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Data Analytics: Paving the Way to Sustainable Urban Mobility

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Health Related Benefits of Non-motorised Transport: An Application of the Health Economic Assessment Tool of the World Health Organisation to the Case of Trikala, Greece

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Abstract. It has been several years now that research coming from various disciplines such as sports science, medicine, urban planning and transport planning has provided strong evidence that sustainable urban mobility (SUM) is not only beneficial to the function of the city but to the human body too. As SUM includes not merely public transport but physical activity (walking, cycling, etc.) and as these can be further combined with exercise, an active urban environment can be created that can contribute to human health. The World Health Organization (WHO) has developed the Health Economic Assessment Tool (HEAT), a software which includes an algorithm designed to estimate the long–term health and economic benefit of a given population's cycling or walking. This paper shows how the HEAT has been applied to the case of the city of Trikala, Greece. It is based on bicycle traffic measurements recorded on September 2016, in Trikala, in the context of the SPACE Erasmus+ EU Programme. The result shows how and how much the increase of bicycle traffic (distance, hours, frequency of use) in the future can increase life expectancy and reduce health care costs, thus being a beneficial investment. The paper, also includes several 'what if scenarios' related to walking, so as to provide a broader picture of a possible urban active environment in the city.

Keywords: Non-motorised transport · Health Economic Assessment Tool Trikala · Sustainable urban mobility · Physical activity

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1 Introduction and Theoretical Framework: Sustainable Urban Mobility (SUM) and Non-motorised Transport: The Benefits for the City and the Human Body

Non-motorised transport as part of sustainable urban mobility (SUM) is considered to have many benefits for the city, as it can provide viable opportunities for urban regeneration allowing for greater flexibility and improving urban sustainability. This is primarily meaningful in the context of the compact city in relation with the transit oriented development idea whereby the city itself is being planned under the perspective of being serviced with public transport and non-motorised transport, i.e. with sustainable mobility modes.

While this might be crucial for modern cities, the trend to grow at high rates and to become bigger and bigger (see population data of UN), affects every day life which becomes more and more problematic resulting to a need for people to humanize their way of life. In big cities, trips are or can become very long, daily trips and commuting can become a huge burden for everyday life and distances can make walking or cycling impossible. Public transport in dedicate lanes (either standard gauge systems or bus rapid transit) can, up to a limit, provide some solutions. The inability and non-affordability (for the average citizen) of these formal transport systems is characterized by high infrastructure costs, environmental impacts (esp. in the case of private cars), a certain degree of institutional complexity and can vary from negative (air pollution) to none or very limited (e.g. some walking) positive impact on health.

A more drastic solution has been acknowledged to be the restructuring or regenerating the city in a way that commuting distances become shorter. But if this were the case, then shorter distances would require less public transport usage and even reduced use of private cars (or taxis), and consequently, at least to some considerable extent, would favour non-motorised transport. Such a solution is in tune with the quest of sustainability which is pursued in today's city and transport planning.

While the benefits of non-motorised transport for everyday life in terms of time consumption productivity, pollution, etc., might be evident, it appears that there is a whole array of additional direct benefits related to the human body as such. This is because non-motorised transport is based on human muscular activity (even ridding does so), i.e. physical activity, which is related to physical exercise. This dimension, directly related to human health, could be understood as a facet of social sustainability, which is one of the four sustainability dimensions, the others being eco-environmental, institutional, and economic [1]. Further on, it has been clearly stated that policies towards this direction cannot be sustained unless steadily supported by the local society with a variety of interventions, hence achieving suitable levels of institutional sustainability [2].

