Using persuasive technology and reward schemes to promote sustainable travel choices

Athena Tsirimpa[a], Amalia Polydoropoulou[a], Ioanna Pagoni[a], Evangelia Anagnostopoulou[b], Babis Magoutas[b], Efthimios Bothos[b], Ioannis Tsouros[a]

[a] University of the Aegean, Transportation and Decision Making Laboratory, Greece

[b] Institute of Computer and Communication Systems, National Technical University of Athens, Greece

EXTENDED ABSTRACT

Traffic congestion, local and global air pollution and noise pollution are some of the negative externalities generated by the increased use of private vehicles in many urban areas. Significant shifts of citizen's travel habits towards sustainable modes of transport encouraged by long- or short-term policies are needed to address these externalities. One short-term solution is to enhance individuals' awareness of the environmental impact of their travel choices and to use behavioural change interventions to motivate urban travelers towards the use of environmentally friendly multimodal options. In this context, this paper concerns the implementation of two motivating behavioural change strategies, namely i) persuasive technologies in the form of persuasive messages and ii) financial and non-financial rewards, tailored for and integrated in a route planning mobile application, and investigates their effect on changing travelers' behavior towards green mobility.

In fact, persuasive systems supporting behavior change in the context of personal urban mobility is an active area of research; see e.g. the recent review of Anagnostopoulou et al. (2016). Particularly, several approaches including behavior feedback, social comparison, goal-setting, gamification, personalized suggestions and challenges have been developed the last years (Bothos et al., 2014; Gabrielli and Maimone, 2013; Jylhä et al., 2013; Meloni et al., 2014; Pucher J. and Dijkstra, 2003). Overall, these studies identify positive changes in users' perception of sustainability in urban mobility and increased concern regarding the impact of their choices on the environment. However, based on Anagnostopoulou et al. (2017), people differ in their susceptibility to different persuasive strategies, and, thus, personalized approaches can be more successful than "one size fits all" approaches. With regards to offering rewards to the urban travelers, various rewarding schemes have been implemented, the vast majority of which concerns rewards offered to car drivers with the aim to avoid rush-hour driving (Ben-Elia and Ettema, 2011; Khademi and Timmermans, 2014; Merugu et al., 2009) and to change their behavior towards eco-driving (Lai, 2015). A growing body of research also focuses on reward schemes that encourage modal shift and the use of public transport or non-motorized modes (Bamberg et al., 2003; Fujii and Kitamura, 2003; Koo et al., 2013; Thøgersen, 2009; Voon et al., 2017). On the one hand, research in travel behavioral psychology suggests that such rewarding systems could be effective in changing individuals' travel habits and supporting green travel behavior, while Khademi et al. (2014) state that the reward schemes may lose their effectiveness over time, since participants may return back to their habitual travel patterns.

In this paper, the simultaneous impact of the aforementioned behavioural change strategies (the provision of persuasive messages and the offer of rewards) on individuals' travel behavior in a multimodal transportation network is explored. For this purpose, both of the aforementioned behavioural change strategies are communicated to individual travelers through a route planning mobile application, which has been developed in the context of the EU-funded OPTIMUM project. More specifically, the mobile application provides personalized persuasive features and offers financial and non-financial rewards with the aim to nudge users towards the selection of environmental-friendly multimodal routes. With respect to nudging, in our case it means to make individuals who mostly use their car to begin using public transportation, those who already use public transportation to consider cycling and walking as well as sustain their current habits and so on. In addition, both behavioural change strategies aim at promoting multi-modal travel activities which refer to using more than one means of transportation to reach a destination (i.e. a combination of public transport and bicycle or walking).

The methodological steps to develop the persuasive and reward features on the OPTIMUM mobile application and evaluate their effectiveness are as follows: The first step is concerned with the pre-pilot phase, where two web-based surveys are conducted, with the following specific aims: i) to collect early opinions on the potential modal shift of individuals in the presence of persuasive messages and reward schemes and acquire insights on their preferences on the type of persuasive messages and rewards, ii) to collect socio-demographic data, data on existing travel habits and attitudinal data from a set of respondents and (iii) to collect data about users' personality traits, mobility types and susceptibility to different persuasive strategies. The first set of data is used to define the requirements of the OPTIMUM mobile application regarding the persuasive and rewards features. The second set of data along with data collected from stated preference experiments on multimodal choices are employed to develop a travel behavioral model which estimates the probability of an individual to choose a certain multimodal option among various alternatives with differentiated attributes, such as travel time, travel cost, weather conditions, type and level of the rewards offered. The model corresponds to a discrete choice model derived in the random utility framework in which decision makers are assumed to be utility maximizers (Domencich and McFadden, 1975; Ben-Akiva and Lerman, 1985; Ben-Akiva and Bierlaire, 2003). The developed model is exploited during the next methodological steps where the persuasive messages and the reward systems are featured on the OPTIMUM mobile app. Finally, the third set of data were used to determine the perceived persuasiveness of the various persuasive strategies on users of different personality and mobility types. This formed the basis for developing the so called persuadability model, which determines each individual's susceptibility to the various persuasive strategies that are incorporated in the persuasive messages, on the basis of his/her personality and mobility type. The developed persuadability model (see Anagnostopoulou et al., 2017), guides the presentation of the persuasive messages, since each individual is presented with a message implementing the persuasive strategy s/he is more susceptible to. The next step corresponds to the first pilot phase where the message based persuasive feature of the mobile application is developed and implemented. Ninety eight persuasive messages have been designed, with each one of them implementing a single persuasive strategy. For the purposes of our work we have selected the persuasive strategies of self-monitoring, comparison and suggestion among the 10 suggested by Orji et al. (2014), by taking into account the appropriateness of the strategy for message-based persuasion and the suitability of the strategy to the overall scope of our

