
Exploring Change Strategies for Sustainable Urban Mobility

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Abstract

This paper presents results from a longitudinal study aimed at evaluating the effectiveness of different behavior change strategies for supporting sustainable transport choices in urban areas. We provided eight users with a mobile app deploying goal-setting, self-monitoring, rewards, social and sharing features and observed a positive impact of the app on users' behavior and environmental awareness.

Author Keywords

Sustainable Mobility, Persuasive Technology, Mobile Interfaces.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design; Experimentation

Introduction

This paper reports recent work conducted in the context of the SUPERHUB project in order to investigate the effectiveness of different persuasive strategies for inducing more eco-friendly transport choices in citizens of urban areas. The study has deployed contextual user research methods and a mobile app prototype for

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Fig.1: Home screen of the Mobile app

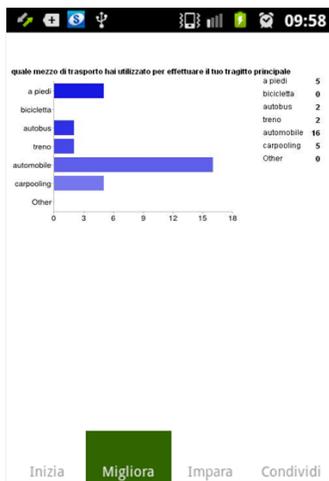


Fig.2: Self-reporting feature

Android smartphones including motivational features such as goal setting, rewards, self-monitoring and data sharing [3]. Logging of user data has been set up in order to track and understand user transport choices in the city of Trento over a four weeks' study. In this paper we describe the main findings collected, which are going to inform the design of future applications and interventions for sustainable urban environments. We include consideration of social influence as a mechanism to induce and maintain sustainable mobility in citizens.

The Mobile App Designed

The mobile prototype designed for the study (Fig.1) aims to induce the user to change her travel behavior/habits by adopting more sustainable transport choices. The mobile prototype does not track the user travel paths (GPS data), but relies on user self-reporting of mode of transport used over a day (a simple multiple choice questionnaire is triggered everyday in order to collect user input). The decision of relying on user self reporting of data was due to the need of avoiding the mobile phone battery drain and to a lack of reliable automatic mode detection alternatives available in the target area when the study started. The types of motivational strategies supported by the mobile prototype were based on previous work on persuasive technologies for relevant application domains (e.g., energy saving, eco-feedback solutions) from which the following four groups of strategies were derived [1,2,3]:

- 1) Goal setting: The user was invited to set weekly goals for mode of transport to use (e.g., car, carpooling, bicycle, walking, public transport);
- 2) Self-monitoring (Fig.2): The user could track progress towards goals and check modes of transport

used over a week in order to support self-reflection about the level of sustainability of the travel choices made (e.g., by means of historical graphs displaying types of transport used over the previous weeks);

- 3) Rewards (Fig.3): Personalized messages encouraging sustainable transport choices were sent to the user, according to her profile and travel behavior (observed from logs; these messages were prepared by the experimenters, in a Wizard of Oz style, and sent to the user by means of the prototype integration with Social Network features, e.g. a Facebook account set up for the study in order to send personalized triggers);
- 4) Sharing (Fig.3): A weekly list of participants ranked eco-scores was provided to users (based on their achievement of goals and sustainability of transport choices made) in order to trigger social influence (e.g., competitive or collaborative behavior among the group of participants) and make more appealing the use of the app. Beyond these motivational features, the mobile prototype provided a local journey planner functionality (based on the local mobility service *ViaggiareinTrentino*) for supporting the user daily journeys across their urban setting (Trento city centre and province area).

Contextual User Study

Eight participants were involved in the study. They consisted of two main groups of people that knew each other (four office colleagues, and four students at the local University) who had different transport habits and needs (e.g., drivers with private car, non drivers etc.) (Fig.4). All participants were asked to fill in a questionnaire in order to provide background information about their travel routines/needs/habits, and their willingness to adopt more sustainable behaviors. After that, they were invited to use the



Fig.3: Share and Rewards features

mobile app prototype as follows: in week 1, participants were just asked to self-report travel paths and mode(s) of travel used every day (e.g., car, carpooling, public transport, bike, walking) in order to be able to log their transport habits previous to any motivational intervention. In week 2-3-4, logging of participants' behaviors was extended, including also frequency of usage of the mobile app persuasive features. Also, motivational messages were sent (through Wizard-of-Oz techniques) to encourage more sustainable behavior according to the travel habits of a user. A final individual interview with each participant was carried out at the end of the study to collect their feedback on the usage experience and possible suggestions for improving the prototype features. As an incentive to participation, users were refunded for the cost of Internet connection on the mobile phone for the duration of the study.