Focussing on the dimension of health in the frame of social sustainability, we argue that, as widely acknowledged, regular physical exercise and physical activity have beneficial effects on the prevention of several diseases and well-being. However, it has to be pointed out that physical exercise and physical activity do not coincide. According to the ACSM's [3] recommendations, physical exercise would mean a programme of moderate exercise of at least five times per week, or at least three times per-week of vigorous exercise, of duration 30 to 60 min, a certain level of pulses, etc. In this sense, non-motorised transport (in our case walking and cycling) would be classified as physical activity rather than as exercise. As ACSM has declared, individuals can benefit even from amounts of exercise less than those recommended [3]. This is especially true of the amount of sedentary time is reduced, something that is achieved when individuals employ non-motorized means of transport. Further, this physical activity may be the basis for enhanced leisure-time physical activity and exercise. That is, there is a carry-over effect of transport related physical activity. This effect may be facilitated by the positive mood created of physical activity and by the availability of respective infrastructure. Third, the increased human energy expenditure caused by non-motorized transport can contribute to weight control. Finally, as reviewed above, increased physical activity is related to individuals' cognitive functioning and their perception regarding quality of life. For all these reasons, non-motorized transport can be considered a health-related physical activity that in conjunction with some more structured exercise can have a significant impact on public health and quality of life.

Conversely, as evident, physical inactivity causes health problems, which according to methodologies that have been developed, can be measured. Yet, physical activity in the city can take place if the urban environment is an active one. The term 'active environment' has recently been coined to denote environments that facilitate the adoption and maintenance of physical activity. (Urban) Active Environments are those that are furnished in a way as to be able to host physical activities by means of the appropriate infrastructure (cycle lanes, foot paths, canal usage, outdoor exercise equipment etc.) and with the support of 'soft' policy measures and initiatives, such as prioritisation of cycling and walking, linking to tourism and active leisure, relevant promotion events, campaigns, games, etc. Cavill et al. [4] have offered the definition of 'active environments' as "physical or social environments that provide positive encouragement in helping people to be physically active, and to make the active choice" (p. 9). If appropriate infrastructures and policies exist, it is meaningful to address the issue of the benefits the usage of these infrastructures and the implementation of relevant policies can bring to the population and, conversely, the problems that can be caused by their absence, their underuse, and/or misuse.

2 Developing a Methodological Framework for the Support of Urban Active Environments

2.1 The Burden of Disease and the Cost of Physical Inactivity

Following this discussion, the research question arising is how can one measure (and why) the positive or negative impact of physical activity in a city. The question expands at two levels: the first concerns the measurement of what has been called the 'burden of disease'[1] and the second the economic impact of physical inactivity. In this

[1] The 'burden of disease' is the impact of a health problem on a given area, and can be measured using a variety of indicators such as mortality, morbidity or financial cost.

paper, we explain both but we attempt an application of the second for the case of Trikala, Greece.

With regard to this issue, the World Health Organization (WHO) has developed the Health Economic Assessment Tool (HEAT)[2] a software that includes an algorithm designed to estimate the long–term health (first level) and economic benefit (second level) of cycling or walking for a given population. The idea is based on the Population Attributable Fraction (PAF)[3] methodology that was developed by Lee, Shiroma, Lobelo, Puska, Blair, & Katzmarzyk, in order to estimate the burden of disease and life expectancy related to physical inactivity [5]. PAF is a measure used by epidemiologists to estimate the proportion of new cases that would not occur at the absence of a particular risk factor. This allows the burden of disease to be compared between different geographical areas, and to predict future health care needs [6].

Following this method, Lee et al. estimated that physical inactivity causes 6% of the burden of disease from coronary heart disease, 7% of type 2 diabetes, 10% of breast cancer, and 10% of colon cancer [5]. More recently, Ding et al. estimated a 4.5% PAF for stroke [7], and Sallis et al. a 3.8% PAF for dementia [8]. Further, Lee et al. reported that inactivity causes 9% of premature mortality, or more than 5.3 million of the 57 million deaths that occurred worldwide in 2008. According to the authors, if inactivity decreased by 10% or 25%, more than 533,000 and more than 1.3 million deaths, respectively, could be averted every year [5]. This is reflected to costs that can be direct or indirect. Indirect costs can be attributed to work absenteeism and work presenteeism (lower productivity due to ill health), and to lost productivity due to premature mortality. However, as large-scale data regarding absenteeism and presenteeism are scarce, indirect costs are usually estimated only by calculating the financial value of premature death.

