Peacox – Persuasive Advisor for CO2-reducing cross-modal trip planning

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D7.5 Field Trials II Report

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Abstract

The PEACOX project aims at developing a persuasive trip advisor to support users in reducing their CO_2 emissions. Within the project two prototypes of a trip planner app and navigation app have been developed and evaluated.

This document describes the second evaluation study that took place in summer 2014. It includes study setup, methodology, procedure, results and conclusions of the second trial with the PEACOX prototypes. We recruited 25 users in Vienna, Austria and 21 users in Dublin, Ireland to use three prototype apps for a period of 8 weeks: The PEACOX trip planner, the navigation app, and the trip diary app. 37 users completed the study.

The trial involved that users made free use of the application for their daily wayfinding tasks. We assessed user experience, acceptance, satisfaction with the quality of the service and impact of the implemented persuasive strategies on attitude towards mobility and mobility patterns using a variety of quantitative and qualitative methods. Quantitative methods included three online questionnaires before, during and at the end of the trial and the logging of usage (app interactions) and travel behaviour (GPS tracks). Qualitative methods included two workshops and two semi-structured interviews with each participant.

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1. Introduction

1.1 Background

This deliverable is built upon prior work in the PEACOX project, and related deliverables can be consulted in case more details are needed. Deliverable D7.1 *User Evaluation Plan* outlines the general evaluation approach. Lessons learned during the first field trial are documented in *D7.4 Field Trials I Report*. Recruiting of participants is described in D8.4.2 *Recruiting Strategies Report 2*. The prototypes that were evaluated are the results of the concerted efforts of WP3 *Behavioural Analysis and Environmental Impact Modelling*, WP4 *Automated Travel Mode and Trip Purpose Detection*, WP5 *Development of Persuasive Strategies for Green Mobility* and WP6 *System Design and Implementation*. Deliverables D6.3.2 *System Design and Interface Definition* and *D6.5 Second Prototype* describe system architecture and the final prototype clients respectively. Within the prototype system, the emission model (Deliverable D3.1 *Door-to-Door Emission Model*), the Trip Mode Detection and Trip Purpose Detection, and the Recommendation Engine (D6.3.1) are included. Also, the second prototype applications (D6.5) deployed the persuasive strategies described in D5.4.2 *Detailed Design Persuasive Eco-Feedback Strategies – Version 2*.

1.2 Scope of This Deliverable

This document gives a detailed rundown of the objectives, research questions, methodology, user sample and schedule of the second user trial. It reports the results derived from analysis of qualitative and quantitative methods applied in the second field trial. Finally, it includes conclusions of this trial and implications for the future developments after the end of the PEACOX project.

In total 37 users participated in the trials. Even though this number of participants allows to collect important feedback from users regarding their perception of the developed concepts and provide important information for the further development of the tested approaches we also want to advise to interpret the results with care. The number of users participating in the testing phase does not allow to derive results with very high robustness against random fluctuations. Results reported in the different sections therefore should be

understood as indicators for trends, which should be further verified and confirmed (or rejected) by more large-scale studies and experiments.

2. Ethical Issues, Legislation and Regulations

In PEACOX ethical issues are considered carefully, as the project follows a user-centred design approach and involves the participation of many potential end-users. For assessing studies in the context of ICT usage directly, there exists no dedicated commission in Austria. As the second trial is also taking place in Dublin, the ethical approval board of the Trinity College Dublin was consulted. Apart from obtaining their approval, the laws and regulations listed in the following sections for the preparation and conduction of the PEACOX field trial were observed.

2.1 Laws and Regulations

The following sections give an overview which European, Austrian, and Irish national laws governed the PEACOX field trial.

2.1.1 European laws and regulations on data security, privacy and ethical issues

During the PEACOX field trial, personal data of the participants was collected. European Parliament and Council Directive 95/46/EC [4] on the protection of individuals with regard to the processing of personal data and on the free movement of such data were taken into account for the main guidelines. This is a directive on European level and includes guidelines related to the:

- Quality of data and data processing
- Legitimacy and categories of data processing
- Right of access to the personal data
- Subject's right of information and objection
- Confidentiality and security of processing

The full text of this directive and a short summary can be found on the official website of the European Union [4].

