D5.3 New Innovative Strategies Report

Austrian Institute of Technology

Author(s)

Johann Schrammel (AIT)

Sebastian Prost (AIT)

Abstract

In this deliverable we discuss the experiences made with different persuasive strategies that were made within the PEACOX project in work performed in different work packages between October 2011 and February 2015. Based on these experiences and considering current developments in technology and research we furthermore discuss opportunities and promising approaches for future research and development in the area of improving persuasive systems for influencing mobility behaviour.

Table of Contents

1. Discussion of strategies used within PEACOX

Within this first section of the deliverable we discuss the main results and conclusions made with persuasive strategies applied during the PEACOX project. We aim to provide a generalized high-level discussion of findings and recommendations for future development, the detailed analysis of results from experimental studies and field trials is reported in related deliverables (*D7.3 Persuasive Strategies Evaluation Report* and *D7.5 Field Trials II Report*). In this section we focus on the main strategies listed below, and dedicate a sub-chapter to each of these topics: feedback, statistics, trip mode and purpose detection, persuasive messages, challenges and social network integration.

1.1 CO2-Feedback

Figure 1: Numbers-based CO2 Feedback in PEACOX

Providing feedback on CO_2 emissions associated with different route options has been used since a long time, and a substantial amount of knowledge on how to use and display it is available. CO_2 Feedback has become a standard feature, and results from other studies as well as our experiences within PEACOX show that this type of feedback helps users to understand the proportions of associated emissions between different trip modes. Feedback on its own does seem to have a general educating effect on users, might raise awareness, but also does not seem to be very effective on its own when it comes to behavior change.

Display possibilities and options have been explored and studied extensively, and empirically founded guidelines on how to show the feedback are available. For future research we think the following lines of research to be the most fruitful:

- Personalized metaphors: Until now – as far as we know – individual differences in appreciation and effectiveness of CO2-feedback has not been not addressed systematically. It remains unclear, which types of users prefer numeric over visual feedback, and what other approaches might be fruitful.

- Also, research on identifying such preferences automatically could help to address the user with the right method right from the beginning. Research should address whether rather accessible data elements such as demographic characteristics can be used do estimate the preference of a user. Also, very short and simple single-item questions should be developed that help to characterize the preferences of a user.

1.2 Behavior Statistics

Figure 2: Behaviour Statistics

Persuasive systems in the context of mobility behaviour frequently provide behaviour statistics in order to inform and influence the user. These statistics summarize the past travel behaviour or the user, and allow them to analyse different aspects of their behaviour. The statistics typically show information on the used trip modalities and associated CO2-emissions, and provide possibilities to compare the own behaviour and emission production of other users. Providing such statistics proofed to be a suitable approach in our project, and future research direction might want to focus on the following aspects:

- Showing behavior statistics in a traditional way is useful. Integrating the statistics with a map display and thereby allowing the users to directly observe the relationships between location, route and associated CO_2-emissions should provide even better information quality for the users. Here proper concepts of integrating these two distinct views on data with a focus on persuadability should be developed.
- An integrate with data of a higher semantic level (e.g. trip purpose) should be provided in the statistics, so users can better understand the underlying reasons for certain behavior patterns.
- Continuing the ideas from the points above research into easy-to-use and easy-to-learn visual analytics tools with a focus on improving the understanding of the users own travel behavior and on identifying entry points for behavior change should be developed.
- Last but not least an improved integration with general quantified-self concepts seems to provide important design opportunities.

1.3 Semantic Feedback

Figure 3: Semantic summary feedback designed as a growing tree as used on the PEACOX start page

With semantic feedback we refer to the approach of evaluating CO_2-emissions, and providing overall feedback on how well one is doing or not. A simple example for semantic feedback is the use of a three level travel light color coded progress feedback. Typical examples for such approaches in the context of persuasion has been the use of an evolving metaphor, e.g. a plant growing (as also used in PEACOX) or an ecosystem developing.