approach. Multiple messages have been designed per persuasive strategy. The messages are context-aware, in the sense that they are valid in specific contexts. Making the messages context-aware enhances the ability of our approach to provide tailored messages, since only messages with a context that is valid for a particular user with a particular trip profile, who is planning for a particular trip made under specific environmental conditions, are selected. In a later step, the app users are additionally presented with the reward scheme where they are rewarded when using sustainable means of transport such as public transport, bicycle, walking or a combination of the above. In this pilot phase, both persuasive messages and rewards are provided to the app users so that their impact on travelers' behavior will be simultaneously assessed. The reward types that are presented to the app users are partially influenced by the preliminary results of the travel behavioral model developed in the first step of our research. Specifically, two reward types are offered to the users when conducting a sustainable travel activity, namely (i) monetary rewards, where the app users receive cash back rewards and (ii) credits, where the users earn credits (in the form of points) which can be redeemed for vouchers or free public transport tickets. Finally, the last step concerns the evaluation of the developed app features in terms of their effectiveness towards altering individuals' travel behavior to more sustainable multimodal options.

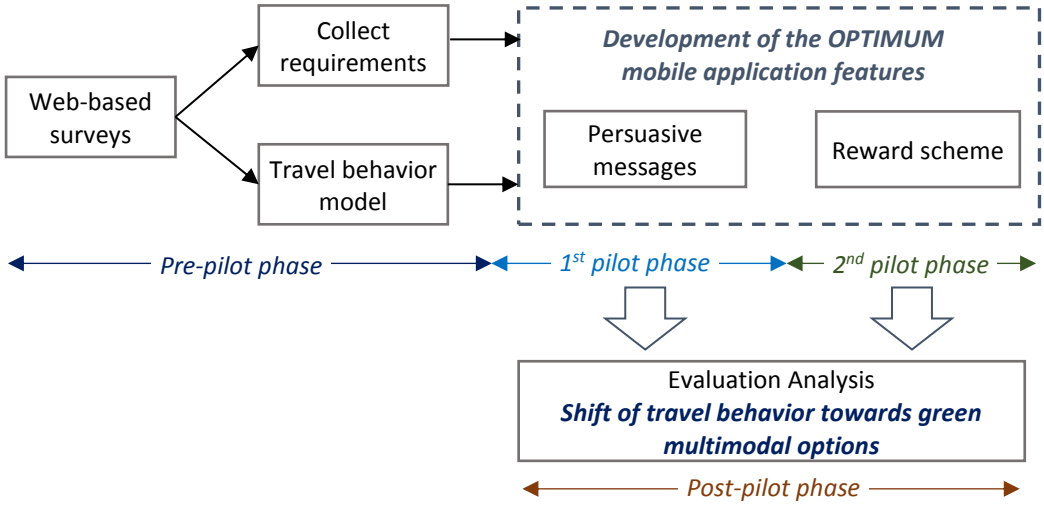

Figure 1. Methodological steps to develop the persuasive and reward features of the OPTIMUM mobile app and evaluate their effectiveness

Within the OPTIMUM project, the on-line surveys and the pilot phases were conducted in three European cities, namely Ljubljana, Vienna and Birmingham. A web-based questionnaire was distributed, while the mobile app users were recruited via social networks and via the communications channels of the OPTIMUM partners.

In total, approximately 80 users in the three regions used the OPTIMUM mobile application during the first pilot phase. Quantitative travel behavior data collected by the use of the OPTIMUM app was exploited to evaluate the effectiveness of the persuasive messages. We identified that messages which nudge users to bike&ride were the most influential. In addition, user-experience data collected via on-line questionnaires, which were administered during the first pilot phase, indicated that, although the personalized persuasive messages were somewhat convincing, the users' experience is differentiated in the three pilots.

The second pilot phase is undergoing and will simultaneously evaluate the impact of the persuasive messages and the reward schemes.

Indicative evidence on the impact of the rewarding schemes on travelers' behavioral change have been so far obtained by the estimated multimodal choice model. In specific, the model estimation results indicate that both monetary- and credit-based rewards can be effective in altering travelers' behavior towards greener multimodal options. Instead, other types of rewards, such as the provision of guaranteed parking space for the car or the bicycle, free wifi access on board or reserved seat on the bus or the metro, are not found to affect travelers' choices. The quantitative travel behavior data which will be collected by the use of the OPTIMUM app during the second pilot phase will further evaluate the actual travel behavioral changes of the app users in the presence of the persuasive messages and the reward schemes. Keywords: reward schemes, persuasive technology, mobile application, travel behavior, discrete choice model, stated preference data, behavioral change.