2.1.2 Austrian laws and regulations on data security, privacy and ethical issues

For the evaluations in Austria, besides adhering the European laws and regulation, particular emphasis is placed on local Austrian laws and regulations:

- **Datenschutzgesetz (DSG, 2000),** BGBl. I Nr. 165/1999 [1]: This act regulates the protection of personal data in Austria (i.e. the Austrian implementation of the European directive on data protection).
- **Informationssicherheitsgesetz (InfoSiG, 2002),** BGBI. I Nr. 23/2002 [6]: This act regulates basic rights of data privacy and the duty to give information.
- **Wiener Antidiskriminierungsgesetz (LBI, 35/2004)** [15]: This act regulates the abatement of discrimination referring to the access to social, health and education as well as public services. It focuses on the non-discrimination and equal treatment regarding sex, age, disability, ethnic group, religion, ideology and sexual orientation.

2.1.3 Irish laws and regulations on data security, privacy and ethical issues

For the Irish evaluation, emphasis was put upon the following legislation and policies:

- **The Data Protection Act of 1988** [2]: The Acts set out the general principle that individuals should be in a position to control how data relating to them is used
- **The Data Protection Amendment Act, 2003** [1]: This updates the 1988 Act in terms transposing necessary legislation as outlined in the EU Directive 95/46.
- **University of Dublin Data Protection Policy** [13]: This policy is a statement of the College's commitment to protect the rights and privacy of individuals in accordance with the Data Protection legislation.

2.2 Handling of Ethical Issues in the PEACOX Field Trial

2.2.1 Data Protection Plan

Research in the PEACOX field trial revolves around information about persons – their travel profiles, lifestyle, behaviours and other personal data – drawn from records, surveys and interviews. These types of information are private and sensitive and need to be protected.

The protection of the privacy of participants is a responsibility of all persons involved in research with human participants. Privacy means, that the participant can control the access to personal information and is able to decide who has access to the collected data in the future.

Due to the principle of autonomy the participants were asked for their agreement (see Appendix A) before private and personal information is collected. It was ensured that all persons involved in the field trial understand and respect the requirement for confidentiality. The participants were informed about the confidentiality policy that is used in this research project.

Privacy plays a major role in the PEACOX field trial and is addressed as following:

- **Publications:** Hints to or identifiable personal information of any participant in (scientific) publications are omitted. It is avoided to reveal the identity of participants in research deliberately or inadvertently, without the expressed permission of the participants.
- **Dissemination:** Dissemination of data among partners. This relates to access to data, data formats, and methods of archiving (electronic and paper), including data handling, data analyses, and research communications. Access to private and information will be granted only to PEACOX partners for purposes of evaluation of the PEACOX system and only in an anonymised form, i.e. any personally identifiable information such as name, phone number or address will be omitted.
- **Protection:** The project partners AIT and TCD are responsible for the protection of the participant's privacy throughout the whole PEACOX project, including procedures such as communications, data exchange, presentation of findings, etc.
- **Control:** The responsible project partners are not allowed to circulate information without anonymisation. This means that only relevant attributes, i.e. gender, age, etc. are retained.
- **Information:** As already mentioned above, the protection of the confidentiality implies informing the participants about what may be done with their data (i.e. data sharing). Individuals that participate in any study must have the right to request and obtain free of charge information on his/her personal data subjected to processing, on the origin of such data and on their communication or intended communication.

During the field trial, participants received a generic user ID to identify them in the system and to anonymise their identities. Full names were stored only for administrative purposes (e.g. contacting the participants) and separate from study data. The only personal data stored on the users' smart phones will be their login credentials. All other data is stored in the PEACOX server database, located at Fluidtime (FLU) in Vienna. All gathered personal data is password protected and encrypted. Users' personal data is safeguarded from other people not involved in the project.

2.2.2 Ethical Principals und Documents

The Informed Consent and the Information Sheet (Appendix A) are the two important documents that were provided to the field trial participants. In order to be able to participate in the PEACOX field trial all potential participants had to read and sign an

informed consent form before starting the participation. These documents aimed to fully inform the participants about the PEACOX field trial and make all parts of the field trial clear.

Informed consent is the process by which a participant is fully informed about the research study in which they are going to participate. It originates from the legal and ethical right that the participant has to be informed what happens to their personal data and from the ethical duty of the researcher to involve the participant in the research. This means that the individual subject has the right to be informed about the research process and outcomes.

The aim of the information sheet was to provide basic information about the study and the project in order to guarantee that participants have basic information to make decision about whether to participate or not in the PEACOX field trial. It included a summary and schedule of the PEACOX field trial, the objectives and descriptions of the PEACOX system and its components.

