ASSESSING THE POTENTIAL HEALTH BENEFITS OF CYCLING AT THE CITY OF VIANA DO CASTELO

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ABSTRACT

Mobility has an important impact on the overall functioning of cities and quality of life of citizens. On the other hand, motorized road traffic is associated with high levels of noise and air pollutant emissions along with congestion and other externalities, leading to considerable social and environmental costs and degradation of human health. Following the World Health Organization, physical inactivity is one of the leading risks in Europe, associated with nearly 1 million deaths per year. In Portugal around 69% of the adult population do not reach the minimum recommended level of physical activity and 31% were considered sufficiently and highly active. Therefore, more sustainable transport modes such as walking and cycling are envisaged.

This paper is built upon the contracted work with the city of Viana do Castelo, located in the North of Portugal, conducted for the World Health Organization (WHO) by the University of Minho and LNEC. The work integrates a research roadmap (case study plan for the application of the Health Economic Assessment Tool) for the appraisal of health benefits of specific walking and cycling investments in the city. The work presented here focus on the former part of the study which involved joint team work with the city officers for defining the target policy scenarios for using the WHO Economic Assessment Tool, the exchange of experiences and practices with other European cities regarding the use of this tool for health benefits assessment, the characterisation of the mobility patterns at the reference and alternative policy scenarios set for the cost-benefit analysis, the data collection plan and the expected impacts from the early consideration of health benefits of those non-motorized investments. Results from the evaluation study can help the City elected officials to demonstrate the health benefits of walking and cycling investments. Individuals' awareness and perceptions of the health benefits of cycling and walking are important to encourage people to uptake active mobility styles.

Keywords: Health Economic Assessment; World Health Organisation; Walking and Cycling; Cost-Benefit Analysis; Sustainable Mobility; City of Viana do Castelo.

1. INTRODUCTION

According to the World Health Organisation (WHO), the leading global risks for mortality in the world are high blood pressure (globally responsible for 13% of deaths), tobacco use (9%), high blood glucose (6%), physical inactivity (6%), and overweight and obesity (5%). These risks are responsible for raising the risk of chronic diseases such as heart disease, diabetes and cancers. They affect countries across all income groups: high, middle and low (WHO, 2009).

Table 1 presents the number of disability adjusted life years lost (DALYs) and mortality due to the nine leading risk factors in Europe, estimated for 2004. It shows that physical inactivity is one of the leading risks, associated with nearly 1 million deaths per year.

TABLE 1: Attributable DALYs and mortality by risk factor and income group in Europe
(Source: WHO 2009)

	Attributable DALYs			**Attributable mortality**		
Risk factor	Total	High income countries	Low and middle income countries	Total	High income countries	Low and middle income countries
Population (millions)	883	407	476	883	407	476
	(000)	*(000)*	*(000)*	*(000)*	*(000)*	*(000)*
Tobacco use	17725	5526	12199	1472	595	877
Alcohol use	17342	3165	14177	618	25	593
High blood pressure	17121	3807	13314	2491	740	1752
Overweight/ obesity	11758	3132	8625	1081	318	763
High cholesterol	8975	1859	7116	926	242	684
Physical inactivity	**8264**	**2189**	**6075**	**992**	**301**	**691**
High blood glucose	7304	2308	4996	748	258	490
Illicit drug use	2395	937	1458	45	11	33

In 2004, the WHO estimated that 20% of the European population was inactive, 43% insufficiently active, 18% moderately active and 20% was highly active. However, for high income countries, the values are slightly different. In Portugal, 69% of the adult population do not reach the minimum recommended level of physical activity and 31% were considered sufficiently and highly active (WHO, 2009).

In 2010, the European Commission published a Eurobarometer survey on sport and physical activity and concluded that 40% of EU citizens play sports at least once a week and that 65% of EU citizens get some form of physical exercise at least once a week. However, 34% of respondents say that they seldom or never do physical exercise. On the other hand, on average men in the EU play more sports than *women ceteris paribus.* However, this difference is more evident in the 15-24 age group. The amount of sport people play tends to decrease uniformly with age. In regional terms, the citizens of Mediterranean countries tend to exercise less than average, while the citizens of the Nordic countries and the Netherlands can be considered the most physically active in the EU (EC, 2010).

The WHO recommends that children can participate in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily. The Health Behaviour in School Aged Children (HBSC) 2005/06 survey showed that there is a tendency for higher reporting of daily MVPA among younger children. In the majority of the surveyed countries, there are significantly higher levels among 11-year-olds than 15-year-olds for both boys and girls and 22% of girls and 30% of boys of 11-year old report at least one hour of daily MVPA (Currie et al, 2008).

