and costs) from investment in cycling we performed a sensitivity analysis by assuming that the project does induce a modal shift from the car and public transport to the bicycle. We assumed that the Second Avenue cycle path would attract 100 new cyclists, 20% of which were previously travelling by public transport, 60% of which were travelling by car and 20% of which were previously "sitting on the couch". This last group consists of people who didn't travel before and now start to cycle because of the new safe cycle path. The average trip length stems from the 2012 'Center City Commuter Mode Split Survey' (page 16). Besides these changes we used all assumption



from the ‘middle’ scenario.

This modal shift results in some other effects we didn’t see in the CBA above (see table below). Besides safety benefits the shift from car, public transport and ‘couch’ to the bicycle results in:

- Travel time and reliability gains for car drivers: a reduction of cars on the road results in less delay for the remaining cars on the road.
- Less productivity loss: because people get healthier due to their physical activity they will be less absent from work because of illness. Besides that healthier people are more productive and deliver better quality.
- Health effects: again, people get healthier due to the extra physical activity. This results in less hospitalisations and other health care costs.
- Excises car transport: because some people leave their car in this analysis to start cycling, they will obviously buy less fuel for their car. And on every litre of car fuel an excise is paid to the government. Therefore, less excises means a negative public effect.
- Public transport subsidies: some of the new cyclists were previously travelling by public transport. With every person switching from bus to bike the chance of needing an extra bus lines in the near future decreases. Implementing extra buses would cost the public more subsidies (in the Netherlands public transport systems are quite heavily subsidized). A modal shift from bus to bike therefore results in a positive effect for society.

Results from the sensitivity analysis assuming modal shift of 100 cyclists

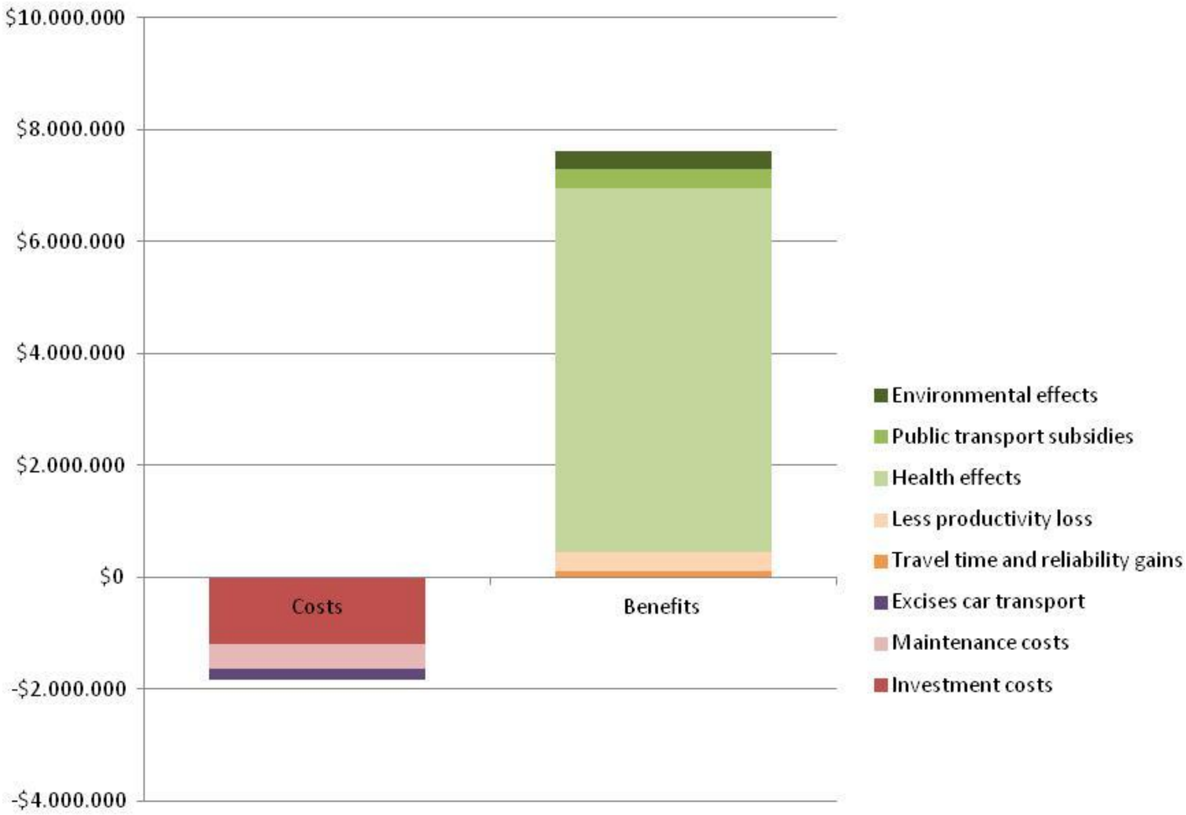
	Costs	Benefits
Investment costs	-$1.200.000	
Maintenance costs	-$434.000	
Travel time and reliability gains car drivers		$115.600
Less productivity loss		$331.100
Health effects		$6.514.700
Excises car transport	-$187.400	
Public transport subsidies		$329.400
Environmental effects		$333.600

