TeMA

Journal of Land Use, Mobility and Environment

There are a number of different future-city visions being developed around the world at the moment: one of them is Smart Cities: ICT and big data availability may contribute to better understand and plan the city, improving efficiency, equity and quality of life. But these visions of utopia need an urgent reality check: this is one of the future challenges that Smart Cities have to face.

Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

CITIES, ENERGY AND CLIMATE CHANGE

Vol.8 n.1 April 2015

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA

Journal of
Land Use, Mobility and Environment

CITIES, ENERGY AND CLIMATE CHANGE

1 (2015)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realised by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

Cover image: digital processing Raffaella Niglio, image Paolo De Stefano

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA Journal of Land Use, Mobility and Environment

CITIES, ENERGY AND CLIMATE CHANGE 1 (2015)

Contents

3 EDITORIAL PREFACE
Rocco Papa

FOCUS

5 **The Padanian LiMeS. Spatial Interpretation of Local GHG Emission Data**
Michèle Pezzagno, Marco Rosini

19 **Smart and Resilient Cities. A Systemic Approach for Developing Cross-Sectoral Strategies in the Face of Climate Change**
Rocco Papa, Adriana Galderisi,
Maria Cristina Vigo Majello, Erika Saretta

51 **Implementing European Climate Adaptation Policy. How Local Policymakers React to European Policy**
Thomas Hartmann, Tejo Spit

LAND USE, MOBILITY AND ENVIRONMENT

69 **Interactivity of Webgis for the Simulation of Land Development**
Tullia Valeria Di Giacomo

83 **Cycle Sustainability**
Francesca Pirlone, Selena Candia

103 REVIEW PAGES
Gennaro Angiello, Gerardo Carpentieri,
Raffaella Niglio, Laura Russo,
Andrea Tulisi

TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2015) 83-101
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2921

review paper received 4 February 2015, accepted 25 April 2015

www.tema.unina.it

How to cite item in APA format:
Pirlone F. & Candia, S. (2015). Cycle sustainability. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 83-101.
doi: http://dx.doi.org/10.6092/1970-9870/2921

CYCLE SUSTAINABILITY

FRANCESCA PIRLONE[a] , SELENA CANDIA[b]

[a] Department of Civil, Chemical and Environmental Engineering (DICCA) - University of Genoa
e-mail: francesca.pirlone@unige.it

[b] Municipality of Genoa
e-mail: scandia@comune.genova.it

ABSTRACT

One of the main problems that affects modern cities is connected to transport/mobility. Urban transport is currently based on car use; the transition to the use of more sustainable means of transport is happening slowly. Bicycles used as main way of transport, combined with walking, it's a successful solution for many towns to really bring traffic and congestion down. For their high density and their short time travels, towns are the best places (in comparison to long time travels as merchandise transport) to reduce the green houses gasses emitted promoting walking, cycling and public transport. For this reason the European Union is directly founding different projects that boost urban cycling. Many examples presented in this paper where collected by an European project. This project sectioned best practices and excellences in cycling as the so called cycle cities: Amsterdam, Copenhagen, Seville,…cities that have recognized the importance of cycling as a solution to traffic congestion. But how is it possible to transfer these experiences to others realities?
The scope of this article is to show the sustainability of cycling according to socio-economic (social and economic sustainability) and environmental terms (environmental sustainability).
For this reason is proposed a CBA (Cost and Benefits Analysis) methodology specific to evidence the advantages of investments in cycling made by public authorities or private companies both, to promote and realize ecological infrastructures.

KEYWORDS:
cycling, transport, cost and benefit analysis

TeMA
有关土地使用、交通和环境的杂志

TeMA 1 (2015) 83-101
print ISSN 1970-9889, e- ISSN 1970-9870
DOI: 10.6092/1970-9870/2921

review paper received 4 February 2015, accepted 25 April 2015

www.tema.unina.it

How to cite item in APA format:
Pirlone F. & Candia, S. (2015). Cycle sustainability. *Tema. Journal of Land Use, Mobility and Environment*, 8 (1), 83-101.
doi: http://dx.doi.org/10.6092/1970-9870/2921

自行车出行的可持续性

FRANCESCA PIRLONE[a] , SELENA CANDIA[b]

[a] Department of Civil, Chemical and Environmental Engineering (DICCA) - University of Genoa
e-mail: francesca.pirlone@unige.it

[b] Municipality of Genoa
e-mail: scandia@comune.genova.it

摘要

影响现代城市的一个主要问题就是交通运输/流动性.城市交通现在是以使用汽车为基础，但向更可持续交通方式的转变进展缓慢．对很多城镇来说，将自行车作为主要交通方式，并与步行相结合，是真正降低交通流量和拥堵的成功解决方案．（与货物运输行程的长时间相比）因密度高，行程时间短，城镇成为用推动步行，自行车出行和公共交通来降低温室气体排放的最佳场所．正因如此，欧盟正直接资助能推动城市自行车出行的不同项目．本文列举了一个欧洲项目所收集的许多例子．这个项目对自行车出行的最佳实践和优点以及所谓的自行车城市进行了划分，这些城市包括阿姆斯特丹，哥本哈根，塞维利亚等已经认识到自行车作为一种交通拥堵解决方案的重要性的城市．但这些经验能否转移到其他现实中呢？
本文的作用是从社会经济（即社会和经济可持续性）和环境（即环境可持续性）角度来展示自行车出行的可持续性.
因此，本文用成本效益分析（CBA）方法，来证明政府当局或私营企业为促进和实现生态基础设施而对自行车出行进行投资所具有的优势.

关键词
自行车出行，可持续性，交通

1 CYCLING AND TOWNS

Towns are modern society main actors. Here are concentrated the majority of habitants, commerce and trades. Inside European towns live more than 70% of the population and it is generated more than 80% of the European PIL, but the majority of these towns is not developed in a sustainable way. One of the main unsolved problems is related to mobility, that is more and more difficult and inefficient. Metropolis are rapidly growing – United Nations say that within the 2050, world population will reach 9 billion of people instead of 7 – and so there is an increasing number of people that need to move every day. "That travel is a derived demand and not an activity that people wish to undertake for its own sake" (Banister, 2008). Urban mobility is based on private car use which are usually alimented with carbon fuels. The gradual change through soft mobility ways of transport is slowing happening.

"Even though there is not yet a unique definition, we can argue that soft mobility (pedestrian, cycle and other not motorized displacements) is a zero impact mobility trying to be alternative to the cars use" (La Rocca, 2010). City as Warsaw, Marseille, Rome, Paris[1] suffer from chronical traffic congestion that costs 80 billion of euro every year. Traditional transport is not only an economical problem, but one of the main causes of climate changings. Towns also produce over 70% of global energy-related CO_2 emissions[2]. Cycling as preferential way of transport inside towns - combined with the creation of new pedestrian zones - is an efficient solution to reduce vehicular traffic. Towns for their high density are characterized by short transfers, so pedestrian, cycling and walking could really be considered as good way of transport to go to move every day. "The majority of nonwork trips are within walking or cycling distance and are therefore of interest to the physical activity, air quality, and transportation planning fields" (Saelens et al., 2003).

The document Europe 2020 - A European strategy for smart, sustainable and inclusive growth underlines the importance to develop sustainable and modern systems of transport inside Europe. For this reason many urban cycling projects were funded directly the European Union. Many examples presented in this article where collected thanks to one of these European projects[3], that selected best practices and excellences of cycle cities – as Amsterdam, Copenhagen, London, Seville, ... -. A cycle city is a town where cycling is promoted and supported in order to avoid traffic congestion. But how is it possible to transfer these good experiences to others realities?