Physical activity reduces the risk of cardiovascular disease, some cancers and diabetes type 2. It can also improve musculoskeletal health, control body weight and reduce symptoms of depression. Physical activity occurs across different domains, including work, transport, domestic duties and during leisure (USDHHS, 2008). In high-income countries, most activity occurs during leisure time, while in low-income countries most activity occurs during work, chores or transport. Physical inactivity is estimated to cause around 21–25% of breast and colon cancer burden, 27% of diabetes and about 30% of ischemic heart disease burden (WHO, 2009).

Active mid-life and older individuals, of both sexes, have approximately a 30% lower risk of developing moderate or severe functional limitations compared with inactive individuals. On the other hand, there is a 20% to 35% lower risk for coronary heart disease (CHD), cardiovascular disease (CVD) and stroke morbidity and mortality. Aerobic physical activity of around 3 to 4 hours per week at moderate or greater levels of physical intensity have on average a 30%, 20% to 40% reduction in colon and breast cancer risk, respectively, compared with those who are sedentary. At least 30 to 60 minutes per day of MVPA is required to significantly lower the risk of colon and breast cancer. In comparison with sedentary people, active people have approximate reductions in risk of lung, endometrial, and ovarian cancers of 20%, 30%, and 20%, respectively. Active men and women have approximately a 30% lower risk of dying prematurely considering all-cause mortality, compared with inactive individuals (USDHHS, 2008).

The objective of this paper is to present the first phase of the study being conducted for the WHO by the City of Viana do Castelo/University of Minho/LNEC (City team) that comprises the application of the Health Economic Assessment Tool (HEAT) for analysing cycling and walking investments. The HEAT focus on the consideration of the health benefits in economic evaluation and results can represent a very important drive to adopt local policies towards active transport modes and healthier lifestyles. The municipality of Viana do Castelo integrates the *WHO* European *Healthy Cities Network.*

The remainder of this paper is organized as follows. Section 2 provides an overview of the challenges posed by recent national and local projects on sustainable mobility, having the participation of the City team. Section 3 starts by introducing the importance of assessing the health benefits of active transport modes such as walking and cycling and the potential use of the HEAT software developed by the WHO. It then presents the development of policy scenarios, data collection and expected results and policy impacts. Finally, key findings are presented and main conclusions outlined in section 4.

2. PROMOTING CYCLING AT THE CITY OF VIANA DO CASTELO

The city of Viana do Castelo joined the movement of the WHO Healthy Cities in 1997, aiming to apply principles that guarantee Health for All (HFA). These followed the guidelines of the Ottawa Charter at local level, in order to integrate all activity in an intergenerational perspective, ensure citizen participation, integrate all sectors, give particular attention to the problems of 'minority' groups, and facilitate access by diversifying opportunities.

Based on the health profile of the population of the municipality of Viana do Castelo, seven priorities for action were established, as set out in the Development Plan in Health, such as: the prevention of cardiovascular disease (the leading cause of death); promotion of accessibility for disabled people; urban rehabilitation and environment; health communication; health impact assessment; integration of migrants; and, promoting active and healthy aging.

The municipality of Viana do Castelo, through its Healthy City Project, defined the priorities for action, in the 2007-2015 Development Plan for Health, to ensure a safe and healthy environment and to promote sustainable mobility. To this end, the project "Come and Go without Polluting" was launched, mainly to encourage people to use forms of transport alternative to the car.

Among various options to ensure sustainable mobility, the project sets out the following objectives: the use of the bicycle for which were built cycle lanes and parking facilities for bicycles in various parts of the city; the promotion of walking, by creating a set of urban routes, the ‘Healthy Footprint’, which constitutes an alternative to mobility as it promotes the practice of physical exercise and also allows the enjoyment of various city spaces; and the incentive to adhere to the practice of car-sharing by residents. This project also created a brochure, which contains information about the various means of transport in the city. As in other cities across Europe, the city adhered to the European Mobility Week and to the European Car Free Day, with the accomplishment of various activities related with mobility, which aimed to improve the environment and quality of life in cities, contributing to a better style of living.

In 2007 the city of Viana do Castelo was involved in the Portuguese Sustainable Mobility Project. This project involved a research network and specific protocols for the development and consolidation of Sustainable Mobility Plans for a total of 40 selected municipalities. The main goals were the improvement of mobility/accessibility conditions, the reduction of the environmental impacts from transport, while enhancing the quality of life of citizens in the municipalities, especially in major urban areas, in order to achieve the principles of sustainability, ensuring a harmonized approach and sustained response to common problems in terms of mobility. Both the University of Minho and LNEC participated actively in the Sustainable Mobility Project.