Acknowledgments

This research is part of the Project "Multi-source Big Data Fusion Driven Proactivity for Intelligent Mobility" - OPTIMUM. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 636160. This publication only reflects the author's view and the European Union is not liable for any use that may be made of the information contained therein.

References

Anagnostopoulou, E., Bothos, E., Magoutas, B., Schrammel, J., Mentzas, G., 2016. Persuasive Technologies for Sustainable Urban Mobility. arXiv preprint arXiv:1604.05957.

Anagnostopoulou, E., Magoutas, B., Bothos, E., Schrammel, J., Orji, R. and Mentzas, G., 2017, April. Exploring the Links Between Persuasion, Personality and Mobility Types in Personalized Mobility Applications. In International Conference on Persuasive Technology (pp. 107-118). Springer, Cham.

Bamberg, S., Rolle, D, Weber, C., 2003. Does habitual car use not lead to more resistance to change of travel mode? Transportation, 30, 97-108.

Ben-Akiva, M.E., Lerman, S.R., 1985. Discrete Choice Analysis: Theory and Application to Travel Demand. MIT Press, Cambridge, MA.

Ben-Akiva, M., Bierlaire, M., 2003. Discrete choice models with applications to departure time and route choice, in: Hall, R. (Ed.), Handbook of Transportation Science, 2nd edition, Kluwer. pp. 7–38. ISBN:1-4020- 7246-5.

Ben-Elia, E.,and D. Ettema, 2011. Changing commuters' behavior using rewards: A study of rush-hour avoidance. Transportation Research Part F, 14, (5), 354-368.

Bothos E., Prost S., Schrammel J., Röderer K., & Mentzas G., 2014. Watch your Emissions: Persuasive Strategies and Choice Architecture for Sustainable Decisions in Urban Mobility. PsychNology Journal, 12(3), 107-126.

Domencich, T.A., McFadden, D., 1975. Urban Travel Demand-A Behavioral Analysis. New York: American Elsevier Publishing Company, Inc.

Elvik, R., Ramjerdi, F. (2014). A comparative analysis of the effects of economic policy instruments in promoting environmentally sustainable transport. Transport Policy, 33, 89-95.

Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation, 30, 81-95.

Gabrielli S., Maimone R., 2013. Digital Interventions for Sustainable Urban Mobility: A Pilot Study. UbiComp'13, Zurich, Switzerland.

Jylhä A., Nurmi P., Sirén M., Hemminki S., Jacucci G., 2013. MatkaHupi: a Persuasive Mobile Application for Sustainable Mobility. UbiComp'13, Zurich, Switzerland.

Khademi, E., Timmermans, H., Borgers, A. (2014). Temporal Adaptation to Reward Schemes: Results of the SpitsScoren Project. Transportation Research Procedia, 3, 60-69.

Khademi, E., and H. Timmermans, 2014. The Long-Term Effectiveness of a Reward Scheme in Changing Daily Travel Choices. Procedia-Social and Behavioral Sciences, 111, 380-389.

Koo, Y., Lee, M., Cho, Y. (2013). A point card system for public transport utilization in Korea. Transportation Research Part D, 22, 70–74.

Lai, W.T., 2015. The effects of eco-driving motivation, knowledge and reward intervention on fuel efficiency. Transportation Research Part D, 34, 155–160.

Meloni I., Sanjust B., Delogu G., Sottile E., 2014. Development of a technological platform for implementing VTBC programs. Transportation Research Procedia 3 129–138.

Merugu, D., B.S. Prabhakar, and N.S. Rama, 2009. An Incentive Mechanism for Decongesting the Roads: A Pilot Program in Bangalore. In: Proceedings of ACM NetEcon Workshop on the Economics of Networked Systems.

Orji, R., Regan, L.M., Julita, V., 2014. Gender and Persuasive Technology: Examining the Persuasiveness of Persuasive Strategies by Gender Groups. Persuasive Technology Adjunct Proceedings, University of Padova, Padova 48-52.

Pucher J., Dijkstra L., 2003. Promoting safe walking and cycling to improve public health: lessons from the Netherlands and Germany. American Journal of Public Health, 93 (9), 1509-1516.

Thøgersen, J., 2009. Promoting public transport as a subscription service: Effects of a free month travel card. Transport Policy, 16, 335–343.

Voon, N.H., Kadir, S.N.H.A., Belayan, M.A., Poon, S.H., Zahran, E.S.M.M. (2016). Rides for Rewards (R4R): A Mobile Application to Sustain an Incentive Scheme for Public Bus Transport. In Computational Intelligence in Information Systems, Advances in Intelligent Systems and Computing 532, Springer International Publishing AG.