Both informed consent and information sheet were available in German and English for Austrian and Irish users respectively. All participants received a copy of both documents.

For any question related to ethical issues that arose during the PEACOX field trial the project participants as well as partners could consult AIT (WP7 Lead).

2.2.3 Ethical Approval by the Ethical Board

The information of this chapter, the study plan outlined in Chapter 3 and all supporting documents provided in the Appendices were submitted to the School of Engineering Ethical Approval Board at Trinity College Dublin. The field trial was approved by the board. A copy of the approval is provided in Appendix A.4.

3. Study Plan

The following sections describe the setup of the second PEACOX field trial. In particular it explains the recruitment procedure, the evaluated prototypes (intermodal trip planner and navigation client), the support strategy during the trial, the research objectives, the methodology and the trial schedule.

Prior to the start of the field trial, AIT conducted expert reviews (D7.2 Usability and User Experience Feedback Report) of the applications under development to ensure most usability problems can be avoided before users get a hand on the application for a longer period of time. In particular, the usability problems found during the first trial (D7.4 Field Trials I Report) were addressed.

The second field trial took place in Austria and Ireland. The Austrian region study included the ITS (Intelligent Transport System) Vienna Region, which includes the City of Vienna, parts of surrounding Lower Austria and Northern Burgenland (more than 2,800,000 inhabitants and 8,400 km of route network). The Irish study region includes the metropolitan area of Dublin. AIT and TCD were responsible for the recruitment of participants for the PEACOX field trial in Vienna and Dublin respectively. The recruitment strategies of the second trial are discussed in detail in D8.4.2 *Recruitment Strategies*. This deliverable will just provide a brief summary.

3.1 User Participation Criteria

The following specifications had to be met for recruiting the participants:

Age	• 18 or older
Sex	• Target distribution: 50% male, 50% female
Education and Occupation	• No constraints
Residence	• Austria: Living and working/studying in the ITS Vienna Region • Ireland: Living and working/studying in the Dublin metropolitan area
Skills & props	• User of an Android smart phone for at least 3 months • Smart phone must at least be running Android OS 4.0 • User must have a data plan (min. 500 MB per month) • Fluent in German or English
Impairments	• Without any difficulties in reading and writing
Availability	• During the 8 weeks of trial planned not more than 1 week absent (e.g. holiday outside of the study regions)

The *primary users* used the PEACOX apps and also participate in lab sessions and telephone interviews. In addition, *secondary users* were invited via an announcement on the project website and PEACOX Facebook page to use the application to gather more real-world usage data. Overall, the recruitment aimed at including a balanced representation of the relevant user groups (car users, cyclists, pedestrians, users of public transport).

3.2 Recruitment Procedure in Austria

Recruitment in Austria was performed in two steps:

1. **Existing Users:** We attempted to recruit up to 10 users that already participated in the first trial to obtain feedback from users that can compare the first and the second prototype.
2. **New Users.** Additionally, potential users were be recruited via telephone from a database of people interested in participating in user studies. This database contains participants with various demographical differences, backgrounds, level of education and more. Also, to also get feedback from new users, 15 of the participants will be first-time users.

3.3 Recruitment Procedure in Ireland

Trinity College contacted individuals who have previously expressed in an interest in participating in the field during previous surveys conducted in 2012 and 2013. These individuals were be contacted in June to remind them of the work of the PEACOX project and to confirm their interest and suitability for the trial.

Additionally, Trinity College used a press release and announcements via the engineering department's mailing lists as well as campus noticeboards to recruit users.

3.4 User Reimbursement

Primary Users were compensated for their participation with €150, if all required participation is fulfilled (participation in introductory workshop, regular use of the applications, online questionnaires, telephone interviews, and final workshops). We encouraged the users to participate in all activities. However, if certain circumstances prevented users from participating in a particular activity, we tried to find a substitute (e.g. a personal interview instead of a workshop).

3.5 Prototypes for Field Trial 2

For the second field trial, users were provided with the PEACOX intermodal trip planner app and the PEACOX navigation app. Both applications are detailed in Deliverable 6.5 *Second Prototype*. Additionally, they were provided with a third app, the trip diary, to verify automatically detected travel modes and trip purposes. In order to better understand the apps in the context of this evaluation, a brief description is given in the following sections.