The Sustainable Mobility Plan of the city of Viana do Castelo focused on the diagnosis of the existing situation of city's mobility, the definition of the principal objectives and scope of interventions in order to achieve sustainable mobility by the development of some proposals. This plan involved the most important urban agglomerate of the city and its surroundings, covering an area of 33.6 km^2 and a resident population of 36545 inhabitants. The city is very attractive for tourists and residents due to its natural landscape on a spread valley around the mouth of the Lima River, where most of the resident population lives, as illustrated in Figure 1. The city transportation system integrates a large number of different transport modes, namely trains, buses, ferryboats, cyclists and pedestrians for a mid-sized city. This provides an opportunity to develop and apply a multimodal approach towards a more sustainable city environment, especially to encourage a more effective and sustainable use of the system and to promote greener modes of transport, like pedestrians and cyclists, or other less pollutant modes.

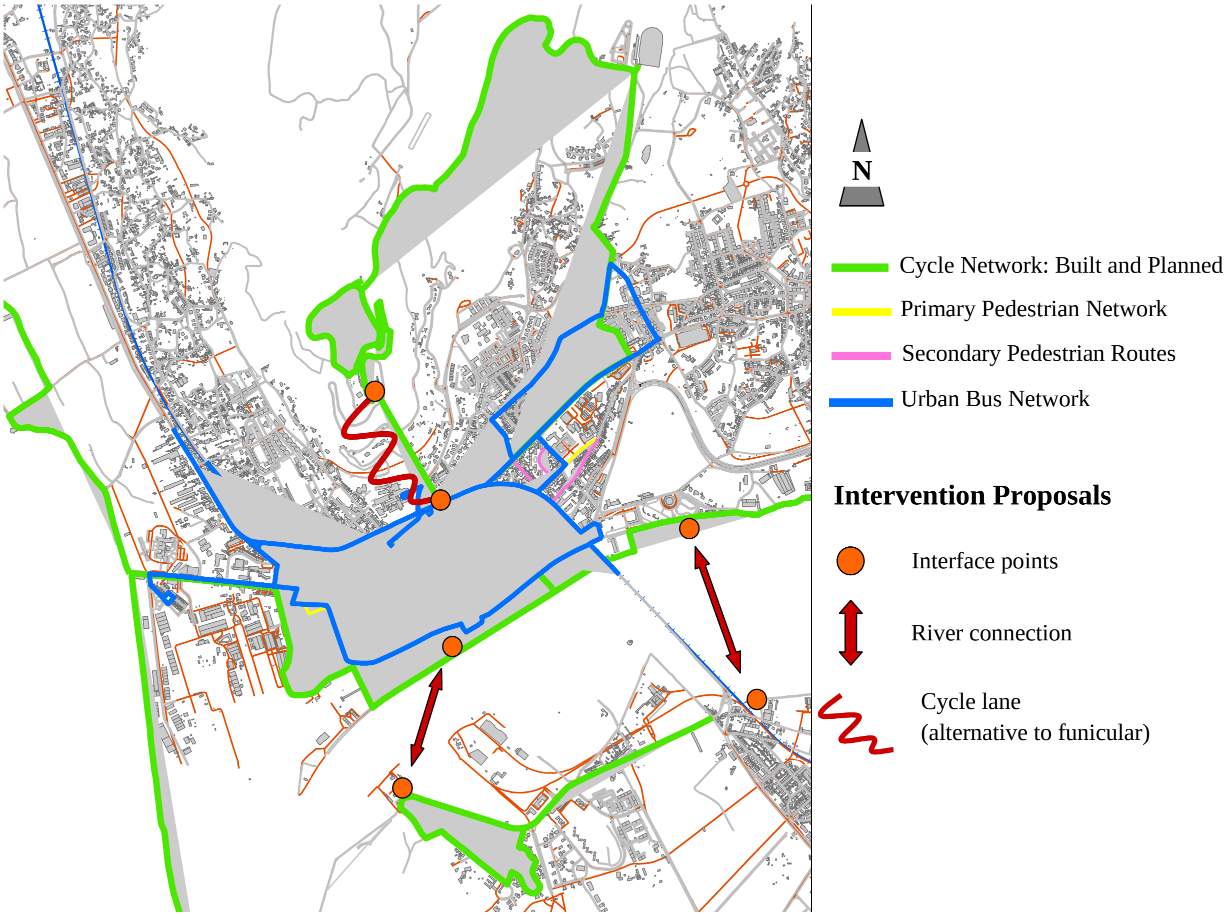
After the diagnosis and characterization of the city's mobility system, it was necessary to understand the main strategies and concepts that city authorities have in relation to the achievement of more sustainable urban transport mobility (Mendes et al, 2008), which were the adoption of innovative solutions of mobility, the enhancement of the importance of railway transportation on the global mobility system, and the reinforcement of the status of an healthy city with the control and monitoring of the negative impacts of the functioning of the transportation system.