Semantic feedback proved to be motivating at least for some users. Regarding future work we propose to focus on the following research needs regarding this topic:

- Detailed studies on the design of algorithms that govern the temporal development and evolution of the summary feedback, i.e. decide whether (and how fast) a tree should grow in the example from above. Current approaches spur-of-the-moment designs, and we are not aware of any empirical data that measures and compare the effects of different algorithms and parameterizations. In order to support the systematic study it would also be helpful to develop a collection and classification of different types of algorithms including accurate characterizations of their key behavior patterns expressed in a semantic way (e.g. 'forgiving', 'all-or-nothing', etc.).
- A second aspect we want to draw attention to is the research of possible tailoring of such algorithms towards specific user types and personalities. Here research should first try to identify a typology of users regarding how they respond to different types of algorithms, and then try to design optimal matching scenarios.
- Another interesting route of research is the integration of research on feedback algorithms with context detection and tracking. Here the main thought is that users might become rewarded stronger if they chose more eco-friendly trip modes in specifically challenging situations.
- Above we outlined several possibilities to improve summary feedback algorithms. More complex approaches have the potential to increase acceptance and effectiveness, but they are also more difficult to understand, and users might get the feeling of randomness of variations. In order to support people in behavior change it is however required that they understand what caused certain outcomes. Therefore we propose to also investigate how to best use different concepts of improving intelligibility and attributing influencing factors within this context.
- Providing summary feedback is currently used for both individual users as well as collectives. For example the feedback might apply to a single traveler, but in other system feedback is provided on a household basis. Research in this area should investigate how the contribution of different person can be best visualized, and how group dynamics can be best utilized to maximize impact.
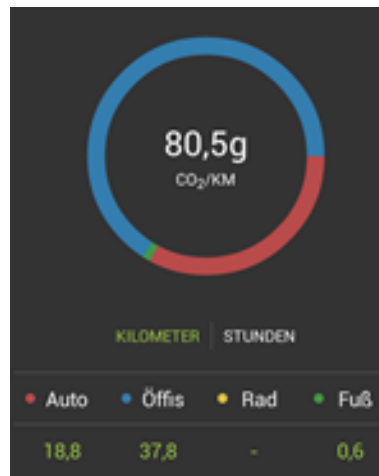
1.4   Trip mode and purpose detection

Figure 4: Information on trip mode statistics in the PEACOX statistics view

Automatic detection of trip mode and purpose has the potential to be good helpers of persuasive systems. These technologies have the potential for providing more detailed feedback to the users, and to tailor persuasive interventions towards the actual trip context and thereby possibly increasing the impact of persuasive attempts. Both, trip mode detection and trip purpose imputation have been successfully tested and applied within PEACOX. Feedback from users during the PEACOX trials also highlights the potential of such approaches, but also showed that the maturity of the methods is not good enough yet to use it without explicitly addressing and mitigating the effects of possible errors in the data analysis. While for trip mode detection data quality already was rather good, and is expected to reach high quality level within a few years, reliable trip purpose imputation is farther off to the future, and persuasive concepts using it will need to address the issue of data quality for the coming years. Again, based on our results we want to emphasize that both technologies provide high potential for increasing persuasive systems. To fully exploit these potentials future research should focus on the following aspects:

- Research should focus on improving accuracy of the mode detection and also on knowing how good or bad the current estimation is. Improvement of accuracy is especially needed for trip purpose detection, and here in the near future system approaches that combine automatic estimation and manual correction seem to be a good way to go.

- Additionally research should work on methods to estimate data quality in a reliable way. This would allow to precisely deploying mitigating methods which can help to overcome the weaknesses without endangering the reputation of the whole approach.

- Also, further methods to deal with data insecurity and how to overcome restrictions by this should be researched. Possible directions of research might want to look into integrating trip purpose detection merely based on GPS and landmark data with more personalized data from calendar applications, social networks and similar services.

- Trip mode and purpose identification should also be used to identify specific situations for a user on the move, where they are most likely to respond positively to persuasive suggestions. Research here should address two aspects. First, to identify situations when to users are open for distractions in general. Here approaches might want to monitor activity on the smartphone and current trip mode, and derive optimal situations for communicating with the users. Second, besides identifying general sweet spots for interaction analysis should also try to identify the situations in which users are most likely to welcome persuasive attempts. For example, while being stuck in a traffic jam users might be very susceptible for recommendations and reflections on using public transportation instead of the car.

- Experiences within PEACOX also showed that there are several basic technological requirements that need to be solved in order to apply the concepts successfully in the real world. Battery drain issues still significantly limit the possibilities to collect high-quality data, and methods to address this are needed badly. Also analysis and processing of data is not done locally on the mobile phone due to issues related to computational power. Methods to solve or mitigate these problems need to be developed in order to use the potentials of trip mode and purpose detection in everyday mobile trip planner systems.