Main Findings

Overall, participants enjoyed the use of the app over the 4 weeks, no one decided to retire from the study. Its ease of use and graphical simplicity was particularly appreciated. Also, all participants complied with the daily request of sending in their self-report of the modes of transport used. An interesting outcome derived from comparing individual participants' mobility choices over the working days vs. weekends. Evidence was found that participants' choices were more strongly constrained by the physical characteristics of the local area (mountain area, presence of slopes, long distances to cover from neighbor villages of residence to city centre, limited offer of public transportation services in some rural areas) during the working days, with respect to weekends when time constraints were perceived as less important and transport choices were

more related to individual preferences and environmental attitudes.

By considering the aggregated data on participants' transport choices over the 4 weeks, we observed that the use of the mobile application did have some impact on user behavior. By comparing modes of transport used by participants during the first week of the study (with no persuasive intervention active) and the last week of the study (persuasive intervention active) we observed 68% of journeys made by car and 32% of journeys made by sustainable modes of transport in the first week, while in the last week journeys by car were 54% and sustainable journeys raised to 46%. This accounts for an improvement in the use of sustainable means of transport of 14%. Regarding individual transport choices across the first and last week, we noticed that 2 participants showed a stable behavior, 4 participants improved their behavior by making more sustainable choices, and 2 participants showed their sustainable behavior decrease. We also observed, a positive change in terms of participants improved awareness of the environmental consequences of their travel choices (e.g., P1 said she used to plan more carefully her daily journeys for commuting and shopping reasons, in order to optimize travel paths, reduce fuel consumption as well as CO₂ emissions). Several attempts to adopt more sustainable behavior were made over weekends or when 'greener' transportation alternatives were available and more feasible to adopt. Among the persuasive features provided, the most appreciated and used was the Self-monitoring feature, followed by the Goal setting and the Sharing of eco-scores distributed by the experimenter at the end of each week. Both positive and negative outcomes were observed about the *Sharing* and *Rewarding* features. Most participants

	Age	Occupation	Env. Awareness	Behavior change
P1	42	Project Manager	Stable	Improved
P2	33	Office Admin	Improved	Worsen
P3	30	Programmer	Stable	Improved
P4	29	Conf. assistant	Improved	Improved
P5	21	Student	Improved	Worsen
P6	22	Student	Stable	Improved
P7	31	Student	Improved	Stable
P8	28	Student	Stable	Stable

J.4: Users' data and pre-post study change

reported that receiving every week a comparative ranking of eco-scores achieved was nice, since it was somehow triggering more reflection on their performance and mobility choices that week. However, it was a bit difficult to trigger real competition among participants, due to the small group of users involved and the lack of 'real' rewards or prizes available for the best performer.

Regarding the integration of our mobile app with *Facebook* Social Network (for messaging exchanges and personalized recommendations on how to improve eco sustainability of travel choices) we got rather controversial results. On one hand, we found our participants quite reluctant to follow the recommendations received and to reply to the messages sent by the mobile app. When interviewed about this, most of the participants stated that they were not very active users of *Facebook* or other social networks, which is why also in this case they did not feel very motivated to express their opinions or provide feedback through the social network. On the other hand, in the final interview most participants said that they would really appreciate the mobile app to provide easier linking to carpooling opportunities, as well as personalized recommendations specifically tailored to the real time traffic situation and their contextual transport needs. In particular, they did not appreciate the local journey planner integrated in the mobile app ('*ViaggiareinTrentino*') for its lack of personalized services offered (e.g., information about disruptive events was provided at province level, not for the roads/areas of interest for a user).

Conclusion

The main obstacles to behavior change observed in this study were due to users' transport habits based on the

use of the private car to reach their working place, also affected by physical and time constraints they perceived not to have particular control upon. Participants were more willing to use more sustainable means of transport during weekends, when the previous constraints were somehow released. Although some positive impact on behavior was observed, it is likely that 3 weeks of behavior change intervention are not enough to deeply affect transport habits, especially if this requires considerable sacrifices to be made by the target users. Rewarding and sharing features can help users to overcome perceived obstacles to behavior change, however this study has shown that *rewards* need to be made more concrete and tangible to be effective (e.g., discounts on public transport tickets) and data *sharing* can leverage on social influence mechanisms only if a critical mass of target users is involved.

Acknowledgements

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