FIGURE 1: Overview of the City of Viana do Castelo
(Source: Google Earth, 2012)

Active modes of transport and public transit play an important role in obtaining more sustainable mobility standards, though this is strongly dependent on political intentions, for that key concepts should be clearly defined by local transport authorities to promote an integrated model of transports. A key point to encourage citizens towards the accomplishment of this goal is the development of comfortable physical interface infrastructures.

Figure 2 shows the multimodal mobility proposal for the city of Viana do Castelo based on the linkage/integration of all transport modes, especially the connection of the entire system with the pedestrian and cyclist network, with the identification of the main interface points. Based on the cycle lane network, it is indeed possible to develop an integrated concept of global multimodality for this city. The core of the case study area has a good supply of pedestrian streets that correspond to the main pedestrian routes. The pedestrian network spreads along the city, mainly around the most important facilities. Nevertheless, other improvements on buses, trains, and ferryboats must be developed to allow, for example, the transport of bicycles. Moreover, the creation of multimodal tickets for all of this mass public transport could be developed in order to promote more sustainable travel patterns.

FIGURE 2: Multimodal Approach: intervention proposals
(Source: Mendes & Ribeiro, 2008)



In the last decade, city authorities have applied a large number of actions in order to restrict the circulation of motorised traffic in the inner city and to improve the service of the more sustainable ways of travel like public transport (trains and buses) and walking. In this context, the city can be considered a walkable city but it is not yet a bikeable city, due to the lack of cycling infrastructures, as well as of cyclists. However, the city is spread out in a radius of less than 3 km characterized by small slopes that give a flat character to this foothill area, and confer a unique opportunity to enhance cycling in the city. Furthermore, the integration of cycling in the city's mobility system can be achieved through the implementation of cycling facilities along the cycle network, namely with parking places, resting areas with seats and water services, city information, among others.

Cyclists are another important green mode and these do not necessarily require a physical associated infrastructure in all situations. However, the cycling infrastructure is being improved with time, with the construction of around 9 km of cycle lanes (Table 2). A relevant aspect of this cycling network is its integration with an elevator, the "funicular", which is another singular travel mode best suited for tourism and sport activities, enabling to travel up and down the most important hill of the city, as illustrated in Figure 3.

TABLE 2: The Viana do Castelo Cycling Network

Cycle lane	Length (m)
Built	8137
Connection by funicular	894
Planned - Approved	14657
Under study	9584

FIGURE 3: Cycling Network (a- existing situation; b- planned)

a) Existing situation

b) Planned – approved and in study

On the other hand, there is an important part of the city's mobility system that was designed for the circulation of private cars, especially in the surrounding area of the historic city centre, which is currently almost exclusive to pedestrians. Since bicycles are vehicles, these cannot circulate in pedestrian spaces, such as pedestrian streets, so cyclists need to travel in roads that were designed for traffic, sharing the space with cars and buses.

In Viana do Castelo, cycling represents a small part of the modal distribution of the city's transportation system. To improve these numbers and promote healthier ways of travel in the city, namely in the historic central area, the municipality defines some political strategies in transportation and urban planning, according to the city's development. Nowadays, all projects that integrate some changes in streets layout or in other public spaces should include the introduction of cycling infrastructures, such as cycle lanes, parking places and cycling support facilities. However, the municipality is concerned with the investment for the construction and completion of the planned cycle network, illustrated in Figure 3, due to financial restrictions. To help technicians and politics in the decision-making process, it is very important to estimate not only the costs, but also all benefits of the investments, particularly those that affect and improve citizen's quality of life, namely those health-related, which usually are not included in economic evaluations of transportation projects in the city and could justify and clarify some unpopular decisions.

In the last ten years, the historic city centre has undergone some physical interventions, namely related with the reconstruction of some public city spaces, as represented in Figure 4. All interventions included improvements on cycling and walking facilities, such as the construction of a park in the eastern sector of the city and the introduction of cycle lanes and comfortable and secure footways on western sector of the city.

FIGURE 4: Main Interventions in Public Spaces in the case study area

3. THE WHO HEALTH ECONOMIC ASSESSMENT TOOL FOR CYCLING AND WALKING

3.1 The importance of assessing the health benefits of active transport modes

Economic appraisal methods such as cost-benefit analysis (CBA) are common tools for the evaluation of transport plans, programs and projects. However, the literature shows that cycling and walking investments are seldom evaluated using the standard CBA tools that are currently applied to other transport modes such as road and airport infrastructures. Impacts of non-motorized modes have been undervalued in comparison to other transport modes in transport planning (Borjesson and Eliason 2012). The number of economic studies on the economic appraisal of cycling is, however, higher than those related to walking.