Cost Benefit Analysis (CBA) is commonly considered as an ex-ante evaluation tool to address the decision for new infrastructures. "The CBA has become a widely used instrument for the appraisal and evaluation of large infrastructure projects in many countries" (Haezendonck, 2007; Mackie, 2010; May et al., 2008; Odgaard et al., 2005; Rotaris et al., 2010; Vickerman, 2000). But even if this analysis has already shown its benefits to support new travel infrastructures, as roads, railway lines, tunnels, it's still rarely used to address investments in cycling.

In this paper the authors[4] want to demonstrate the convenience to adopt this methodology for public and private investments in cycling. The analysis proposed considers costs and benefits related both to social or environmental aspects and it underlines the advantages that come from the realization and promotion of cycling thanks to public and private joint investments. Many examples and indications are later given to reach a perfect balance between this two form of investment. Obviously, main benefits are related to health and environmental aspects (air pollution, CO_2 production, land use, …). From conclusive CBA data it is

1 Top 10 most congested cities in Europe, The Telegraph, UK 2015.

2 Cities, towns & Renewable Energy, International Energy Agency, OECD/IEA 2009.

3 CycleCities project, INTERREG IVC Innovation & Environment - Regions of Europe sharing solutions, involved 8 partners.

4 Selena Candia has done an analysis about public investments in cycling thanks to an European project. The author developed the methodology proposed in this article after doing many researches on the existing best practices about cost-benefit analysis in public and private investments. Francesca Pirlone has done an analysis about private investment in Cycling in European Countries. The author enhanced the CBA methodology considering costs, general benefits and environmental impacts connected to public and private investments in infrastructures. This CBA methodology is a useful tool for local transport plans and policies.

evident the importance and the convenience to invest in cycling: bicycles are less expensive (1 Km of new car ways correspond to 110 Km of new bicycles lanes) and they are cleaner (zero emission) compared with other means of transport. Cycle cities are more liveable and a synonymous of quality.

2 COST-BENEFIT ANALYSIS FOR PRIVATE AND PUBLIC INVESTMENT IN CYCLING

A world widely used systematic process for calculating and comparing gains (benefits) and costs of projects, decisions and policies is the Cost Benefit Analysis, this tool is used in order to determine if it is a sound investment (justification / feasibility) and to see how it compares with alternative projects (ranking / priority assignment). 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 the potential of cycling.

In particular to analyze investments in cycling it have been used a SCBA, Social Cost Benefit Analysis that can include soft factors besides hard effects reflected by real behavior and real economic value. "Social Cost Benefit Analyses (SCBA) are used in many western countries as evaluation tool for infrastructure projects ex ante" (Mouter et al., 2013). Making a SCBA gives insight to policymakers and the public into the costs and benefits of an infrastructure project or several alternatives. Not only the simple costs of building a road, bridge or rail track are included but also soft costs such as damage to nature, pollution and accidents are taken into account. The SCBA appeared in the literature in 2000 as a renewed version of the well-known CBA method as a result of the Dutch OEEI guideline[5].

"Despite all the theoretical studies performed on the types of information policy makers can process, the need for transparency and for an active multi-actor involvement in the evaluation and decision process has become politically essential and explains why SCBA became successful" (Haezendonck, 2007). The SCBA includes different assessment procedures and in particular it integrate some participation techniques to include stakeholders in the decision-making process. On the benefit side a SCBA calculates the benefits of a certain infrastructure project to society in terms of welfare. These benefits include travel time gains, better accessibility, safer traffic environment, agglomeration effects and so on.

"In the Academic spheres as well as in public policy the Societal Cost Benefit Analysis can count on some critics as well" (Beukers et al., 2012). Those critics mainly focus on the problems of quantifying softfactors due to an infrastructure project, such as effects on nature. However, translating the soft factors into money makes it possible to involve them into the analysis so that a decision is far better supported. In summary, a SCBA attempts to measure the positive or negative consequences of a project, which may include: effects on users or participants, effects on non-users or non-participants, externality effects and Option value or other social benefits.

To do a correct CB analysis – for public or private investments in cycling - is important to follow an accurate planning composed by different steps: problem analysis; formulation of alternative solutions; identification, quantification and monetization of effects; comparison between cost and benefit; sensitivity analysis and final decision. This CBA planning is reported in figure 1. 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 cycling can play an important role in saving time and money. A new bicycle could cost around 150€, for a new car are necessary 20.000€. Bicycles don't have any maintenance costs, cars' maintenance costs are really high: fixed cost as the insurance and operational costs as fuel, parking, highway costs.

[5] OEEI Onderzoeksprogramma Economische Effecten Infrastructuur - Research Programme on the Economic Impacts of Infrastructure – Netherlands.