Total effects (excluding safety)	-$1.821.400	$7.624.500
Balance (excluding safety)		**$5.803.000**
Safety		$95.297.100
Total	**-$1.821.400**	**$102.921.600**
Balance		**$101.100.200**
Cost/benefit ratio		**57**

This analysis shows that the safety effects are by far the largest benefits in this project. The project seems to be effective; the whole idea behind the project was to create a safer traffic environment for cyclists. The sensitivity analysis shows that a growth of only 100 cyclists in Seattle ensures an extra $7,3 million of societal gains. The health effects draw most attention here. More than $6,5 million on health effects due to these 100 cyclists; that equals $65.000 per cyclist. The other effects are marginal compared to health and safety effects, but still quite substantial when viewed on their own.

The travel time and reliability gains for those car drivers that stay on the road accounts for roughly $100.000 of the benefits. This figure has been calculated using Value of Time (VoT) indicators and the economic value of being more certain to arrive on time. As explained above the excises from car fuel drops down because some car drivers transfer to the bicycle. U.S. figures would be needed to calculate this effect more accurately. The saved losses in productivity are roughly $300.000, which means that an average person who starts to cycle saves his employer some $3000. We must notice here that Dutch indicators were used to calculate this effect. Using U.S. indicators would result in higher benefits; because rates of physical activity are already quite high in the Netherlands the increase in cycling has only marginal effect.

Figure 3 Results of the modal shift from car, public transport and couch to bicycle, excluding safety effects (Net Present Values).



Another positive effect of cycling that is often brought up is the environmental effect. The Dutch indicator that is used here includes a benefit per kilometer for the reduction in greenhouse gas emissions and the reduction of noise due to less cars (and buses) on the road. This brings another $333 thousand of societal benefits. The same applies to the effect of public transport subsidies; Dutch indicators are used here. Using U.S. indicators would result in a different number. Notice that this analysis gives an indication of the set-up of societal benefits through different effects – some further research would be needed to find U.S. indicators for all effects.

<u>Conclusion: 2nd Avenue is a goldmine to Seattle!</u>

Even though this social cost benefit analysis on the Second Avenue project was only a quick scan, we can conclude that the project is very favorable to society. Even in the most negative scenario the benefits from increased safety outweigh the investment and maintenance costs by far.

The sensitivity analysis gives some insight in other potential effects from cycling investment. The outcomes show that social cost benefit analysis can be a very effective tool to help mobility and city planners in making the right choices. **If cycling is good to society will not even be the question in most cases (see the enormous safety effects in this project) - which alternative will be most beneficial and why will be the most interesting question.**

Social cost benefit analysis is a very effective tool for this; by expressing all costs and benefits in Net Present Values costs and effects at different points in time become comparable. Performing a thorough CBA for U.S. projects however would ask for some further research on country or city specific indicators. But the information is out there: searching for the relevant indicators should take no more than one or two days.