Ding et al. used the global PAFs calculated by Lee et al., in order to estimate direct and indirect costs for health-care systems for 142 countries. Their results showed that, conservatively estimated, physical inactivity cost health-care systems 53.8 billion Int$[4] worldwide in 2013. In addition, physical inactivity related deaths contributed to 13.7 billion Int$ in productivity losses [7]. For Greece, direct health-care costs were 116.45 million Int$ and indirect costs were 30.53 million Int$ proving a total of 146.98 million Int$ cost for 2013.

2.2 The Health Economic Assessment Tool of the World Health Organization/Europe

Along the same lines, the World Health Organization/Europe (WHO) has developed the Health Economic Assessment Tool in order to assess the economic impact of

[2] See http://www.heatwalkingcycling.org.

[3] Population Attributable Fractions (PAFs) can measure the fraction of each disease that is attributable to physical activity.

[4] Int$: An international dollar has the same purchasing power as the U.S. dollar has in the United States. Costs in local currency units are converted to international dollars using purchasing power parity (PPP) exchange rates. …. An international dollar is, therefore, a hypothetical currency http://www.who.int/choice/costs/ppp/en/ [12].

cycling and walking. HEAT is designed to estimate the economic benefits based on the reduction of mortality rates due to cycling or walking for a specified period. The estimated reduction in mortality rate is quantified in monetary terms using the Value of Statistical Life (VSL) method. VSLs are derived from population surveys employing the 'willingness to pay' concept. This concept indicates how much each individual of the population would be willing to pay for a specific reduction of the population's annual risk of dying. Currently, HEAT provides country specific VSLs based on related data from the Organization for Economic Cooperation and Development. It assumes a linear dose-response relationship between physical activity and mortality. Estimations are provided for people between 20 and 64 years of age for cycling and for people between 20 and 74 years of age for walking. Therefore, HEAT is not suitable for older or younger people. Further, the developers of the Tool [9] note that HEAT "does not take into account differences in the intensity of walking and cycling" (p. 8).

HEAT can be used, among others, in two ways: (a) to estimate the reduced mortality and, based on that, the economic benefit of current levels of cycling and walking of a specific population, and (b) to estimate the economic effects of increased cycling or walking caused by interventions in the built and social environment. The former requires data from a single point of time, while the latter pre- and post-intervention data. Data required are: (a) an estimate of how many people are cycling or walking, and (b) an estimate of the average time spent or distance covered walking or cycling by the population under study.

3 Measuring the Economic Impact of Change in the Direction of Urban Active Environments: The HEAT Application in Trikala, Greece

A study of the former was undertaken in the context of the Erasmus+ program SPACE for the City of Trikala[5], a city in Central Greece of ~60,000 inhabitants, capital of a prefecture of ~130,000 (2011 Census). The modal split back in 2010 showed a 9.8% for cycling and 61% for private car use [10] [6]. In the frame of the SPACE action-based research project, the Trikala Municipality, with the assistance of the University of Thessaly and the core of the international collaborators prepared an Action Plan (AP) for developing an Active Urban Environment for cycling and walking that broadly targets adults, retired adults, and a certain group of schoolchildren. The AP includes the materialisation of interventions for non-motorised transport, which were thought to be vital for the city in the context of a town planning vision.

The general objectives of AP comprise (a) the connection of the leisure and recreation settings to the city centre by cycle lanes and pedestrian roads, (b) the creation of a sense-making network by the improvement of the connectivity of pedestrian routes and cycle lanes, (c) the promotion of walking and cycling. These are concretised in specific measures to be undertaken by the municipality.

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[5] For more information on this project and on Trikala, see www.activeenvironments.eu [13].

[6] A later (2012) survey by "Public Issue" showed increased cycling usage up to 15% [11].