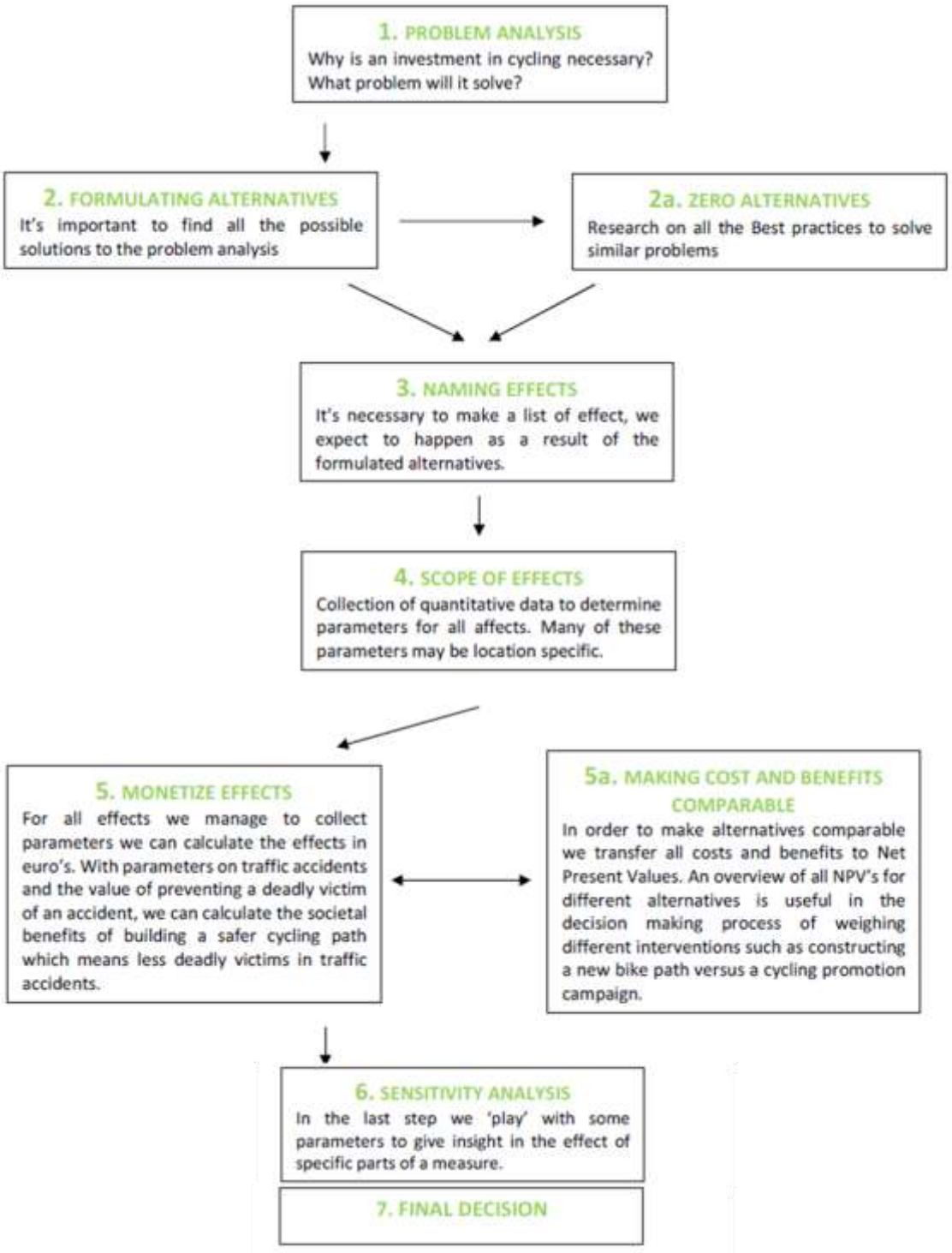

Fig.1 CBA analysis procedure

The operational costs for a small car are estimated around 8.500€ - considering 15.000 km/year -. To this amount a car owner have to had 1.800 € of fixed costs. The city of Hamburg with the project We are the traffic (see figure 2) showed that cycling instead of car driving in ten years could make you save more than37.000€. All these costs related to cycling are not comparable with the costs needed to build new roads, tunnels, railways, (see figure 3).

Traffic and congestion are the main causes that could really extended the costs prolonging everyday trips. Inside Mexico City center to do 20 kilometers it could take more than four hours, this is really a contradiction because it's possible to cover the same distance in less time on foot.

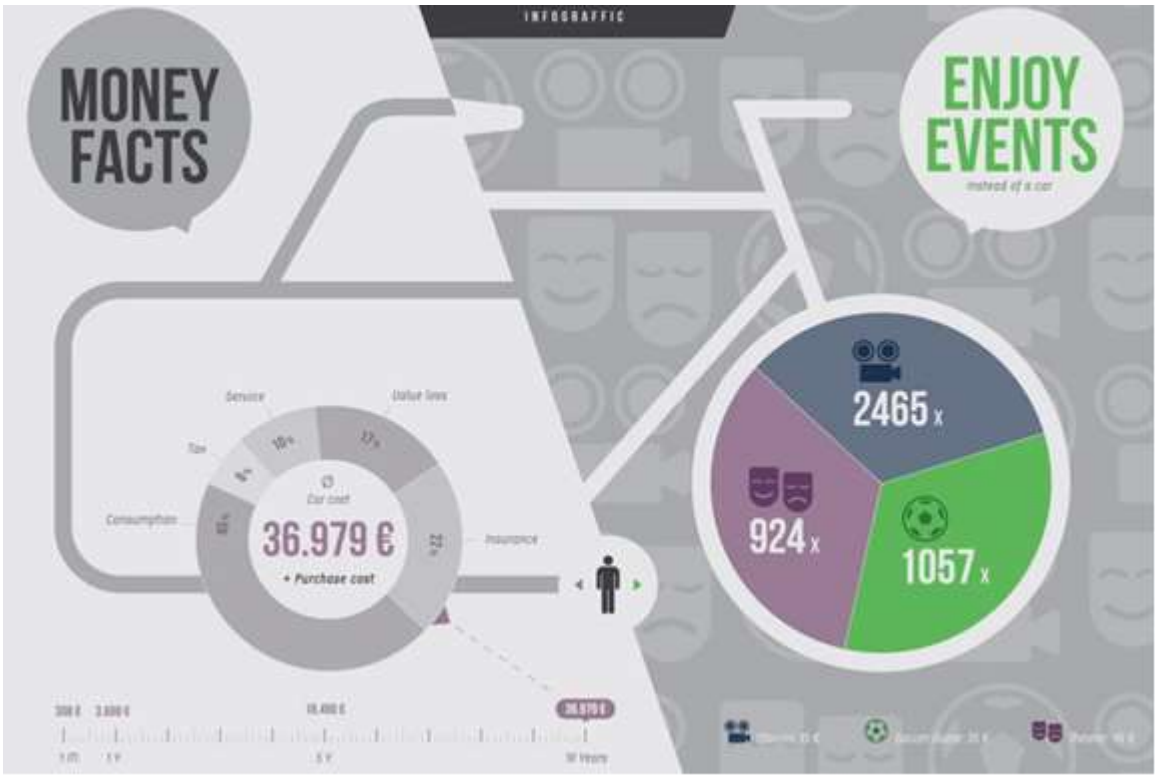

Fig. 2 We are the traffic cycling campaign in Hamburg

1 KM OF…….	IS EQUIVALENT TO N°Km OF BIKEWAY
Rail	29 Km
Road	110 Km
Bus Way	138 Km
Road with tunnels	324 Km
Underground rail	533 Km

Fig.3 Comparison between cycle infrastructure cost and the infrastructure cost of the other mean of transport

Traffic congestion costs Europe about 1% of Gross Domestic Product (GDP) every year. Different cities have already adopted drastic measures: in Sigapore each day could enter a pre-determined number of cars, many Italian towns have a car-free center,… 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.

To do a correct CBA is also important to know which are the drivers or the inhibitors that can facilitate or prevent investments in cycling (see figure 4). First of all is necessary a solid collaboration between national and local Authorities and private companies. Public administration have to give the right example. Which could mean financially invest in cycling infrastructure themselves, but it could also be by providing a Master plan on how cycling should get a more important position in a city's infrastructure.