4.4 Drivers and Inhibitors

In the previous sections we have examined the costs and benefits from the introduction and adoption of cycling in urban mobility management schemes. In these sections it became evident that cycling has a variety of indirect effects on society (externalities). These effects have a significant impact on policy priorities and public perceptions. However, although evidence suggests that the benefits outweigh the costs, adoption of cycling is advancing slowly and is facing many obstacles. In this section we will investigate how public perception and/or official policy can be a force that facilitates or impedes the expansion of bicycle usage. The following discussion will, to a great degree, show the dual nature of every aspect; every barrier to the adoption of cycling if lifted can become a driver that will increase bicycle usage and facilitate the successful incorporation cycling in urban mobility management schemes. Therefore the line of separation in this section will not be between drivers and inhibitors, but, as already indicated, between factors related to citizens' perceptions and factors related to public policy.

4.4.1 The perceptions of citizens

Every investment, prior to its approval undergoes an extensive assessment regarding many of its aspects, and among them its estimated costs and the expected benefits. This is the basis of the cost benefit analysis, which has been explored in earlier sections. The same cost benefit analysis is also a part of the assessment process for public investment in cycling friendly infrastructure.

In order to estimate both the costs and benefits from cycling, as discussed earlier, it is important to estimate the uptake of cycling by citizens. The latter affects both aspects. The portion of the population that will shift towards cycling affects both the cost and the benefits. Cost is affected through the size of the necessary investment; a large shift will demand extensive investment in infrastructure to cover the demand, and this implies a rising costs. Similarly a large shift from motorized transportation to cycling will increase the positive impact of cycling. As discussed earlier, cycling has extensive positive externalities (e.g. health effects). The impact of these externalities is positively correlated to the extent of cycling adoption.

It becomes obvious that both the costs and the benefits from cycling adoption have a positive relationship with the size of the cycling uptake. However it cannot be assumed that those relationships are comparable. Take for example the construction of a cycling lane. It requires a high initial investment and a fixed maintenance cost. Both costs are not related to the actual usage of this lane by the public[55]. On the other hand, the expected benefits will differ depending on the uptake. As a result, if a low uptake is expected, then the cost will probably outweigh the benefits, and thus the investment might not be undertaken. In this way public perception can work as a driver or as an inhibitor of investment in infrastructure that promote the adoption of cycling friendly mobility management schemes.

[55] The estimated usage can affect this cost by affecting the size and extent of lanes that will be constructed.

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At this point it is interesting to highlight the fact that public perceptions differ, depending on the group being asked[56]. An interesting, and pertinent, distinction is between car drivers and cyclists. These two groups, to some degree, express different opinions on what they consider to be attractive or discouraging with regard to cycling. However if someone were to attempt and summarize the (actual and perceived) factors affecting the uptake of cycling, the main issues that are raised are the following:

- Health. This is a recurring aspect. As we have seen earlier there are health benefits, due to increased physical activity and some negative effects, due to the air-pollution in modern urban environments (especially the gases inhaled by cyclists during their trips).
- Available infrastructure. Modern urban environments have severe deficiencies in infrastructure that would facilitate a trip with the bicycle. This includes the availability of appropriate cycling paths and lanes, as well as signs that provide directions and information.
- The size of modern cities. Urban agglomerations in many cases cover an extensive area. This makes the distance that needs to be covered by bicycles increasingly larger. The effort and time that takes to cover such distances may counteract the perceived gains from avoiding the car traffic.
- Safety. This is a very important factor that concerns both current and potential bicycle users. Using the bicycle among motor vehicle traffic increases risk for accident and injury. These risks can be mitigated by the existence of appropriate infrastructure (paths, lanes etc) and on average decline as bicycle uptake increases. However the risks can be discouraging, especially for potential cyclists.
- Security. Bicycles can be easily a target for theft and vandalism. Since there are few counter-measures that can be used by owners, the only viable solution is the existence of parking infrastructure that offer increased protection. Additionally an

[56] ECMT (2004) and WALCYNG project

aspect that is taken into consideration by cyclists increased danger to be attacked when using a bicycle during the night or in low-traffic areas.

- Weather conditions. Cycling is an activity that is severely affected by weather conditions. For example too high or two low temperatures can be discouraging. Similarly frequent rainfall can be a deterrent to using the bicycle, both for leisure and (especially) for commuting.
- Topology. The morphology of the terrain can be an important factor as well. For example an uneven terrain, with differences in elevation can be a significant barrier to the uptake of cycling.