- Based on the learnings from the PEACOX trials regarding the actual usage of positioning data on smart phones we recommend for future research to also focus on trying to derive trip mode and purpose information from trip data that is based on less accurate Wi-Fi and Cell-ID positioning data and not on GPS signals. Users frequently turn of GPS due to battery drain issues but use the less power intense (and less accurate) Wi-Fi and Cell-ID positioning functionality.
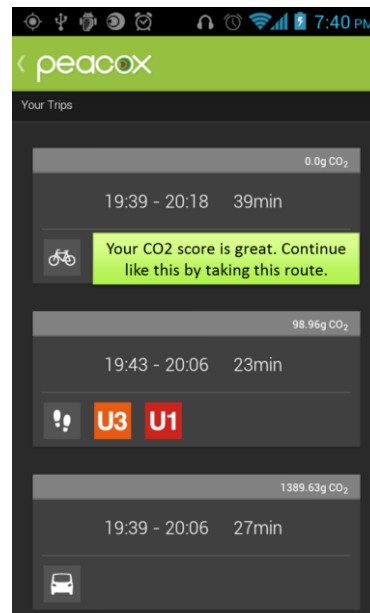
1.5 Persuasive messages

Figure 5: Example of a persuasive message shown in the route overview.

Persuasive messages are short texts intended to nudge the users towards modifying their routine behavior or introducing reflections questioning their common practice. In the context of trip planner systems these messages are typically related to a specific rout suggestion. Due to the restricted place messages have to be very short and to the point.

Such messages were applied within PEACOX directly integrated into the route results display, and were perceived well by most of the trial participants. However, no direct behavior change was visible in the data that can be directly attributed towards the persuasive messages in the system. Based on our experiences we think the following directions of research are most promising for future designs of persuasive messages:

- Future research should focus on how to further personalize persuasive messages and how users susceptible to specific types of messages could be easily identified.
- We envision this work to result in the development of a complex ontology of persuasive messages, which allows to selectively deploy specified messages (or compose new based on rules) to targeted users considering all the relevant criteria such as user type, current trip mode, actual location, derived trip purpose, etc.

- Related to this idea of on persuasive messages ontology is the problem of avoiding repetition of similar interventions and annoyance of the future. Here research is needed on how to better vary the formulation of messages, and what an acceptable frequency of messages per se and of repetitions is.
- As already mentioned above we also recommend researching how to optimize the timing and tailoring of persuasive interventions towards the current context of the users in all relevant terms.
- Finally we think it would be a very interesting rout of research to systematically analyze which persuasive suggestions actually were taken up by users, and to use big data analysis techniques to develop empirical models (in addition to the theoretically driven ones) of when and how to best apply different interventions.
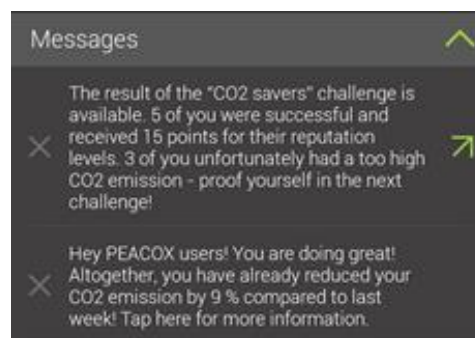
1.6 Challenges

Figure 6: Two examples of messages related to challenges shown in the message overview.

Challenges have been successfully used to promote more eco-friendly travel behavior, and also have been integrated into trip planner systems. Within PEACOX the usage of challenges for persuasive systems has been studied specifically with a focus on individual versus collaborative challenges. During the second field trial empirical data on the usage, acceptance and impact of this approach were collected, and also qualitative date to better understand the quantitative results was gathered. Based on this information sources we derived the following directions of research for future studies and applications of challenges within persuasive systems:

- Further work on the optimized identification and definition of goals for challenges to be posed to different users is needed. Currently the guidelines on how to design challenges are limited towards very general heuristics (e.g. measurable, realistic, etc.), but no detailed guidelines are available. We understand that it is not possible to provide detailed quantifications and requirements for designing challenges on a general level, but for the context of persuasive mobility it should be possible to identify several candidate scenarios and also derive detailed recommendations for them.
- Another interesting approach for research is the integration of challenges with data from the trip mode and purpose detection. This should allow to design and specify challenges much more focused and suited towards an individual user. Also, such an approach would provide the possibility to introduce challenges in specific situations and not just announce them in an unspecific and untargeted way.
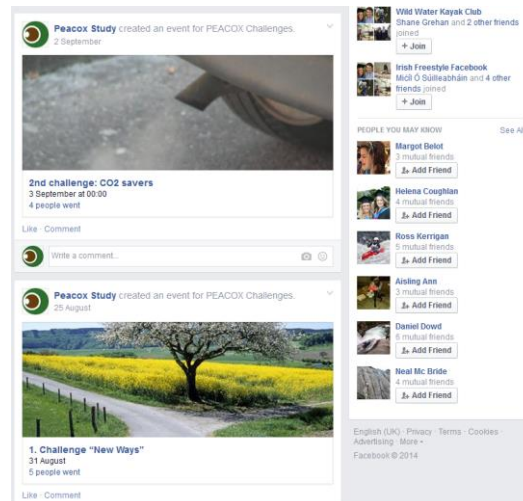
1.7 Social network integration

