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Big Data Concerning Travel Preferences as a Means to Support Decision Making in the Field of Environmentally Friendly Urban Development

Abstract. The article addresses a procedure for acquisition of data on travel preferences using a travel planner. The set of queries obtained, forming Big Data, may constitute a major source of information for local authorities and a means to support making decisions on changes leading to adaptation of the area of a city or of a region to the inhabitants' needs. The procedure in question is based on a tool developed under the Green Travelling project.

1. Introduction

Contemporary municipalities and regions are often faced with issues of intense road traffic. It exerts considerable impact on climate change and accelerating environmental degradation [18], [24].

Building strategies and plans for the future of municipalities and regions requires local authorities to make appropriate decisions concerning further implementation of sustainable development. With reference to one of basic definitions of sustainable development [23], one should note that two aspects are taken into account, namely needs and limitations of natural environment. The former aspect involves a necessity to learn about the actual needs, which can be brought down to needs of inhabitants when considering municipalities. The latter translates into a challenge for the contemporary development of technology.

Integration of actions requires deployment of strategies by application of multi-criteria analyses. It allows for the inhabitants' needs to be entailed as well as developed. In this respect, the knowledge of travelling needs seems to be crucial. The transport system provides for the very fundamental structure of a city and exerts considerable influence on the manner in which the latter functions, but also on how efficiently it proceeds.

New technologies make communication far easier. Information transfer is particularly important for an efficiently functioning municipality. Widespread access to the Internet

(including via mobile devices such as smartphones, tablets etc.) may also be used for the sake of environmentally friendly urban development.

With reference to the example of a tool developed under the Green Travelling project [1], [25] the article provides a proposal of a costless method for acquisition of data concerning needs of the travelling population, which makes it possible to build Big Data in this respect. The solution discussed in the article is universal in nature, since it may be used at any place in the world. It constitutes one of deliverables of the international project entitled "A platform to analyze and foster the use of Green Travelling options" implemented under the ERA-NET Transport III Future Travelling programme and co-financed by the National Centre for Research and Development.

2. Travel needs as important information for sustainable urban development

An efficient urban transport system should respond to the needs of the travelling population. On the other hand, it is exactly for the appropriate development of the system that one can adapt behaviour patterns of the travelling population to the requirements imposed by sustainable development. Consequently, the behaviour patterns displayed by travellers are challenges for local authorities. This issue becomes particularly relevant under conditions of a constant increase in the number of travels on a parallel increase in the number of cars in the population. Congestion is a negative phenomenon typical of contemporary cities. In many of them, the percentage share of travels made by passenger cars is considerably higher than that of other travelling modes. What becomes necessary is a change in the modal split of traffic in favour of eco-friendly transport.

Unfamiliarity of travel needs considerably hinders or even precludes making decisions concerning the shape of a transport system functioning in a city or a region. It is all the more important on account of the worldwide approach to the notion of mobility, assuming that minimisation of negative environmental impact of transport cannot be pursued through mobility limiting, but rather through efficient utilisation of natural resources [8], [30].

The need to travel stems from a necessity to perform everyday activities. Consequently, travels can be divided into work-related ones (most usually defined as home-work-home travels), education-related ones (home-education-home) and a number of other forms which may be used in a more irregular manner (travels related to entertainment, shopping, health

care, administration, tourism etc.). Due to the fact that more than 90% of rush hour travels are made for work and education related purposes, these two categories should be considered the most important ones from the perspective of the urban transport system. They are also very significant on account of their repeatability.

It should also be noted that the manner in which needs are being satisfied (choice of route and travelling mode) is influenced by a number of factors [4], [5], [7], [11], [13], [16], [17], [21], [22]. It is a complicated process difficult to predict, dependent on such factors as, for instance, cultural differences, habits, age as well as geographic positioning of individual facilities and economic factors, but also on the existing transport system. Some travels are made in a specific manner due to the lack of alternatives (e.g. no bus stop, timetable maladjusted to actual needs, no safe parking place for bicycles near the travelling destination, too high public transport fares etc.).