3.5.1 PEACOX Intermodal Trip Planner

The PEACOX Intermodal Trip Planner allowed the users to search for routes in the Vienna ITS region and in the Dublin metropolitan region. Route recommendations were multimodal and include driving, public transport, cycling and walking. Recommendations were personalised to the users profile and past behaviour. Each presented route option included information on the amount of CO_2 emitted. When available, certain routes were be particularly highlighted, depending on the context (trip length, time, weather), the user (past behaviour) and persuasive strategy (e.g. recommendation, simulation, authority). For example, a user that owns a bicycle but has been driving the car recently, on a sunny day, for fairly short trip, could get a personalised recommendation to try using his or her bike.

The app further provided quick feedback of a user's eco-balance through a virtual tree that grew or lost leaves depending on the user's behaviour. Furthermore, the app provided detailed statistics on a user's emissions in a day, week, or month view. It also allowed comparison with other users through a leader board and suggested actions to improve a user's score. Comparisons were made without revealing the users' identity by using the pseudonyms users could choose at the start of the trials. Additionally, the app promoted challenges (e.g. to reduce mobility related CO2-production by a given percentage) and their outcome to the users.

3.5.2 PEACOX Navigation App

The PEACOX navigation app could be launched from within the PEACOX trip planner when the user had chosen a route or could be run as a standalone app. It allowed searching for car and walking routes using Dynavix's route engine and public transport routes using the ITS Vienna route engine. Its main feature was true turn-by-turn navigation instructions for drivers and pedestrians.

3.5.3 PEACOX Travel Diary App

The PEACOX Travel Diary App was not evaluated as such during the field study. Its purpose was to give the user the possibility to verify and correct automatically recorded trips. Based on the GPS and accelerometer data, travel modes and trip purposes were automatically detected by ETHZ's algorithms and stored in the database. This data was used for calculating the virtual tree score. Using the travel diary app the user could browse through the trips and correct wrong data, which was needed to verify the quality of the detection algorithms.

3.6 Research Objectives

During the second field trial, participants were continuously using the PEACOX apps for 8 weeks. Their mobility behaviour, their travel mode choices as well as their attitudes and user experiences were investigated during this time. Moreover, the impact of the PEACOX app on user behaviour and attitudes were examined.

In particular, the following research questions guided the evaluation:

3.6.1 Attitudes

A1. Differences in attitudes towards the use of cars, public transport, and cycling

- A1.1. How do attitudes towards the use of cars, public transport, and cycling differ between before and after using the PEACOX apps?
- A1.2. How do attitudes towards the use of cars, public transport, and cycling differ between different mobility types?
- A1.3. How do attitudes towards the use of cars, public transport, and cycling differ between Austria and Ireland?

A2. Differences in attitudes towards the environment in general

- A2.1. How do attitudes towards the environment in general differ between before and after using the PEACOX apps?
- A2.2. How do attitudes towards the environment in general differ between different mobility types?
- A2.3. How do attitudes towards the environment in general differ between Austria and Ireland?

A3. Did the CO2 feedback influence users' attitudes towards the environment?

A4. Did the CO2 feedback influence users' perception of their individual impact on the environment?

3.6.2 Travel Behaviour

Actual behaviour change in terms of using more environmentally friendly behaviour is hard to detect, therefore the study did not only quantitatively assess changes in transport mode, but also explores to topic qualitatively.

B1. How did the usage quantity of different transport options (car, public transport, cycling, walking) change during the trial run?

B2. Did users change their trip mode choice behaviour (car, public transport, cycling, walking) when comparing before and after the trial run?

B3. What reasons did users have when they changed their trip mode choice behaviour?

B4. Influences on trip mode choice

B4.1. Did the personalised CO_2 emission feedback for a planned route influence trip mode choices?

B4.2. Did the personalised CO_2 emission feedback for past routes (tree visualisation, statistics) influence trip mode choices?

B4.3. Did the challenges that were announced users participated in influence trip mode choices?

3.6.3 Usage & User Experience

UX1. How usable are the applications? How did found issues with the application influence its usage?

UX2. How does the user experience of the PEACOX applications change after using it for 8 weeks?

UX3. How does the frequency and length of usage of the PEACOX applications change during the trial run?

UX4. How often and for what reasons do users use other apps, similar to the PEACOX apps, before, during, and after the trial?

UX5. In which situations do users use or not use the PEACOX applications?

UX6. What reasons do users have to change the frequency/length of using the applications during the trial run?