We have seen from the previous discussions that there is a variety of aspects that could affect the propensity towards using bicycles, and indirectly decisions regarding public investment in the appropriate infrastructure. Some of these factors are exogenous and cannot be a subject of official policies (e.g. weather and topology). Others are related to general policies and can be a subject of a general approach to cycling (e.g. security). Finally some are directly related to infrastructure investment (e.g. availability of suitable paths and parking infrastructure). The latter are also part of the cost/benefit analysis regarding the assessment of an investment proposal.

Car Drivers

Barriers to cycling

- inappropriate to transport heavy things
- dependent on weather conditions
- safety
- insufficient availability of bycicling routes
- incomplete cycling route signage

Faciliators of cycling

- enjoyable activity
- health benefits
- environment-friendly
- good for physical excercise

Cyclists

Barriers to Cycling

- danger because of car speed
- inssufficient availability of cycling routes
- insufficient availability of secure parking infrastructures
- car noise and fumes

Facilitators of cycling

- health benefits
- increased flexibility and independence
- increased speed of travelling
- environment-friendly

The previous discussion indicates that attitudes and perceptions towards cycling can have a great impact on the uptake of cycling, and indirectly on the willingness to invest in appropriate infrastructure. Therefore it is in the interest of public authorities that wish to implement a cycling friendly mobility management policy to attempt to change these attitudes and alleviate possible inhibitors. Some indicative examples of how this could be achieved are the following:

- Improve the image of cycling. Actions in this direction should attempt to improve the public perception towards cycling. The target group should be those who believe that cycling is only a leisure and sports activity, and the objective should be to shift their opinions towards considering cycling a viable commuting alternative. Additionally efforts should be taken to promote the status of bicycles as an "equal right" occupant of roadwork with other vehicles. Tools that can be used towards this objective are highlighting the environmental, health, time and cost benefits from using a bicycle.

- Creating an extensive network of cycling infrastructure is an expensive endeavor, especially in cases where public attitude is negative or indifferent and uptake uncertain. However traffic management interventions are an inexpensive option that could create a seed network and facilitate the shift toward bicycles. One-way streets, traffic calming measures and other similar interventions give the option to promote cycling and create a wider pool of potential regular cyclists.
- An important factor discouraging regular bicycle use is lack of information regarding the available routes. Creating appropriate documentation and installing the necessary signs can ease the adoption of cycling and shift attitudes by providing the necessary information to interested citizens.
- Safety issues are a major concern both to current and potential cyclists. This is partially based on facts and partially on erroneous perceptions. It is true that cyclists are more exposed to accidental injuries than car-drivers. However these dangers can be reduced with the appropriate infrastructure and traffic management measures. Effectively communicating this to the public can shift attitudes and affect the possibility to adopt cycling.
- Integration of cycling with public transportation can effectively mitigate negative effects from many factors, including weather conditions and topology. The option to take the bicycle on trains and bicycles can reduce trip distances and alleviate the negative effect of uneven terrain morphology. Such measures in most cases do not necessitate investment and can facilitate a shift in perceptions.
- Security issues can be assisted through effective policing and by raising the enforcement of law. Additional investment in infrastructure can also help in this direction, especially with regards to bicycle theft and possible vandalisms.

4.4.2 Public policy

A different type of drivers and inhibitors related to the implementation of investment in cycling infrastructure can be located in institutional restrictions and rigidities. Similar to the citizens' perceptions they all have a dual impact and depending on local/national circumstances can be either drivers or inhibitors. The present section presents them as barriers, however alleviating those barriers can function as a force that will drive infrastructure investment in cycling friendly mobility management schemes.

Financial Constraints

Investment for the construction of cycling infrastructure necessitates the commitment of significant resources. Taking into account that the uptake of cycling cannot be safely estimated in advance, and the resulting positive benefits are not immediately visible, this can result in low prioritization of cycling infrastructure in public administrations' budget. Furthermore, given the constrained resources available for transportation infrastructure, authorities tend to give higher priority to investment in other forms of public transportation, which are more visible and have direct and measurable impact on the traffic management issues. Both forces contribute to cycling infrastructure being low-priority policy and receiving limited funding.