In order to support the prospect of the materialisation of AP, the research team organised an action in the context of the European Mobility Week 2016 in cooperation with the Municipality. The aim of the action was to assess the economic impact of the current level of cycling, as well as to make estimations of the economic impact of future increases of cycling as derived by the Municipality's stated policy. The reason for this action was to support the argumentation for the transformation of the city centre into an active urban environment for the benefit of the citizens.

Data Collection and Handling

A questionnaire covering a range of themes, such as perceptions of current state of cycle paths, preferences for expansion, perceived easiness to move by bicycle, perceived usefulness of more pedestrian roads etc. was developed by the Municipality of Trikala. The Municipality posted an electronic version of the questionnaire on its website and forwarded relevant notifications to citizens. Further on, employers of the Municipality distributed printed questionnaires to citizens individually. Three hundred and sixty printed questionnaires and 198 electronic ones were collected. Obviously, this is an opportunistic sample and its representativeness is somewhat limited. However, it can provide a rough estimation of the benefits of possible increased cycling in the city. Regarding HEAT, data collected involved days of cycling per week and distance travelled on an average day. From the 558 respondents, 255 were retained (after excluding those not between 20 and 64 years of age, those who do not have a bike, and those who use their bike less than once per month). This sample reported a mean days cycling per week 5.04 and a mean distance covered per day 1,830 m. An estimation was set for 200 days usage per year taking into account weather conditions in Greece. The most recent (2011) available data of the Greek Census Bureau provide a number of 33,349 persons living in Trikala aged between 20 and 65. A national survey of bicycle use (2012) indicated a 15% daily usage in the Region of Thessaly (compared to an overall 2.5% for Greece) [11]. Based on the above data, the number of current cyclists in Trikala was estimated to be 5,000. Further HEAT specifications were a Value of Statistical Life of 2.690,703 euros, a mortality rate for 238.55 deaths per 100,000 persons per year and a discount rate of 5%.[7], Entering these data in the HEAT Tool provided a calculation of the economic impact of current cycling. Further projections (shown in Table [1]) were calculated in line with the Municipality's goals for increasing cycling. These results are going to be used by the Municipality in order to estimate cost/benefit for developing infrastructure for the promotion of cycling.

[7] For the full set of specifications used in this case study see: http://activeenvironments.eu/media/SPAcE-Output-3-Measuring-the-Value-of-an-Urban-Active-Environment-using-HEAT.pdf [13].

Table 1. Economic benefits of current cycling and future projections for Trikala.

	Cyclists n	Days per w/y	Mean dist./day	10 years economic benefit
Current cycling	5000	5/200	1,830 m	7,480,000 €
Projection: increase cyclists from 15% to 18%	6000	5/200	1,830 m	8,970,000 €
Projection: increase mean daily distance to 2300 m	5000	5/200	2,300 m	9,400,000 €
Projection: increase cyclists to 18% and mean daily distance to 2300 m	6000	5/200	2,300 m	11,127,000 €

4 Conclusion

It has been shown in this paper that modern cities, becoming compact, have to adopt, as some of their most crucial policies, sustainable transport modes, primarily non-motorised transport. Besides the well-known technical transport advantages, this has the additional benefit of enhancing the health of the population by preventing, or even curing, a number of diseases. This can best take place in urban 'active environments' i.e. physical and social environments enhanced with all possible ways to inspire people towards physical activity. The benefits of physical activity have recently been measured by HEAT, a method devised by the World Health Organisation/Europe. This method was applied to the case of Trikala Greece, in the context of an Action Plan of the City written in the frame of the SPACE Erasmus+ European programme. The research team, applying this method by means of a widely distributed questionnaire survey measured the possible economic results of several scenarios for the adoption of more cycling. The outcome is expected to be useful to the local community in order to support and argue for more opportunities towards creating an active urban environment. As becomes evident, the adoption of non-motorised transport modes is not merely ecologically and socially sustainable (the latter because of health enhancement) but also economically sustainable in the sense that it creates net 'profits' for local communities in the medium and long run. It remains to be seen whether a more generalised adoption will be sustained in a way as to become institutionally sustainable too.

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