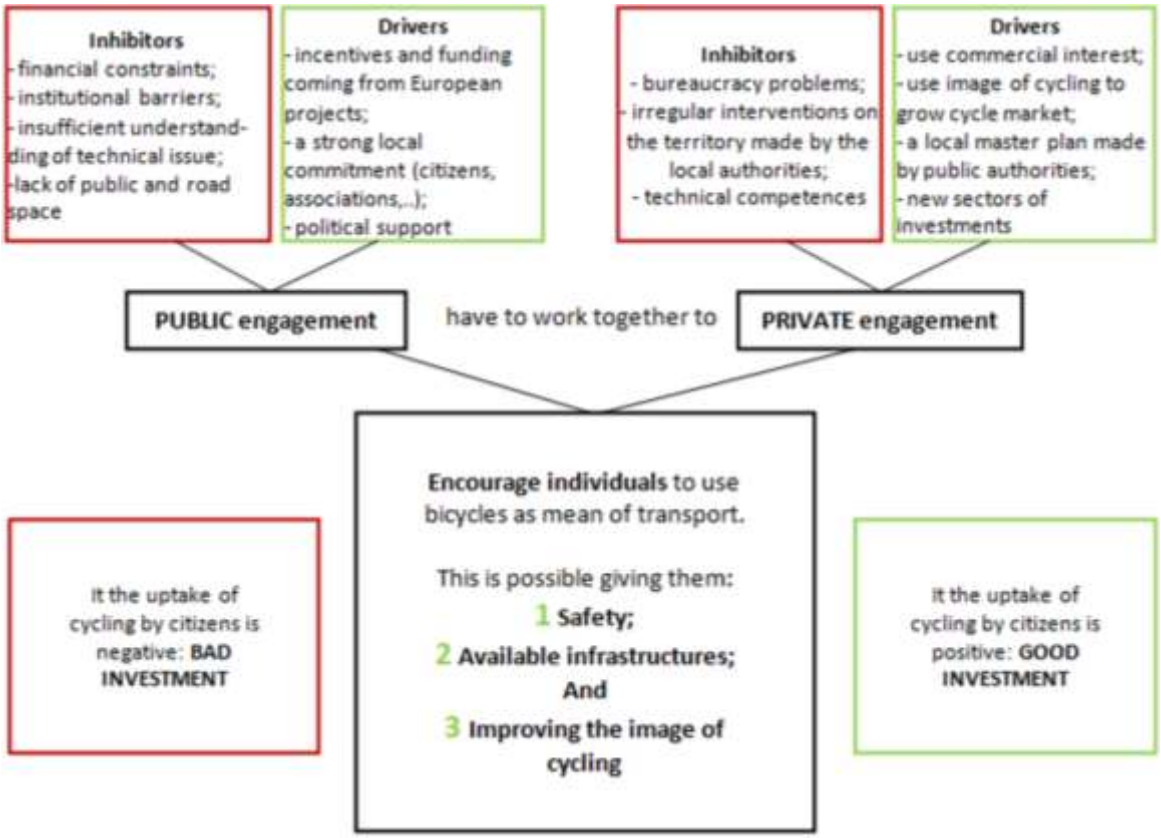

Fig. 4 Drivers or inhibitors that can facilitate or prevent investments in cycling

It's also important to set out a national/local approach to prioritize future investments in capital and revenue spend on cycling, and challenges policy makers to ensure that programs are in place to influence, enable and encourage individuals, families and communities to take part in physical activity and adopt active travel choices. An important driver or inhibitor is connected to the portion of population that will shift towards cycling. Generally if a low uptake is expected, then the cost will probably outweigh the benefits, and thus the investment might not be undertaken.

3 CYCLING COSTS

In Italy there aren't many cycle cities. Public Authorities and administrations are not always aware about cycling's benefits or cycling is not seen as a priority. There is the necessity to spread the reasons that make bicycles important to reduce traffic congestion and pollution for short travels, contributing also to people health. Cycling costs are related to cycling infrastructures/activities. In this paper these costs have been studied. These are the costs associated with the initial construction of an infrastructure and there 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). Other costs are related to maintenance and operational expenses.

Firstly are here reported the infrastructure costs. To understand these costs it's important to have a general description about the type of infrastructure[6]. Infrastructure costs has been divided into four main categories: Travel infrastructure for cycling (A); Bike parking and end of trip facilities (B); Integration of bicycling with public transport (C); Bike sharing system (D).

[6] Type of infrastructures starting from The national Cycle Manual edited by National Transport Authority of Ireland 2014.

The first category, travel infrastructures for cycling, includes infrastructures upon which bicycles can travel and other measures (through infrastructures) that facilitate the flow of cycling traffic. Within this first sub category has been distinguished two kinds of travel infrastructures differentiated by the existence or not of a physical separation of the cycling path from the rest of the road used by other vehicles. Travel infrastructures without physical separation are called Mixed Traffic; they are 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. Examples of Mixed Traffic are: one road bicycle lanes; two-way travel on one-way streets; shared bus/bike lanes; bicycle boulevards; colored lanes; shared lane markings; advanced stop lines (see figure 5).

MIXED TRAFIC	EUROS	UNIT
Bicycle lane on bus lane	51,88	Per meter
Pavement marking	7,59	Per meter
Cycle logo (each)	38,91	Each

Fig.5 Costs of different types of infrastructure in Europe in 2014

Travel infrastructures with physical separation are called Separated Traffic, they are 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. Examples of Separated Traffic are: cycle tracks and off-street paths (see figure 6).

SEPARATED TRAFIC	EUROS	UNIT
Bicycle lane with major junctions	950,82	Per meter (wide 1,5m)
Bicycle lane with simple junctions	345,72	Per meter (wide 1,5m)
Raised white line	17,05	Per meter

Fig.6 Costs of different types of infrastructure in Europe in 2014

Other measures, that facilitate the flow of cycling traffic, are infrastructures where various types of lanes/tracks 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. Indicative examples of this type of investments are: bicycle phases/traffic signals, traffic calming methodologies, way finding signage and techniques to shorten cyclists' routes. All this category includes traffic arrangements that facilitate cycling traffic especially in intersections and involves the construction of cut-through that provide cyclists with more direct ways than motor vehicles (see figure 7).

OTHER MEASURES	EUROS	UNIT
Traffic light	4.447,30	each
Bike route signage	127,46	each
Raised white line	17,05	Per meter
Traffic calming / managed area	345,72	

Fig.7 Costs of different types of infrastructure in Europe in 2014

The existence of the necessary lanes and routes examined in the previous pages 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 importance are the so called End-of-trip facilities. These are infrastructures that cyclists can use when they have reached their destination.
In this vein a categorization that can be made is the following: unsheltered, sheltered, guarded, bike parking; bike lookers; bike rentals; bike repairs; bike washer; showers and changing room.
On a per parking space basis, unprotected outdoor bicycle stands or racks are the cheapest to provide. The only significant cost is the cost of the stands themselves. A single inverted 'U' or post-and-ring stand, which accommodates two bicycles, costs roughly €100-€150 or €50-€75 per bicycle parking space (City of Ann Arbor, 2008). A canopy or shelter for weather protection for twenty bicycles could cost anywhere between €5,000 and €15,000 (€250 to €750 per bicycle), depending on the quality of the design and materials used (Bikeoff, 2008). Bicycle lockers are considerably more expensive. A single bicycle locker can cost from €1,000 to €2,500, depending on the model (see figure 8).

END OF TRIP FACILITIES	EUROS	UNIT
Unsheltered bike parking	100	Per bicycle
Sheltered bike parking	300	Per bicycle
Bike lockers	1500	Per bicycle

Fig.8 Costs of end of trip facilities, City of Ann Arbor Bike Parking for Your Business, 2008

Other infrastructure costs are related to the realization of a new bike sharing system. A bicycle sharing, or bike share scheme, is a service in which bicycles are made available for shared use to individuals on a very short term basis. Each bicycle cost is about €1,000, and the annual operating cost per bike was €1,860[7].
There are other costs related to cycling differently from the over mentioned cycling infrastructure costs. These expenses could be divided into two categories: promotion measures including information, formation and marketing also using new technologies (smartphone app, virtual maps,…) and organization managerial measures including financing.
After constructing any cycling infrastructure and releasing it for usage the maintenance costs have to be considered to prevent the continuous and gradual degradation. This degradation is a combined result due to the usage and other environmental factors. It's important to ensure and to maintain an acceptable level all physical and qualitative properties of an infrastructure making periodically repair. These periodic reparations involve different maintenance costs that are around 1700 €/(km*year)[8]. Some types of investment have also operational costs not only maintenance costs. These cost are related to the normal infrastructure operation. Examples of operational costs are: the salaries of personnel operating bike-sharing system, the energy consumption of lights and of traffic lights. Operational costs for traffic lights, street lights and the like are marginal compared to initial infrastructure investment and maintenance costs.

2.1 PUBLIC AND PRIVATE INVESTMENTS: EXAMPLES AND GUIDE LINES

The over mentioned cycling costs could be effort by Public Authorities, Private companies or private and public subjects in partnership. Private investments in cycling infrastructure are more and more substantial; in Europe and in the North of America exist cycle lanes or bike-sharing programs entirely financed by private investors. Here below are reported different examples to understand how public and private could work together. The Velocity 2025 (Manchester UK) Master Plan from the Transport for Greater Manchester

7 Bike Share Under Consideration, Alexandria Gazette Packet Retrieved May 14, 2011.
8 PSC, Realizzazione e manutenzione straordinaria piste ciclabili, Comune di Firenze 2010.