Although the CBA of road transport improvements was mostly concentrated on standard users' benefits such as travel time savings and those from the expected reduction of road accident rates. Increased attention is now dedicated to improved CBA methodologies to account for environmental externalities and health related impacts. Regarding walking and cycling investments, it is increasingly recognised that health effects can represent important benefits to communities. Rabl and Nazelle (2012) found that shifting from car to active transport modes such as cycling had higher health benefits (due to increased regular physical activity) and these would outweigh the costs of increased exposure.

Overall, physical activity is associated to improvements in well-being and quality of life. From a public health perspective benefits on morbidity such as those related to type II diabetes and musculoskeletal health, are most likely perceived by walkers and cyclists as potential immediate effects/improvements. On the other hand evidence on expected reductions in mortality, although more abundant, are more difficult to be understood by potential users. However, as mentioned by the WHO the inclusion of morbidity in an economic appraisal leads to greater uncertainty.

The WHO work already proved a strong consensus that higher levels of physical activity are associated with higher health benefits (physical activity has a dose-response relationship with most health outcomes). Therefore, investments in cycling and walking if associated with higher levels of traffic are also associated with a reduction in risk. For accounting the increase in total physical activity in economic appraisal, it is recommended to verify if any activity substitution occurred (e.g. a shift from walking to cycling and using a shorter cycle path may lead to less levels of overall physical activity).

As part of the Transport, Health and Environment Pan-European Programme, the WHO has developed an economic assessment tool of health effects for walking and cycling – the HEAT tool (WHO 2007; WHO 2011). This tool is intended for aiding transport planners, traffic engineers, health economists and those involved in the economic analysis of cycling and walking plans, programs and projects.

Being a support instrument for economic decisions, the HEAT tool is also an important awareness tool for the promotion of active modes at the community level. The evaluation of the health benefits of walking and cycling can represent an important step for moving towards more sustainable models and healthy lifestyles at the community level.

3.2 The application of the WHO HEAT tool in the city of Viana do Castelo

3.2.1 Functioning of the HEAT tool

The objective of the HEAT tool for walking and cycling is to support the estimate of potential health benefits and, hence, to aid the cost-benefit analysis of investments on active transport infrastructures.

The HEAT assessment focus is on long-term average activity behaviour of pedestrians and cyclists, focusing on the habitual behaviour of groups of people (and, thus, not individual behaviour) and regular commuting or regular leisure time activities. The relative risk values adopted in the HEAT tool refers to adult population of the age group 20-64 years, since no information was available on the relative risk for younger or older age groups.

The HEAT tool estimates the maximum and the mean annual benefits in terms of reduced mortality of cycling investments. Besides the total annual benefit, values are expressed per cyclist and per trip. The HEAT can be applied in a number of planning situations. More simply, the HEAT tool can help to answer the following question (WHO 2011):

> If *x* people cycle a distance of *y* kilometres on most days, what is the economic value of the health benefits?

In the above question, the health benefits are those that result from the reduction in mortality due to the potential increase in the physical activity levels.

Therefore, the tool is considered as "input to comprehensive cost-benefit analysis of new transport infrastructures or for assessment existing infrastructures" (WHO 2011). It shall be noted that improving walking and cycling has several other categories of benefits such as user benefits derived from increased accessibility, user convenience, enjoyment and comfort, the option value related with having mobility options available to use in the future and equity benefits of economically, socially or physically disadvantaged people (Litman 2012).

The HEAT tool is based on the best available evidence. The basis of the relative risk data is from the Copenhagen Centre for Prospective Population Studies. The relative risk for all-cause mortality was found to be 0.72 among commuters aged 20-60 years who regularly cycled to and from work, relative to the general population.

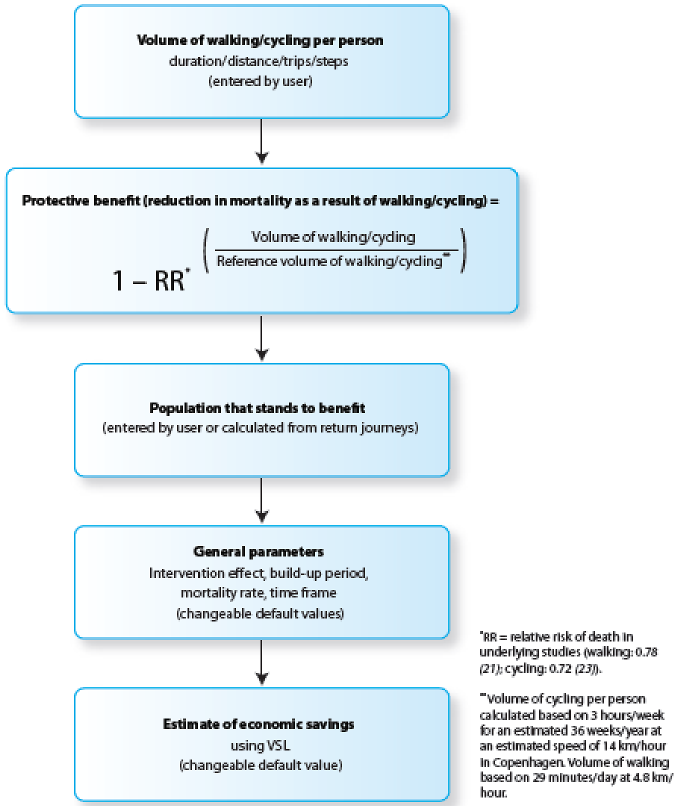
The HEAT tools works with the data entered by each user (e.g. total number of trips per days cycled; distance cycled per trip) and estimates the total economic savings (aggregate estimate) due to all-cause mortality amongst cyclists or walkers. The tool assumes a linear dose-response relationship between all all-cause mortality and physical activity levels (risk reduction for higher total activity levels). It provides an estimate of economic savings based on reduced mortality among cyclists in the study area. The following value estimates can be produced (example for the case of cycling):