UX7. How do users perceive the quality of the recommended routes compared to a standard routing device in terms of personal preferences?

UX8. How engaging are the challenges promoted through the app?

The following sections describe the methods applied to answer these research questions.

3.7 Methodology

The second field trial focused on the collection of usage behaviour and feedback data to assess the effectiveness of PEACOX in terms of persuading users to use environmentally friendly modes of transport. To this end, a variety of methods was deployed. All methods applied were guided by our ethical principles described in Section 2.

3.7.1 Online Questionnaires

Online questionnaires were issued three times during the trial: at the beginning (t_0), in the middle (t_1) and at the end (t_2).

The first online questionnaire asked for demographic data (age, sex, education, occupation, place of residence, relationship status, family status, distance between work and home place), mobility type (main mode of transport used), attitudes towards different modes of transport (car, public transport, cycling, and walking) [12], and environmental attitudes [5],[11],[16].

For assessing persuasive effects on attitudes and behaviour a custom questionnaire was developed within PEACOX. The questionnaire relies on an established model of Lehto et al. [9], which is combined with selected factors of the Technology Acceptance Model 3 [14] and the UMUX [6]. To detect potential changes in attitudes and mobility behaviour, the according questionnaires was administered in the third round again.

The second and third questionnaire also contained questions regarding usage and user experience of the evaluated apps. First, the standardised UEQ – User Experience Questionnaire [8] were administered. In addition, we asked questions asking for opinions and impressions specifically related to the features of the apps. The areas covered are route search, tree visualisation, statistics and challenges. All questionnaires can be found in in Appendix D.

3.7.2 Focus Groups & Workshops

Workshops and focus groups are interactive sessions with a smaller group (6-10 participants) and were held at AIT's and TCD's premises. Multiple sessions were held to allow all participants to take part. A focus group is a method to gather qualitative feedback on a specific topic. Its semi-rigid structure allows on one had adjusting the course of questions depending on the flow of the discussion. On the other hand, a moderator can direct the course of discussion by specific questions. If needed, it can be supported with short

questionnaires. In comparison, a workshop is a more hands-on experience. Usually participants get specific tasks to brainstorm ideas or evaluate specific design concepts.

We used the workshop format to present prototypes and schedules to the primary users at the beginning of the trial. Users were be given all relevant information, e.g. whom to call in case of technical or other problems. Moreover, the workshops were used to gather expectations from users about the coming weeks and collect attitudes towards different modes of transport and the environment in general.

We used a fix of focus group and workshop at the end of the trial. In the first half of the session we discussed experiences with the applications and situations where transport modes were changed or not changed. Building on top of that, in the second half we looked beyond the trial. As participants wouldn't be using the app for much longer after the end of the trial, we encouraged them to make their personal reminder tool out of craft material to continue the changes they have started.

Furthermore, the focus groups at the end of the trial will be used to debrief users and inform them on future developments. Workshop guidelines are included in Appendix B.

3.7.3 Interviews

Interviews were semi-structured, that means that the interviewer had a loose set of guiding questions to make sure all topics of interest are covered during the interview. Interviewees can, however, freely talk about a subject matter. The interviewer could rearrange the order of questions and make up new questions depending on the answers given by the interviewee. This form of qualitative investigation is useful to gain deep insights and understanding into why users show certain behaviour and why or why not attitudes and behaviours changed during the field trial. Interviews were carried via telephone after 2 weeks and after 7 weeks and lasted for about 30 minutes each. Interviews were audio-recorded and transcribed for analysis.

Topics covered during the interviews include:

- General impression of both apps, user experience related topics
- Typical usage frequency and patterns of all apps
- Usage situations of trip planner and navigation client apps
- Opinions about routing, recommendations and feedback
- Reasons for (not) changing transport behaviour and to (not) choose a certain route
- Influence of CO_2 emission information for a planned route on travel mode choices

- Influence of statistics and tree visualisation on travel mode choice
- Influence of challenges on travel mode choice
- Personal environmental impact awareness
- Fit between preferences/intention and persuasive recommendation

Appendix C lists the guiding questions for the first and the second interview in detail.

3.7.4 User Tasks

In order to be able to observe natural usage behaviour, users will generally not be given instructions on how often they have to use the apps. They will be told to use the app whenever they would use another trip planner app or when they do not know the way from A to B and think the app could help them. Only during the introduction workshop users were given the task to perform 20 requests with a predefined set of start and destination addresses that include known and unknown routes and vary between users. Table 1 lists the scenarios presented to the users.