Fig.9 London Barclays Hire

Committee shows how public and private parties can cooperate in stimulating cycling. The Plan actively engages the private sector to invest in cycling infrastructure. The Barclays Cycle Hire (London, UK) is a good example of combination of public and private investment. Initiated by the municipal government the private investment involved is substantial: Barclays contributed 25 million pounds in exchange for being the name carrier of the prestigious project (see figure 9).

"In countries with a high popularity of cycling like the Netherlands or the Scandinavian countries, cyclists are a very important group of customers for retailers, especially in the city center" (Kastrup, 2013). Bad or missing parking facilities for bikes are an important barrier for people to take their bike for a shopping trip. This should be an incentive for retailers or developers of retail real estate to take care of enough parking facilities for bicycles around the shopping area or in front of shops. Private companies in general could stimulate cycling by investing in parking facilities for bicycles at their own location. Besides stimulating their own employees to take up their bicycle for commuting trips they can stimulate visitors to come by bike as well. "Investments in physical facilities at the workplace that offer better comfort to cycling commuters are called investments in a Bicycle-Oriented-Design" (Phyllis et al., 2010). Bad or missing facilities at the end of a commuting trip can be a major barrier towards cycling for commuters. So the other way around, investments of the employer in a bicycle-oriented-design could encourage the employees to take up their bicycle to work. Opening up bicycle shops therefore can be seen as private investments in cycling infrastructure, in the end even influencing peoples travel mode choice towards cycling. The opportunity of fixing defects like a flat tire in close proximity to a cyclists route makes it far more comfortable to cycle around the city. In Europe, local governments exploit still 27% of the existing bike sharing systems. "However, the future of bike-sharing is to private (or public-private) initiatives as new business models are emerging" (Parkes et al., 2013). The most efficient way to involve private investment is to give to private companies the possibility to show their logos and advertisements for free in public spaces in exchange of their investment in cycle infrastructures (at the bike sharing- stations as for London Barclays Cycle Hire example).

Local governments could involve private investors in several ways according to:

- the advertising model: a private company builds the infrastructure and provides the bike fleet for a bike sharing program in order to have the right advertisements on the streets (at the bike sharing-stations). Local governments mostly exploit the system;
- the sponsor model: another advertisement based business model to realize bike sharing programs. In this case, the local government is the initiator of the program but private companies do (most of) the investment. The program is often named after the sponsor, but exploited by the local government.

Sponsoring professional cycling teams by bicycle manufacturers, or other companies, can be seen as private investment in cycling as well. Reason for sponsoring a cycling team is simple: getting good publicity and eventually growing their market share. There are also private investments connected to health insurances. For employers promoting cycling towards their employees could be a very good economic investment.

The health and wellbeing program of the American bicycle company Quality Bike Products (QBP) shows that offering financial incentives towards employees to commute by bike, results in significant health effects and appurtenant financial benefits. The company offered their employees an account of €110 to buy QBP products and paid € 45.000 on commuter rewards to cycling commuters every year. The program resulted in a 4.4% reduction in health costs associated with a saving of €170.000 over three years.

But what Municipalities have to do to stimulate these private investment in cycling? (see figure 10)

- an active campaign on cycling can encourage private parties to start investing in cycling;
- giving the right example and making a Master Plan on how cycling should get a more important position as a city's infrastructure;
- think about different ways of financing public cycling infrastructure, using commercial interest of private companies (like the right to advertise in public space);
- keep on boosting cycling even if there are political changes in the Public Administration.

First of all, when private companies investments in cycling are requested, Public Authorities have to capture their attention supporting a significant campaign to promote cycling as a daily mean of transport. This could mean financially investing in cycling infrastructure themselves, but it could also be by providing a Master plan on how cycling should get a more important position in a city's infrastructure. Private companies will probably follow public efforts to improve the infrastructure.

When the cycling infrastructure is expanded by public effort, resulting in an increase of cyclists, private companies will follow by investing in parking facilities for instance because people will start to reach their location by bike. Commercial interests can be used to co-finance cycling infrastructure. Sponsoring a bike sharing system has two major benefits for private companies.

First of all it provides advertisement space in the public environment. Besides that, supporting a sustainable transport project is good for the image of a company, which is quite a driver in these times when consumers seem to value Corporate Social Responsibility. Moreover parking facilities at shopping centers or streets should be in the interest of retailers because cyclist are good customers.

4 CYCLING BENEFITS

"The benefits of such cycling are potentially extensive – reduced local noise and air pollution, decrease in emissions of greenhouse gases, improved safety, better fitness levels of the population, as well as changes which are more difficult to quantify such as greater sociability of the urban environment, increased freedoms for children to use the environment and an overall improvement in urban quality of life" (Tight, 2011).

The main socioeconomic benefit of cycling is on the health side. 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. 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. A Danish study proved that women bikers live 2/3 years more and men bikers 4/5. Moreover Tour de France participants live around 8 years more than other athletes (according to a study published on The International SportMed Journal).

Another important aspect is connected to environment, transportation choices contribute to global warming and affect the environment. Three quarters of the volume of CO_2 emissions from land transport operations are produced by road traffic. The greenhouse-gas emissions from air transport and international sea transport must also be taken into account. They are responsible for about 3% (air transport) and 4% (sea transport), respectively, of the CO_2 emissions in the EU-27. In other to measure the real benefits of cycling on the environmental, this research developed a specific methodology to determinate the environmental impacts related to transport systems. The assessment of environmental effects requires identification of:

- thematic areas of influence;
- parameters per thematic area;
- indicators per parameter or thematic area;
- indicators assessment.

Typology of cycling infrastructure	Public investment in cycling		Private investment in cycling	Combination of public and private investment
Travel infrastructures	mixed trafic	On-road bicycle lanes. A stripe separating bicycles from other vehicles.These lanes occupay part of existing roadway	The "Velocity"2025 (Manchester UK) master plan from the Transport for Greater Manchester Committee shows how public and private parties can cooperate in stimulating cycling. The plan actively engages the private sector to invest in cycling infrastructure. The "Barclays Cycle Hire" (London, UK) is a good example of combination of public and private investment. Initiated by the municipal government the private investment involved is substantial: Barclays (an important bank in the UK) contributed 25 million pounds in exchange for being the name carrier of the prestigious project.	Mostly the local government is the initiator of the program but the investment is done by private companies in exchange for advertisement or for being name carrier of the project. What Municipalities have to do to stimulate private investment in cycling? - An active campaign on cycling can encourage private parties to start investing in cycling; - Giving the right example and making a master plan on how cycling should get a more important position as a city's infrastructure; - Think about different ways of financing public cycling infrastructure, using commercial interest of private companies (like the right to advertise in public space); - Keep on boosting cycling even if there are political changes in the public administration.
		Two way travel on one-way streets. In this case bycicle can travel in the opposite direction in one-way streets.		
		Shared bus/bike lanes. Bicycles are allowed to travel on bus lanes.		
		Bicycle Boulevards. These are signed bicycle routes usually on low-traffic streets.		
		Colored lanes. Bicicle lanes more visible thank to the use of color.		
		Shared lane markings. Lanes where both bicycles and cars can travel.		
		Advanced stop lines. It's a marked "box" where cyclist can wait when traffic lights are red.		
	separated traffic	Cycle tracks. There is a physical separation between motorized traffic and cyclist instead of a simple stripe.		
		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.		
	other infrastructures	Traffic signals. Signals dedicated to cyclist.		
		Way finding signage. Sings to help cyclist to find directions for prominent estination.		
		Techniques to shorten cyclist' routes. This category includes traffic arrangements that facilitate cycling traffic especially in intersection.		