a) maximum annual benefit as the total value of reduced mortality due to the level of cycling; b) savings per km cycled per individual cyclist per year; c) savings per individual cyclist per year; d) mean annual benefit; e) present value of mean annual benefit.

The key output of the HEAT tool is the mean annual benefit. It adjusts the maximum annual benefit (total value of lives saved due to the levels of cycling entered by the user in each context) by three main factors (WHO 2008): i) timeframe over which benefits occur (mortality reductions within 5 years of a change); the default value for this timeframe is 10 years ii) period of cycling uptake (between 1 and 25 years); iii) discount rate to account for the present value of mean annual benefit, to be entered by each user (the default value is 5%).

The basic functioning of the HEAT tool for walking/cycling is represented in Figure 5.

FIGURE 5 Basic Functioning of HEAT
(Source: WHO 2011)



When using the HEAT tool it shall be dedicated particular attention to the interpretation of default parameters (these refer to specific contexts/data). These default parameters can be changed only if reliable local data or evidence from studies is available. For example, the mean number of days cycled per year has a default value of 124 days per year but this was reported in a study carried out for the city of Stockholm (Schantz et al. 2008). The value of the proportion of these trips that are one part of a return journey is set at 0.9 (this means that 90% of cyclists travelling in one direction will be assumed to make the return journeys). The default value for the proportion of trips undertaken by people who would not otherwise cycle (new users as a result of the cycling infrastructure provision or policy) is set as 0.5. The average cycle speed is 14 km/hour (estimated distance of 4km per trip based on commuting studies for Stockholm by Schantz et al. 2007).

As already mentioned, the HEAT tool for cycling refers to active age groups that are most likely to cycle (25-64 years). The default value for the relative risk of all-cause mortality is set at 0.005847, the average for the WHO European Region according to the European Mortality Database (WHO 2007). The default value for the value of statistical life is EUR 1.5 million. Table 1 provides an overview of the scope to use HEAT for cycling and walking.

TABLE 3: Comparison of the scope for the use of the HEAT tool

Use of HEAT conditions→	**Cycling**	**Walking**
Group population target	20-64 years	20-74 years
Type of behaviour	Habitual behaviour (e.g. home-work commuting trips)	Habitual behaviour (e.g. home-work commuting trips)
Source for risk data estimates	Three combined cohort studies for Copenhagen (Andersen et al. 2000)	Meta-analyses of studies
Dose-response/ Physical activity and morbidity and mortality	All-cause mortality	All-cause mortality
Activity level conditions to verify	Not suited for populations with very high average levels of cycling (around 1.5 hours per day or more)	Not suited for populations with very high average levels of walking (2 hours per day or more)

3.2.2 Development of the Policy Scenarios for the HEAT Analysis

One of the objectives of the City of Viana do Castelo/University of Minho/LNEC (City team) was to select which local investment actions are most suited for applying the HEAT tool in the context of the City, having in mind the focus on the assessment of the health benefits of walking and cycling plans.

Indeed, the HEAT tool can be used in a wide number of planning and policy situations, as follows:

- Cycle Planning: ex ante assessment of the impact of different levels of cycling; benefit-cost ratio indicator of the investment;

- Valuation of health benefits (in terms of reduced mortality) related to different levels of cycling;
- Prospective health impact assessment studies (e.g. benefits that result from achieving national targets for increases in cycling levels).

The City team agreed to develop the following scenarios for testing the HEAT tool:

1) **Scenario A – Improving Public Space for Pedestrians**

This refers to a reconstruction project of a street at the historical city centre which was concluded in September 2012. This project forecasts a change on pedestrian traffic volumes. For estimating the health impacts of scenario A, the following reference alternatives are to be considered for comparison purposes:

- *Ex ante* situation (before street reconstruction);
- During construction;
- *Ex post* situation (after the street reconstruction).
- Therefore, the HEAT tool is considered as an economic tool to support the benefit-cost ratio of the intervention (potential health benefits from increased activity levels).