3. Concept of using GT Planner as a Big Data source

Acquiring knowledge about travel needs is not a simple process, nor does it happen one time only. It requires cyclic repetition and updating on account of variability in time (in a 24-hour horizon, but also in terms of consecutive days and months). A traffic distribution prepared for the municipal transport network also changes because of progressing organisational and economic changes (varying locations of traffic generators, e.g. workplaces, hypermarkets etc.). A sample traffic distribution obtained from a chosen test group of people has been provided in Figure 1.

Fig. 1. Examples of travels made at different times of the day within the area of the Upper Silesian conurbation (different shades of green) (source: own research)

Similarly to other travel planners (see [3], [9], among others), the tool proposed, namely Green Travelling Planner (GT Planner), is intended for seeking the optimum route and mode of travelling [27]. What makes it distinctive is a set of features enabling multiple travelling modes to be chosen (11 modes + "All" mode; Figure 2) [10] as well as several optimisation criteria to be applied.

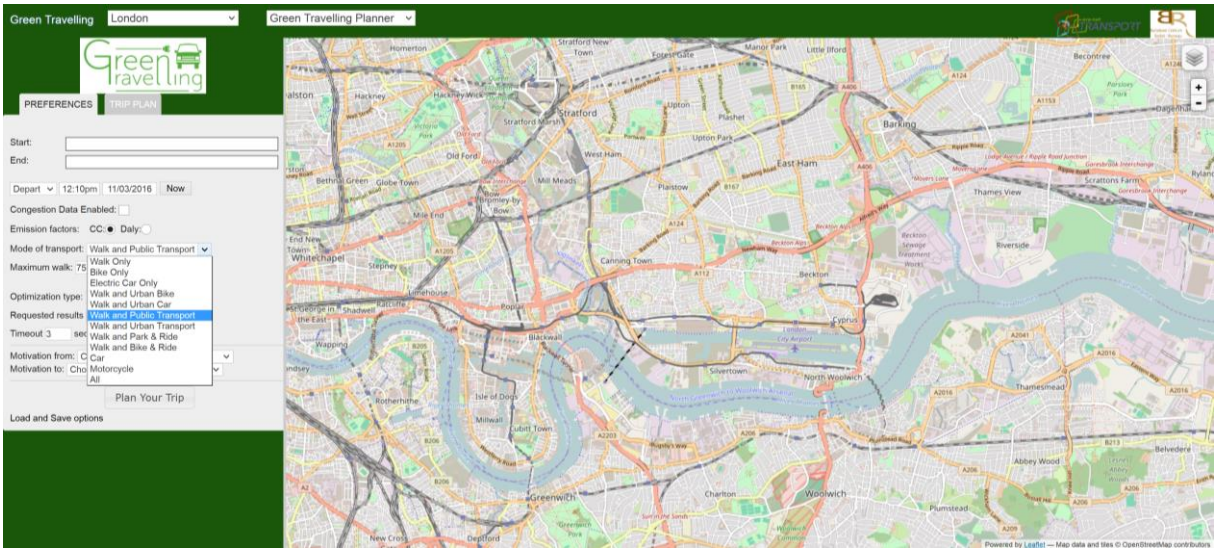

Fig. 2. GT Planner – available travelling modes (source: own research)

What the planner also incorporates is an additional component used to collect data concerning the queries submitted. A planner user should specify the travelling motivation in order to use

its functions. These motivations include home, work, education, shopping, duty travel, sport/recreation etc. (Figure 3).