Figure 7: Screenshot from the Facebook site used to promote and manage challenges

A commonly suggested and successfully applied feature for persuasion is to use to power of social relationships for influencing behavior. By making commitments visible to the social environment and by harnessing the power and spirit of social cooperation approaches integrated into social networks provide important possibilities for influencing behavior and attitudes. Within PEACOX social network integration focused on promoting and publicizing

individual and collaborative challenges users could subscribe to. The chosen direct integration with the most commonly used social network (Facebook) proved to be a good choice, and interesting initial findings (see D7.5) and also questions, ideas and approaches for future directions of work could be identified:

- Within PEACOX the challenges and feedback possibilities were directly linked with Facebook, however the PEACOX functionality was not directly integrated with the other functionalities of the social network. We think that a better integration (which requires cooperation with a social network) can increase visibility and impact of the concept and therefore should be further researched and developed.
- Another interesting aspect that warrants more research in future is the composition of groups and its impact on the persuasiveness and behavior change. Research is needed on how to best compose groups (e.g. based on mobility type, personality, place of living, etc.), and how to capitalize on effects of group dynamics for persuasion.

2. Discussion of selected future research and design opportunities

Within the second part of this deliverable we focus our attention on persuasive strategies and approaches that we think – based on the experiences made during the PEACOX project - have the potential to substantially enhance the impact and effectiveness of persuasive systems. In contrast to the strategies described in prior section we did not directly explore these strategies, but data and comments of participants lead us to the assumption that these strategies are especially interesting for future research.

2.1   Mood recognition and Sentiment analysis

Our experiences within PEACOX showed that people not only are different in their principal susceptibility to persuasive strategies, but also that situational factors are important. Situational factors are related to the physical situation (e.g. which travel mode people are currently using, whether they are travelling alone or with family, they have luggage or shopping trolleys with them, etc.), but also the emotional context of the person seems to be decisive for people and how they respond to persuasive interventions. Understanding and considering situational mood and emotional needs of users for persuasion therefore seems to be a good approach, and recently different technological developments have become accessible that allow to access estimations regarding the users emotional context based on automatic analysis of data derived from different sources, e.g. sentiment analysis of social networking messages, analysis of gait and movement patterns, etc.

Addressing users in the right mood and maybe even with an intervention tailored for the specific emotional status of the user is an interesting possibility for research on how to further increase the impact of persuasive technology. Additionally, such approaches also have the potential to increase acceptability of persuasive technology. When users are only 'bothered' with persuasive attempts when they are in the mood for responding to them the likelihood of acceptance and positive experience of such measures is increasing.

2.2 Real-time data analysis and timing of interventions

In several areas of the PEACOX system automatic interpretation of data e.g. from GPS or accelerometer sensors was used to improve persuasive attempts. Here typically big amounts of data need to be processed, and this processing is not done on the users' smart phone, but data is uploaded to a server and then analyzed. Therefore the results of such analysis steps typically are only available within a significant time delay, and frequently (as also done in PEACOX) only updated once a day. Unfortunately this also means that this information cannot be used in-situ, but only in retrospective. We think that an extension towards real time information processing can provide important design possibilities for persuasive research, and that further research on this aspect will provide prolific results.

2.3 Beyond the mobile phone

Currently the mobile phone is the main device for accessing trip information while on the move, and therefore also the main channel of delivery for persuasive interventions. However, already now the first new technological tools such as smart watches or augmented or virtual reality glasses become available, and future research should explore the possibilities of such devices for supporting navigation in general as well as eco-friendly navigation and route and mode choices in specific.

3. Conclusions

In this deliverable we provided an overview of or experiences with innovative strategies and provided an outlook on research directions that we think have the potential to further enhance the possibilities and impact of persuasion in the context of mobility. Based on our experiences within PEACOX and an observation of current technological developments we identified further attempts to personalize persuasive interventions, the utilization of emerging data analysis and interpretation methods and new tools and interaction methods as promising research areas.