For scenario A, the City team aims to assess the value of improving walking facilities and the benefit-cost ration of the investment (health benefits component). Since walkers may link with activities of high value for residents, visitors and tourists travelling in the city and will increase the value of public transport in the proximity. Therefore the HEAT results will be conservative estimates of the total benefits.

2) **Scenario B – Planning Future Cycling Infrastructures**

The City of Viana do Castelo has a cycling network plan for the municipality which is under development (some sections are still under planning and others are under construction). The HEAT tool is used here to calculate the required inputs in the uptake of cycling levels along different time horizons, this means to achieve potential cycling demand thresholds that can assure plan and project profitability.

For scenario B, the City team wants also to examine potential savings that might be achieved if the number of cycling trips will increase in the future to 10%, 20%, 30% and 50%. This important to understand the contribution of investing in cycling infrastructure and other related measures to generate future value.

Following Litman (2012) cycling is an efficient and cost-effective transport mode and if there exists suitable support it can serve a significant share of travel, typically 5 to 15% in communities with good facilities. Therefore, the HEAT results will be important inputs to support future cycling investment decisions.

During the second phase of the project, the City team aims to contribute with some methodological insights and recommendations in light of the results obtained from applying the HEAT tool.

3.2.3 Data collection

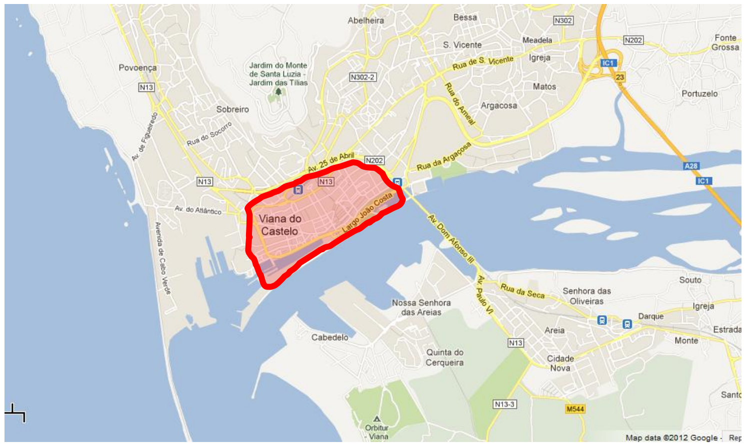
Since no disaggregate data on pedestrian and cyclist traffic levels and mobility behaviour was available for the study area, the city team developed a comprehensive data collection plan.

The data collection comprised the following steps:

a) estimates of walking and cycling volumes based on traffic counts;
b) data collection through the development of a local mobility survey targeting both potential walkers and cyclists; data indicators included origin-destination of trips, average distance/time travelled, number of trips and identification of key barriers for walking and cycling.

The case study area is represented in Figure 6. It covers the historic city centre, which has undergone some street reconstructions in recent years. Therefore, the mobility survey was implemented in here.

FIGURE 6: The case study area



The case study covers a resident population of 4002 inhabitants (1726 men and 2276 women) distributed by 1802 families and 2891 households in an area of 70 ha. Taking these figures into account, the number of residents that should participate in the mobility survey was estimated. For that, the sample size calculator Raosoft (www.raosoft.com) was used, which recommended a minimum sample size for this survey of 351 persons (assuming a 5% margin of error, 95% of confidence level and 50% response distribution). Figure 7 presents the distribution of the inquiries in the case study area in order to get a good spatial coverage.

FIGURE 7: The spatial distribution of the inquiries in the study area

The main objective of the mobility survey is to get information on the mobility patterns of the resident population living or going to the case study area. The survey does not take into account only pedestrians and cyclists, but covered all types of street users. For that reason, the inquiry was structured in three distinct parts: the first part was on general mobility questions, the second part focused on cyclists and the third one on pedestrians.

The first part of the survey had the objective of characterizing the mobility patterns of all users of the transportation system of the city of Viana do Castelo and for that the following issues were included:

- regular mode of transport used during the week and weekend, such as car, motorbike, bus, train, ferryboat, bicycle, foot;

- origin and destination of trips, where origins could only be two parishes of the city centre and the destinations were split into three categories, the parishes of the city centre, others parishes of the municipality and outside the municipality;

- the main mode of transport used on daily travelling, during the morning, lunch and in the afternoon (after school or work), for house-school, house-work, house-leisure and house-shop journeys;

- the average time spent and length of the principal journey of the day;

- user characteristics, such as sex, age, parish of residence, level of education and car ownership.