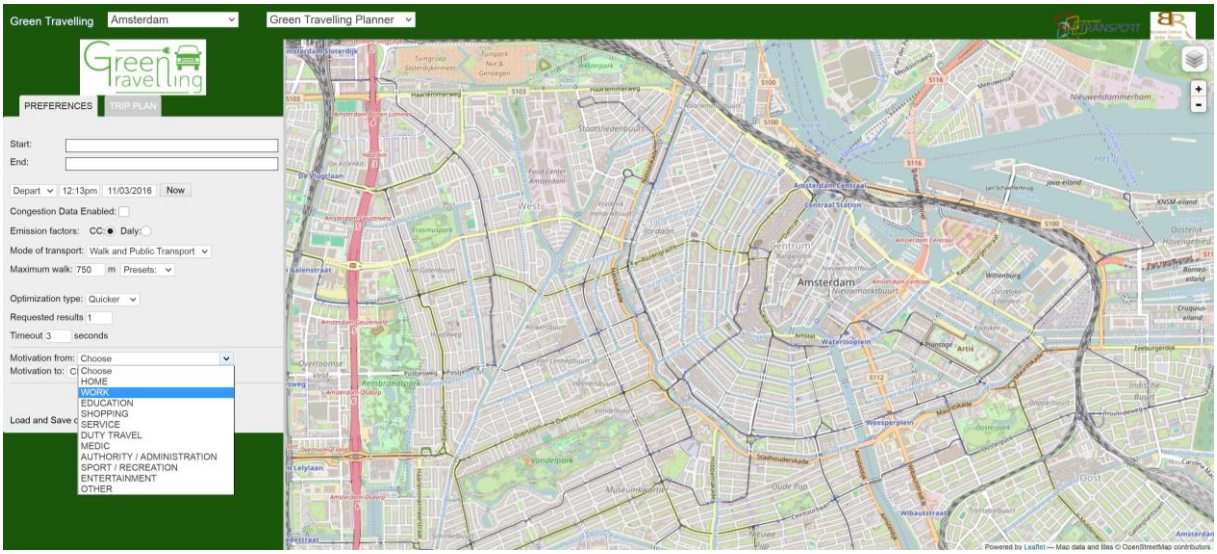

Fig. 3. GT Planner – travelling motivations (source: own research)

In parallel to the operations performed by the GT Planner server, a database of queries is built [26], where besides the travelling motivation also user-defined parameters are stored, and these include e.g. the start and the destination point (geographic coordinates), the travel beginning time, the chosen travelling mode and the route optimisation criterion. By that means, the set of queries characterising the travelling population's needs becomes Big Data, making it possible to monitor the behaviour patterns and habits displayed by travellers (Figure 4)

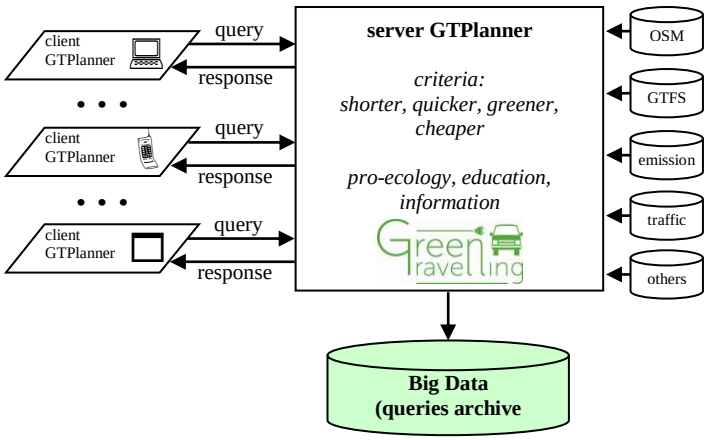

Fig. 4. GT Planner functional diagram with Big Data marked (source: own research)

As regards the queries for which no fast travelling option is available at the given time of the day (e.g. due to the public transport timetable), there is a reasonable concern that the user will ultimately choose the passenger car (non-eco-friendly travel) anyway.