Typology of cycling infrastructure	Public investment in cycling	Private investment in cycling	Combination of public and private investment
Bike parking and end of trip facilities	bike parking bicycle rentals bycicle repairs bycicle washer showers and change rooms	bike parking bicycle rentals bicycle repairs bicycle washer showers and change rooms	In this kind of investment the private is the predominant part. These end of trip facilities can create new jobs (bicycle rentals, repairs, washers…) or can be done by enterprises to get better the condition of their employees (showers, bike parking,…)
Integration of cycling with public transportation	Extensive network of parking spots for bicycles close to metro and railway station as well as central bus hub.	Private advertisment in interconnation hot spots.	This kind of investment is typically public, but integrating bicycles with other mean of transports, municipalities can save money for example investing less in busses.
Bike sharing	Bike sharing system and network. At multiple locations throughout a city there are bike-sharing station where people can grab a bike on as-needed basis.	In Europe, still 27% of the existing bike-sharing system is exploited by local governments. According to Parkers et al. The future of bike sharing is to private, or public-private initiatives.	Mostly the local government is the initiator of the program but the investment is done by private companies in exchange for advertisement.
Industry alliances		On the national but also on the European level, bike manufacturers unite themselves in industry networks.	More cyclists mean more bikes and more bikes are good for business. If cycling levels in Europe matched those of Denmark, we would sell 30 million more bikes per year. But even by doubling cycling in Europe, we could increase the market by 10 million bikes.
Professional cycling		Sponsoring professional cycling teams by bicycle manufacturers, or other companies, can be seen as private investment in cycling.	Reason for sponsoring a cycling team is simple: getting good publicity and eventually growing their market share. But why these investments are interesting in the light of investment in cycling in general is the chance of growing the total market for bicycles.
Health insurances' investments		Promoting cycling towards their clients could be an interesting investment for insurance companies.	This kind of investment is typically private, but also public administrations could benefit of it, moreover in Countries where the Health system is guaranteed by National governments.

Fig.10 Integration and synthesis of data analyzed about public and private investments

The first two steps of this methodology are important to identify all the possible environmental impacts caused by transport. This identification starts with an accurate research work on a lot of scientific documents. Step 2 involves quantification of as many as possible of the indicators emerged from previous research stage in order to establish a data basis of unit prices for cycling for each EU country. After the quantification of indicators is possible to compare and to assess all the different means of transport from an environmental point of view.

The five thematic areas of interest, identified by this research- direct or indirect responsible for climate changing - are: Energy use, Air quality-CO_2 production, Noise, Quality of urban space and Land use. For each thematic area, specific parameters and indicators have been identified. This is necessary to correctly asses the real impact of different mean of transport on each thematic area and to give a final evaluation.

The first thematic area is Energy use. The energy exploited by the transportation sector includes energy consumed in moving people and goods by road, rail, air,…. In the IEO2013 (International Energy Outlook) reference case, world energy consumption in the transportation sector increases by an average of 1.1 percent per year. Petroleum and other liquid fuels are the most important component of transportation sector energy use throughout the projection.

The second category is Air quality. Smog hanging over cities is the most familiar and obvious form of Air pollution. But there are different kinds (CO_2, PM_{10}, NO_x, SO_2,..) of pollution—some visible, some invisible—that contribute to global warming. Air pollution harms human health and the environment. In Europe, emissions of many air pollutants have decreased substantially over the past decades, resulting in improved air quality across the region. However, air pollutant concentrations are still too high and air quality problems persist. Environmental Noise pollution is the third thematic area and it relates to ambient sound levels beyond the comfort levels as caused by traffic, construction, industrial, as well as some recreational activities. It can aggravate serious direct as well as indirect health effects. Night-time effects can differ significantly from day time impacts. According to a European Union (EU) publication: about 40% of the population in EU countries is exposed to road traffic noise at levels exceeding 55 db(A); 20% is exposed to levels exceeding 65 dB(A) during the daytime and more than 30% is exposed to levels exceeding 55 dB(A) at night.

With the category Quality of urban spaces are gathered together two different sub-categories: Transport safety and Transport accessibility. The last impact considered is Land use that stands for the space (square meters) occupied by each mean of transport. Then measurable indicators have been found for each urban mean of transport according to the over mentioned thematic area (see figure 11). This process is very important to compare the final direct impact of each mean that derives from the total value obtain considering all the areas. The results obtained demonstrate that bicycles and pedestrians are the best way of transport in terms of almost all the thematic areas - energy use, greenhouse gasses, air quality, noise and land use –except for safety. The cause is the high mortality of cyclist in comparison to the other way of transport. But this negative result could be easily changed creating new cycle lanes, signals and educating both cyclist and car drivers.

This research had also analyses different existing methodologies to assess environmental impacts connected to each way of transport. Cycling is really good for the environment: bicycles don't produce pollution or noise and are a good solution to traffic congestion. Here below are reported two of this methodologies: the GEF and the Evaluating the environmental effects of transportation modes using an integrated methodology and an application.

The GEF developed a manual detailing specific methodologies for calculating the Green Houses Gases (GHG) impacts of energy efficiency, renewable energy, and clean energy technology projects.

			Mean of Trasport				
Environmental impacts	**Parameters**	**Indicators**	**tram**	**bus**	**car**	**bicycle**	**pedestrians**
5.2.1 Energy Use	Typology and quantitative of energy used by each mean of transport	%Fuel used	x	25 l fluel oil/ 100 Km 0,5 l / person 100 Km (avarage capacity 50 people)	7 l fluel/100 Km	x	x
		%Energy from different sources used	5 kwh/km 0,0025 Kwh / person Km (avarage capacity 2000	1 kwh/km 0,02 Kwh / person Km (avarage capacity 50 people)	0,2 kwh/Km	x	x
5.2.2 Green House Gasses	CO_2 introduce in the environment by each mean of transport	% CO_2	33g/person Km	75 g/person Km	237 g/Km	x	x
5.2.3 Air Quality	Analisys of the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere	% PM_{10} ,	x	0,75 g/Km	diesel 0,068 g/km petrol 0,0171 g/km	x	x
		% CO	x	4 g/Km	diesel 0,97 g/km petrol 1,55 g/km	x	x
		% NOx	x	12,5 g/Km	diesel 0,202 g/km petrol 0,07 g/km	x	x
5.2.4 Noise	Analysis of the disturbing or excessive noise that may harm the activity or balance of human or animal life.	n°dB day and intensity (max 55dB)	45 dB	80 dB	70 dB	35 dB	30 dB
		n°dB night and intensity (max 40dB)	45 dB	80dB	70 dB	35 dB	30 dB
5.2.5 Quality of Urban Spaces	Safety	% mortality	0,3 death each billion of km	0,4 death each billion of Km	3,1 death each billion of Km	44,6 death each billion of Km	54,2 death each billion of Km
	Funtionality/Accecibility	% of use in Europe	pubblic trasport 22%		53,00%	7,00%	13,00%
	Upkeen services	cost of upkeen services for infrastructures in a year	not found	8.500 €/(km*year)	8.500 €/(km*year)	1700 €/(km*year)	1300 €/(km*year)
5.2.6 Land Use	Modification of the environment couse to trasportation needs	n° square meters occupied for a km of mean of transport	3000 mq/km (doubble lane)	10000 mq/Km (doubble lane)	10000 mq/Km (doubble lane)	3000 mq/km (doubble lane)	2500 mq/Km (dobble sidewalk)
		n° square meters for services connected to each mean of transport	81 mq*1 tram	38 mq*1 bus	12,5 mq*1 car	0,83 mq* 1 bike	0,5 mq*1 pedestrian

Fig.11 For each thematic area this research produced measurable indicators

This new Manual provides the first methodology designed specifically for projects in the transportation sector. The GEF models are designed to develop ex-ante estimations of the GHG impacts of transport interventions (projects) as accurately as possible, without requiring data so exacting that it discourages investment in the sector.