The second part of the mobility survey had the objective of exclusively characterizing the mobility patterns of cyclists living in the city centre of Viana do Castelo and questions were made to obtain information about the following issues:

- the target was regular bike users; otherwise, users are asked to state main reasons/barriers for not cycling.

- trip frequency by motive (home-school, home-work, house-leisure and house-shop journeys);

- average time spent travelling and length of regular bike-only journey;

- main reasons for regular cycling in the city, which could include economic, environmental, physical exercise, health, friends' influence, events and information, fashion, speed of travel, easy parking, limited coverage of public transports and pleasure of riding a bike;

- activity levels and experience of cycling;

- preferred infrastructures/routes for cycling;

- safety issues, such as the use of helmet and the type and number of accidents when cycling;

- key criteria to choose a cycling route.

The third part of the survey aimed to characterize the mobility patterns of pedestrians living in the city centre. It focused on similar issues to those surveyed for cyclists, with the necessary adjustments related to the differences on cycling and walking.

The survey is still undergoing as well as the pedestrian and cyclist traffic counts, which involved the use of quantitative tools, such as manual bicycle/ pedestrian counts and 24-hour video counts for the street under reconstruction. Meanwhile, to evaluate the actual speed of pedestrian in the street, speed measurements were made for a specific representative section of the street.

3.2.4 Expected results and policy impacts

The application of the HEAT tool can provide relevant information for policy making regarding walking and cycling investment. On the other hand, the City team aims to contribute with some methodological insights and practical recommendations in light of feedback obtained during the HEAT tool applications. It shall be noted that Cavill (2007) already identified key methodological issues related to the economic assessment of walking and cycling.

The studies reviewed by the WHO have attributed to each new walker or cyclist values in the range of EUR 120 to EUR 1300. This range of variation is due to the different methods used in the valuation and on the quantification of the health effects of physical activity levels, along with other factors such as used data and assumptions made for the analysis such as those regarding the relationship between observed cycling/walking and total physical activity and risk reduction variables. Indeed, it was found “no consensus on the diseases to be included in mortality calculations, and few studies included a measure of morbidity”.

The WHO review of CBA analysis found positive benefit-cost ratios (median of 5:1). The range of values was between -0.4 to 32.5. The case study at the city of Viana do Castelo would provide novel evidence for the Portuguese context.

4. Conclusions

Results of the HEAT tool are understood as important feeders of the City strategy to promote cycling and walking as healthier transport modes. The use of the tool can help the City elected officials to demonstrate the health benefits regarding walking and cycling.

Using the HEAT default values, the savings per kilometre cycled per individual cyclist per year can be estimated. The average value per kilometre cycled per individual adult per year is EUR 0.81. Using the value of 3.9 km for each trip and considering that each cyclist to undertake 160 trips annually, this corresponds to savings of EUR 505.44 and EUR 408.67 (2008 constant prices).

When using the HEAT tool the same default parameters related to risk were used because no other reliable local data was available for the context of the study area.

Reducing uncertainty in value estimates requires developing specific studies in the Portuguese context, e.g. for a local estimate of the value of a statistical life and relation of mortality risk with physical activity levels within the context of the city of Viana do Castelo. This may lead to future research developments using stated preference approaches to value risk reductions considering users' perceptions. In the HEAT tool, men and women are assumed to have the same level of relative risk which may not be appropriate for the city of Viana Castelo. Other measures such as years of life or quality-adjusted life years (QALYS) can improve the analysis. Although there exists substantial epidemiological evidence on the strong positive correlation between physical activity and the prevention of several chronic diseases, it shall be noted that limited empirical evidence exists for the city of Viana do Castelo regarding the relation of active transport (walking and cycling) with levels of physical activity by the population.

On the other hand, a sustainable mobility plan update is essential to guarantee a healthy increase of traffic of pedestrians and cyclists in the city, meaning that increased exposure to the risk of injury in street traffic conflicts/accidents is kept at very low levels, through the implementation of additional measures to allow a safe walking and cycling. It shall be evaluated which situations require the physical segregation of pedestrians and cyclists from motorized road traffic is required and those that suit a shared street space. Jacobsen (2003) pointed out the "safety in numbers phenomenon" as he found that the average cyclist is safer in communities where there are more people cycling because car users adjust their behaviour in the expectation of encountering cyclists.

Individuals' awareness and perceptions of the health benefits of cycling and walking are important to encourage people to uptake active mobility styles. These active modes will have even an increasingly role to play in future transport strategies at the local and regional levels. Active modes such as walking and cycling are associated with smaller carbon footprints in comparison to other motorized modes. Overall, these active modes will have the potential to improve the public health of citizens at the community level, contributing to a more inclusive transport and healthy cities.

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