Institutional Barriers

Another important factor preventing effective implementation of cycling friendly policies and investment are barriers that are a result of institutional factors and rigidities. They can prevent coherent and effective strategic planning, as well as erect obstacles to planned policies. Many countries for example do not have a national plan on cycling friendly mobility schemes. As a result it is left upon regional and local authorities to devise policy initiatives and proceed with the necessary investment. However this can be counter-productive in many aspects. One of the most important is the fact that local and regional budgets are in general very limited in size leaving little room for accommodating all needs; similarly lack of coordination at national level results in duplication of efforts and costs, as well as in diminished credibility of and commitment to cycling friendly policies. Another aspect is the fact that in most countries ownership of existing road network is not given to a single authority; as a result there are local, regional and national roads servicing a specific area. This can create obstacles in the implementation of cycling friendly policies, since the interests of each owner might be diverging; imagine the case where a local authority wants to build a cycling track, and needs to use the regional road crossing the area; it is conceivable that the regional authorities do not want to follow such a policy, thus creating an institutional barrier to the cycling friendly investment initiative.

Safety Concerns

In previous sections we have explored the fact that potential cyclists are discouraged from the perceived safety concerns. These concerns are also a subject of public policy; the latter can be facilitating investment or impeding it. Public authorities might be discouraged by the safety issues in their area (e.g. chaotic traffic, and poor drivers' behavior) and not proceed with cycling investment; the reasoning in this case would be that cycling infrastructure would create dangers for the population and increase accident and injury risk. On the other hand public policy could also be used to address the safety concerns expressed by citizens; a campaign exemplifying the advantages of cycling and alerting both drivers and cyclists to the implied dangers and the proper attitudes, could help improve sentiments towards cycling and alleviate the safety concerns.

Insufficient Understanding of Technical Issues

Engineering is a very important factor affecting cycling conditions. It can contribute to cycling infrastructure network being safer and more convenient. A complete network would include measures and interventions that cover the full spectrum of possible infrastructure proposed in section 3. However in order to ensure the proper implementation of all interventions it is necessary to have an adequate technical understanding of cycling infrastructure issues. This is not always the case and guidance documents to share technical information are not always available to traffic planners. This can lead to the network design being flawed or cycling infrastructure is of poor quality leading to conflicting interfaces between cyclists, car drivers and pedestrians. Further, there is often a lack of continuity of networks, and road junction design that can endanger cyclists.

Scarcity of Road Space

In most cases the construction of cycling infrastructure is ad-hoc to existing road network. In most cities (especially in Europe) this is very difficult to be accommodated, given that there is very limited availability of space. In this case, cities usually reduce the space available to motor vehicles, in order to create appropriate cycling infrastructure. However this results in negative sentiments from drivers (a significant part of the electorate), since reductions in the roads available to automobiles intensify traffic problems, which in most of the cases are already severe. These negative sentiments of the electorate, in conjunction with the limited availability of budgetary resources can discourage authorities from adopting cycling friendly policies and proceeding with the necessary investment.

Lack of public awareness

Public policy can play an important role in affecting public perception towards cycling. An awareness campaign can transform common beliefs and increase the potential of adopting cycling for frequent transportation. In order to do that such a campaign could address the environmental and health benefits and thus create and foster a positive public opinion. Additionally it could address safety and security concerns, and reduces possible misperceptions. Finally it could highlight the fact that cycling is not only a leisure/sports activity, but can also be a viable alternative for every day commuting needs[57].

[57] Public awareness issues are addressed in greater detail in Section 4.4.1

5 Conclusions

The objective of the present document is to explore the costs and benefits from public investment in cycling infrastructure, and locate factors that could facilitate or impede them. In order to do that the document provides a comprehensive list of possible infrastructure investment that could be undertaken by the public sector. This was necessary in order to provide a reference framework and the vocabulary that was used extensively in the subsequent discussion. We present an indicative overview on costs of different types of cycling infrastructure, but in the end these are very much country specific. A distinction has been made between initial investment costs, maintenance costs and operational costs.