The methodology provides uniformity in the calculations and assumptions used to estimate the GHG impact over a very diverse array of potential projects. These include projects that: improve the efficiency of transportation vehicles and fuels; improve public and non-motorized transportation modes; price and manage transport systems more efficiently; train drivers in eco-driving; package multiple strategies as comprehensive, integrated implementation packages.

Another methodology to understand transport's environmental impact is reported in a research[9] done by the Department of Industrial Engineering inside the Technical University of Istanbul. Measuring the environmental effects of transportation modes may be a complex process because of the different criteria which approach to the subject from different aspects. However, the criteria that contain uncertainties or cannot be given precisely are usually expressed in linguistic terms by decision makers.

The methodology proposed by the Department of Industrial Engineering of Istanbul, uses a mathematical procedure called fuzzy logic for determining the weights of each criteria. "The term fuzzy logic is used to describe an imprecise logical system, FL, in which the truth-values are fuzzy subsets of the unit interval with linguistic labels such as true, false, not true, very true, quite true, not very true and not very false, etc" (Zadeh, 1975). The Department of Industrial Engineering connects different ways of transport (road, railway, sea, air, multimodal) to different environmental categories: noise, emission reduction, effects on open land, undesirable view, safety, energy resources utilization, transportation capacity of the vehicle, infrastructure of the transportation network, seasonal affect.

Then to find the best way of transport (in environmental terms) this methodology uses the fuzzy logic to give a weight to the abovementioned categories. Then it put in relation this results with all the possible alternatives of mean of transport for a specific travel. To link criteria to alternatives the Department of

[9] Evaluating the environmental effects of transportation modes using an integrated methodology and an application.

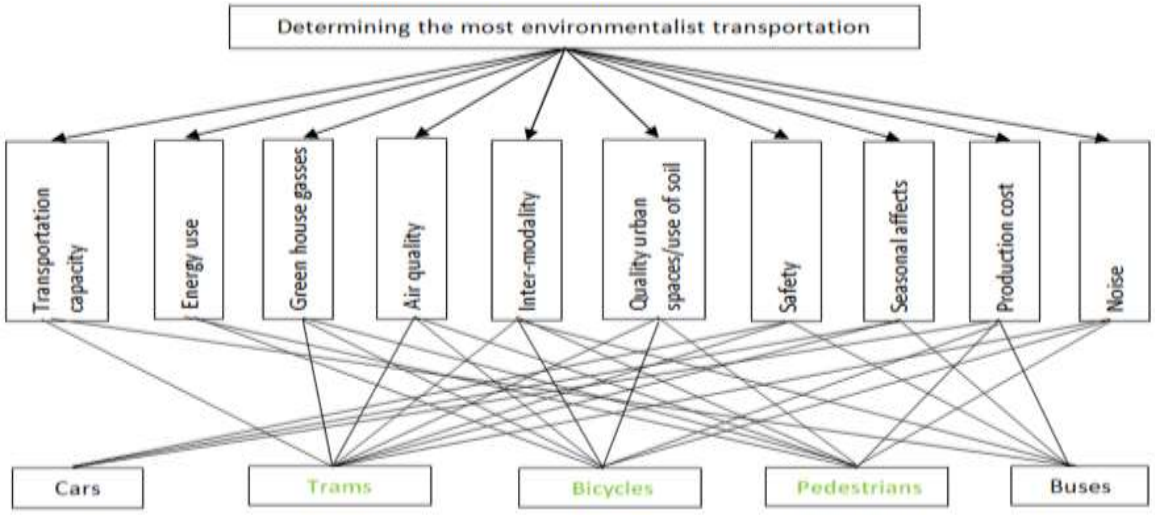

Fig. 12 Hierarchical structure of the criteria and alternatives to determinate the most environmentalist transportation at urban scale

Industrial Engineering's methodology uses a neural network. "The field of transport studies has seen an explosion of interest in neural networks in the 1990s.This can been seen as part of a general pattern of increased use of artificial intelligence techniques in transport" (Kirby and Parker, 1994). This paper adapts this methodology to an urban scale. The research adds new categories (according to the environmental thematic area reported in this chapter) to the Department of Industrial Engineering's methodology: Quality of urban spaces and Land use. From figure 12 is clear that the most environmentalist transportation at urban scale are cycling and walking.

5 CBA ASSESMENT AND CYCLING RECOMMENDATIONS

After reporting cycling costs and benefits, it's possible to precede with the CBA assessment. Cycling networks are generally good for the economy. Calculating all internal and external benefits of cycling together, based on 7,4% of use of the bicycle in Europe, and adding the turnover of related industries, ECF estimates the number to be well above € 200 billion annually, or more than € 400 for every person that lives in the EU. The evidence demonstrates that investments in cycling infrastructure make good economic sense as a cost-effective way to enhance shopping districts and communities, generate tourism and support business. This research reports two examples (one from Denmark and the other from the Netherlands) to assess investment in cycling. In the first study, unit prices are connected to expected effects; different parameters are considered as time, safety, health,…(see figure 13). Using data collected on those parameters it was possible to calculate average costs (benefits) per kilometer for cycling. However this approach is limited by the fact that for some cases no model exists that can perform such calculations. Cycling costs are separated 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 the directly affect him/her. On the contrary external costs are the ones creating externalities to third persons (for example a better quality of air to breath). It is assumed that these costs (benefits) do not enter the cyclists' decision process. The Danish study shows that the unit cost for each kilometer done by bike is 0.60, instead the cost for each kilometer done by car – driving at 50 km/h –is 3.74.
Bicycle kilometer is a Dutch web tool 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.

EFFECT FOR THE ECONOMIC CBA	METHODOLOGY TO QUANTIFY TRAFFIC EFFECTS	DATA REQUIREMENT
Vehicle operating costs	Change in vehicle kilometer by mode, i.e. for different motorized vehicles, public transportation and bicycles.	Traffic counts and/or modeling
Time cost	Change in transport time by transport mode	Traffic counts and/or modeling
Accident cost	Change in the number of accidents with and without bicycles involved.	Accident registrations, traffic counts and/or modeling.
Pollution and externalities	Change in vehicle kilometers for each mode of transportation	Traffic counts and/or modeling.
Recreational Value	Change in cycle kilometers and cyclists' statements.	Interviews and traffic counts and/or modeling.
Health Benefits	Change in cycle kilometers.	Traffic counts and/or modeling.
Safety	Change in the number of accidents, cyclist statements and change in cycle kilometers.	Accident registrations, interviews and traffic counts and/or modeling
Discomfort	Change in cycle kilometers.	Traffic counts and/or modeling.
System Benefits	Change in cycle kilometers.	Traffic counts and/or modeling.

Fig. 13 Methodology to quantify traffic effects. Source, Economic evaluation of cycle projects – methodology and unit prices, 2009, COWI, City of Copenhagen

Behind this tool lies a rich database with key figures on time values, health effects, environmental effects, accidents and so on. When all these figures are translated into a per kilometer value, it is possible compare the costs and benefits of the bicycle to those of driving a car or travelling by public transport. According to this study riding a bicycle is €0,41 more beneficial to society than driving a car per kilometer. So every kilometer on a bike instead of a car has 0,41€ of benefits to society. The effect of lower congestion due to less car kilometers is the largest part of this. Health effects (life years) are relatively low in this case but it's important to notice that these values are applicable to the Dutch case where physical activity is already relatively high. The societal benefits of riding 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.