4. Process of decision making support based on Big Data from GT Planner

The data thus obtained from GT Planner can be used to analyse the transport system as it currently functions, including the system of public transport. The next step in the process is making a decision on the changes to be introduced in the scope of organisation (e.g. by altering routes of bus lines, modifying timetables, introducing parking fees and charges for entering the given city district) as well as transport infrastructure (e.g. implementing a system of bicycle or electric urban car rental services, building dedicated bus lanes). Examples of activities were described among others in [2], [6], [12], [14], [15], [19], [20], [28], [29]. Moreover, deploying the solution proposed, through the feedback received, enables monitoring of changes occurring in the sphere of needs of the travelling population, and consequently also assessment of the solutions being implemented. It is an iterative process, but when monitored in time, it may simplify decision making on the level of local authorities (Figure 5).

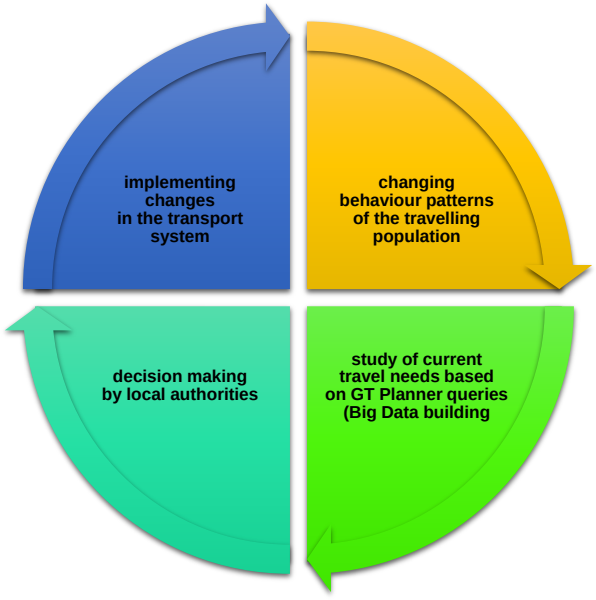

Fig. 5. Diagram illustrating the process of the current status monitoring and decision making by local authorities using Big Data from GT Planner (source: own research)

The foregoing procedure enables implementation of changes which assume the form of operational and strategic actions while simultaneously monitoring the response of travelling persons to the changing situation. These actions may be performed under a global strategy established for the city or the region, but also using the method of small steps. The tool applied in this case makes it also possible to freely choose the solutions to implement, since not only does it comprise the basic services rendered by the city in terms of travelling options (such as public transport), but also local bicycle and car rental services. What GT Planner also accounts for is eco-friendly travelling by means of electric cars, and consequently, this aspect may also by studied and monitored by application of the procedure in question. The task each time faced by local authorities is to identify the reasons for the choices made by a specific group of people, e.g. a passenger car, and to devise individual actions potentially triggering a shift towards environmentally friendly travelling. For that purpose, one may apply both incentives (for eco-friendly solutions) and restrictions (against the use of passenger cars). It is through balancing of incentives and restrictions that one may attain the goal being pursued, namely environmentally friendly urban development. For instance, having collated the queries received from the travel planner, the timetable and the route of the given public transport line, one can establish corrective measures required to adapt the current state of matters to the

travellers' needs. It is assumed to trigger a shift in the modal split, and consequently improve the transport system efficiency.

4. Conclusions

Travelling preferences exert significant influence on how the transport system functions, and thus, when perceived from a global perspective, also the city or the region. In order to attain suitable modal split of traffic (with the emphasis put on eco-friendly solutions), all the foregoing preferences need to be appropriately moulded. It is possible owing to various organisational, legal and infrastructural activities. At the same time, mobility-related needs must be taken into account while introducing changes. It is the only way to orient them towards sustainable development. Modern technology offers extensive opportunities to acquire information. The significant development of web-based travel planners observed within the recent years makes them increasingly popular tools among the general public. The said boost of interest has been used in the study addressed in the article in order to collect data concerning travellers' needs to be subsequently applied as a means to support decision making with regard to urban development. The advantages of the tool discussed include its territorial universality and absence of additional costs.

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