Section 0 forms the core of this document, where **all aspects and necessary ingredients for a Cost Benefit Analysis were explored**. Quantitative indicators were given to monetize societal costs and benefits of Cycling investment. Comparing costs and benefits it is possible to assess whether an investment is worth being developed, and also rank alternative investment to make the optimal selection. An overview of potential benefits of cycling investment includes direct revenue streams, other direct effects (travel time gains) and indirect effects such as health effects, environmental effects, less congestion, safety effects and effects on use of space.

By discussing two different Cost Benefit Analyses we explain the methodology and its usefulness for the public decision making process. Almost every CBA on cycling investment turns out to be very positive; **the social costs outweigh the benefits by far.**

Finally in this document the **drivers and inhibitors** that can affect investment decisions are explored and discussed. The synthesis of this report allows us to express that public investment face severe adversities. They require significant financial commitments from public authorities, while the returns are uncertain and intangible. With Social Cost Benefit Analysis we present a tool that can take away some of these uncertainties.

It’s important to see cycling as an integral part of the total mobility plan of a city. Synergies with public transport are an important part of that. Also important are efforts to adjust car driver’s behavior in favor of the cyclist and the planning of pedestrian areas. ‘Hard’ investment in physical cycling infrastructure also requires crucial investment in promotion and awareness campaigns.

Future recommendations

The best continuation of the work performed by the CycleCities project is twofold. First of all, the **Cost Benefit Analysis** tool for cycling as developed in the reports on private[58] and public investment in cycling **is ready to be assessed** on any investment in cycling to be planned or built anywhere in Europe (and beyond). It could become an instrument of great relevance in the decision-making process of public administrations – it is therefore very much advisable to execute these analyses on a regular basis. Expansion with the social element would be a great step forward to a ‘**Social** Cost Benefit Analyses (SCBA)’

Secondly, it would be a very interesting continuation of the CycleCities work to develop and perform a **Cost Benefit Analysis on an ‘Urban Master Plan for Cycling’**. Such an analysis would give insight in the social gains and costs of a total ‘package’ of cycling measures that would be – in case of a positive outcome – a major argument to policy makers to give more attention to cycling. Developing such a method would be a great addition to the extending knowledge production on the effects of cycling, public policy on cycling and how to raise cycling numbers in the urban environment.

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Appendix

Complete table with cycling tourism numbers per country in the EU-27 plus Switzerland and Norway.

Country	Daytrips (number, million)	Overnight trips (number, million)	Daytrips (billion €)	Overnight trips (billion €)	Total (billion €)
Austria	62	0,46	0,96	0,20	1,16
Belgium	39	0,21	0,60	0,09	0,69
Bulgaria	12	0,13	0,19	0,06	0,25
Switzerland	55	0,42	0,85	0,18	1,03
Cyprus	0	0,00	0,01	0,00	0,01
Czech Republic	55	0,56	0,85	0,24	1,09
Germany	607	4,62	9,34	2,03	11,37
Denmark	42	0,32	0,65	0,14	0,79
Estonia	1	0,01	0,02	0,00	0,02
Spain	80	0,89	1,23	0,39	1,62
Finland	112	1,14	1,72	0,50	2,22
France	373	4,01	5,73	1,76	7,49
Greece	21	0,23	0,32	0,10	0,42
Hungary	98	1,00	1,50	0,44	1,94
Ireland	13	0,09	0,20	0,04	0,24
Italy	103	1,05	1,59	0,46	2,05
Lithuania	5	0,04	0,07	0,02	0,09
Luxembourg (Grand-Duché)	1	0,00	0,01	0,00	0,01
Latvia	9	0,10	0,14	0,04	0,19
Netherlands	138	1,01	2,12	0,44	2,57
Norway	23	0,20	0,35	0,09	0,44
Poland	101	1,06	1,56	0,47	2,02
Portugal	7	0,07	0,10	0,03	0,14
Romania	9	0,10	0,14	0,04	0,18
Sweden	134	1,20	2,06	0,53	2,58
Slovenia	9	0,07	0,15	0,03	0,18
Slovakia	17	0,14	0,26	0,06	0,32
United Kingdom	149	1,23	2,29	0,54	2,83
Total	2.274	20,36	35,00	8,94	43,94

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