There are other tolls available on the web as The Health Economic Assessment Tool. The HEAT for cycling is a tool online designed by the World Health Organization. This tool provides quantitative information regarding the health benefits of active transportation (cycling and walking) establishing a methodology for an economic assessment of the health effects. According to this methodology, it results that ride a bike regularly (30 minutes a day) reduces of the 15% the risk of mortality.

This paper wants to show the triple sustainability of cycling: economical, environmental and social. From the CBA proposed it' s evident that investing in cycling, rather than in other way of transport, is fundamental for the sustainable development of towns (less pollution, noise, ...), to ameliorate the quality of life and it's less expensive than investing in cars or public transport. Benefits overpass Costs.

It is important to conclude reporting some recommendations for a good cycling policy:

- cycling policy needs continuous political leadership and coordination from the very top down;
- as the main socio-economic benefit of cycling is on the health side. Health departments should actively reach out to other departments for fully inclusive cycling policies. This also relates to the concept of health in all policies;
- the polluter pays principle is finding more and more political support. The European Commission stated in the White Paper on Transport (2011) the ambition to proceed to the full and mandatory internalization of external costs (including noise, local pollution and congestion);
- to use European funding to create a mixed partnership (public and private) to promote projects in cycling;
- to do Sustainable Mobility Plan that includes a CBA. This report shows that almost every CBA on cycling investment turns out to be very positive; the social costs outweigh the benefits by far;
- to consider cycling as an integral part of the total Mobility Plan of a city. Synergies with public transport are an important part of that;
- to work for a new green economy including bicycles considering that: cycling spend more than car drivers; cycling employees are more productive and deliver better quality; the cycle economy ensures economic and social gains.

REFERENCES

Akinder, M. (2010). Policy Manual for Calculating Greenhouse Gas Benefits of Global Environment Facility Transportation Projects. New York: UNEP.

Banister, D. (2008). The sustainability mobility paradigm. (15) 73–80. Elsevier: USA.

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, 68–78. USA: Elsevier.

Cecchini, A., & Talu, V. (2011). Camminare (e pedalare) per trasformare la città. *TeMA Journal of Land Use, Mobility and Environment* (4), Mobilità e Conflitti, 4/11, 99-108, ISSN 1970-9870. Napoli: Università degli Studi di Napoli Federico II. http://www.tema.unina.it

Cramer, M. (2009), Soft mobility Measures for a climate-friendly transport policy in Europe, Brussels: The Greens.

Department of Industrial Engineering, Mechanical Faculty, Yildiz Technical University (2009), Evaluating the environmental effects of transportation modes using an integrated methodology and an application, Vol.6, 277-290, Iran: International Journal of Environmental Science & Technology.

Dougherty, M. (1995). A review of neural networks applied to transport. Vol.3, 247–260. USA: Elsevier.

Ege, C. & Krag, T. (2002). Cycling will improve environment and health. Vol.37, 766-777. USA: Elsevier.

European Commission (2009). A sustainable future for transport: towards an integrated, technology-led and user friendly system. Luxemburg: Publications Office of the European Union.

European Parliament (2012). The European Cycle Route Network Eurovelo, Challenges and Opportunities for Sustainable Tourism. Brussels: Publications Office of the European Union.

EU transport (2014). European statistical pocketbook. Belgium: Publications Office of the European Union.

Haezendonck, E. (2007). Transport Project Evaluation: Extending the Social Cost-Benefit Approach. Amsterdam: VU University Amsterdam.

Institute for sensible transport (2012). Integrating cycling with public transports. Australia: Queensland.

La Rocca, R. A. (2010). Soft Mobility and Urban Transformation. *TeMA Journal of Land Use, Mobility and Environment*, Selected Paper, (SP.09) 3/10. doi: 10.6092/1970-9870/2f493. ISSN 1970-9870. Napoli: Università degli Studi di Napoli Federico II.

London Borough of Merton (2014), Analysis of private investment infrastructure. UK: Project CycleCities.

Mackie, P. (2010). Cost-Benefit Analysis in Transport: A UK Perspective. Mexico: Publications Office of the International Transport Department.

May, A.D., Page, M., & Hull, A. (2008). Developing a set of decision-support tools for sustainable urban transport in the UK. Vol 9, 184-201. UK: EJTIR.

Mouter, M., Annema, J., & van Wee, B. (2013). Cost-Benefit Analysis in Practice. Belgium: Nicis Institute.

Municipality of Genoa & DICCA-University of Genoa (2014). Analysis of environmental aspects, enrichment of individual reports, development of synthesis report. Italy: Project CycleCities.

Odgaard, T., K, C., Laird, J. (2005), Current Practice in Project Appraisal in Europe, Trafikdage Aalborg Universitet, DK: Institute for Transport Studies.

Regional Development Agency of Gorenjska - BSC, Kranj (2014). Analysis of public investment costs, inhibitors and externalities. Slovenia: Project CycleCities.

Rotaris, L., Danielis, R., Marcucci, E., &Massiani, J. (2010). The urban road pricing scheme to curb pollution in Milan, Italy: Description, impacts and preliminary cost-benefit analysis assessment. Transportation Research, (Part A) 359–375., USA: Elsevier.

Saelens, B.E. et al (2003). Environmental Correlates of Walking and Cycling: Findings From the Transportation, Urban Design, and Planning Literatures. Annals of behavioral medicine. DK: Publications Office of the Danish Ecological Council.

Tight, M. (2011), Visions for a walking and cycling focussed urban transport system. Institute for Transport Studies. UK: University of Leeds.

Vickerman, R. (2000). Evaluation methodologies for transport projects in the United Kingdom. Transport Policy Vol.7, 7-16, USA: Elsevier. doi:10.1016/S0967-070X(00)00009-3

Whitelegg, J. (2008). Integrating Sustainability into the transport. Stockholm Environment Institute. UK: University of York.

Zadeh, L. A. (1975). Fuzzy logic and approximate reasoning. India: India Statistical Institute.

IMAGE SOURCES

Cover: Cycling in Amsterdam, Jorge Royan Phot
Fig. 1, fig. 3, fig. 4, fig. 10, fig. 11, fig. 12: elaborated by the authors
Fig. 2: Björn Lexius and Till Gläser image
Fig. 5: Regional Development Agency of Gorenjska BSC, Siebe Visser, Kees van Ommeren – Decisio, Pascal van den Noort – Velo Mondial, Slovenia, 2014
Fig. 6: National Transport Authority of Ireland, 2014
Fig. 7: National Transport Authority of Ireland, 2014
Fig. 8: Bike Parking for Your Business, City of Ann Arbor, 2008
Fig. 9: Mariordo (Mario Roberto Duran Ortiz) Photo
Fig. 13: City of Copenhagen, 2009

AUTHORS' PROFILES

Francesca Pirlone

PhD, engineer and assistant professor in town planning at Polytechnic School - University of Genoa. She has developed different lines of research, from requalification, natural risks, sustainability, infrastructures and mobility, activities carried out in particular in EU programs. Author of numerous publications and speakers at International and National Conferences.

Selena Candia

She is graduated in architecture and construction engineer. Actually she is working for the Municipality of Genoa – Culture and Tourism department - European Project Office as European project manager. She managed different European projects about sustainable development and urban regeneration.