Table 1: Search Scenarios to be performed with users during introductory workshops

Scenario	Description	Restrictions
1	Home to Work	No Restrictions
2	Work to Home	No Restrictions
3	Home to Work	No Car Available
4	Work to Home	No Car Available
5	Home to Work	Bad Weather
6	Work to Home	Bad Weather
7	Home to Shopping	No Restrictions
8	Home to Friend's House	No Restrictions
9	Home to Friend's House	No Car Available
10	Home to Sports Arena	No Restrictions
11	Home to Social Event (Restaurant/City Centre)	No Restrictions
12	Unknown to Unknown* (<2km)	No Restrictions
13	Unknown to Unknown (<2km)	No Car
14	Unknown to Unknown (<2km)	Bad Weather
15	Unknown to Unknown (<5km)	No Restrictions
16	Unknown to Unknown (<5km)	No Car
17	Unknown to Unknown (<5km)	Bad Weather
18	Unknown to Unknown (<10km)	No Restrictions
19	Unknown to Unknown (<10km)	No Car
20	Unknown to Unknown (<10km)	Bad Weather

*Unknown means an origin or destination that is not familiar to the User. A number of these were selected by the researcher.

Users were then asked to decide on one of the routes by pressing the appropriate button in the app, imagining they would actually take the route. These requests served as a failsafe measure to guarantee sufficient data for evaluation of the behaviour model by TCD, which is reported in *D3.5 Evaluation of developed models*.

3.7.5 Logging of Data

The following interactions with the PEACOX trip planner and navigation client were logged:

- User interface interactions
- Which requests each user was performing
- Which recommendations were presented to a user for a given request
- Which route alternative was chosen by the user (if any)
- GPS tracks and accelerometer data

Interactions with the apps were logged to measure how actively users were using the app. The recommendations and chosen route alternative are necessary for validation of the behaviour model.

GPS tracks are needed for validating trip purpose detection, emission model (estimation and statistics), and evaluating behaviour change. Position data was collected in the background by the PEACOX app. GPS data was collected with a frequency of 1 Hz and uploaded to the server every minute. Accelerometer data was specified to use the standard frequency of the sensor which is usually set to 5 Hz, data was uploaded every 70 seconds. Dedicated programming of the app made sure that the logging process was not stopped by the Android Task management, and that all available location information sources (GPS and network) were used for acquiring position information. To process GPS and accelerometer data the software package POSDAP (2012) was used. The three most relevant steps when creating travel diaries are:

1. Cleaning of raw data GPS points are filtered when too few satellites are in view or accuracy measures are bad.
2. Identification of activities and trips is mainly based on point clouds, signal gaps and changes in the accelerometer signal if mode is changed to or from walk.
3. Identification of transport mode and activity type this is either done using a fuzzy rule or a random forest classifier.

3.8 Duration & Schedule

This section details in which time order each of the methods presented in the previous section was applied. The second user trial took place from August to October 2014. The total duration was 8 weeks. The reason to schedule the trial for this length is to be better able to observe changes in attitudes and behaviour over time. In Austria, the trial ran from 11

August to 4 October. In Ireland, the trial started one week later for administrative reasons and ran from 18 August to 10 October.

One week before the start, four introductory workshops in Vienna and four in Dublin took take place with users as described in Section 3.7.2. After the workshops and before the start of using the apps the online questionnaire was issued (see Section 3.7.1). During the first weeks users were getting familiar with the system. These first impressions were gathered as part of the first round of telephone interviews after about two weeks (see Section 3.7.3).

After participants had been using the application for four weeks, the second online questionnaire was sent out (see Section 3.7.1). After seven weeks a second round of telephone interviews was carried out. At the end of the 8 weeks, users were invited to one of the final focus groups (see Section 3.7.2). In parallel, the third online questionnaire was sent out. Table 2 summarises the methods that were used in each phase of the trial for. For reasons of coordination, there will be an offset of one week between the trials in Austria and in Ireland. Figure 1 shows the schedule of the second PEACOX field trial in a graphical representation for both countries.

Table 2: Timing of methods of the second PEACOX field trial

Timing	Method
Pre-interaction	Introductory Workshops Online Questionnaire t_1
Week 3	Interview 1
Week 5	Online Questionnaire t_2
Week 7	Interview 2
Week 8	Final Focus Groups Online Questionnaire t_3

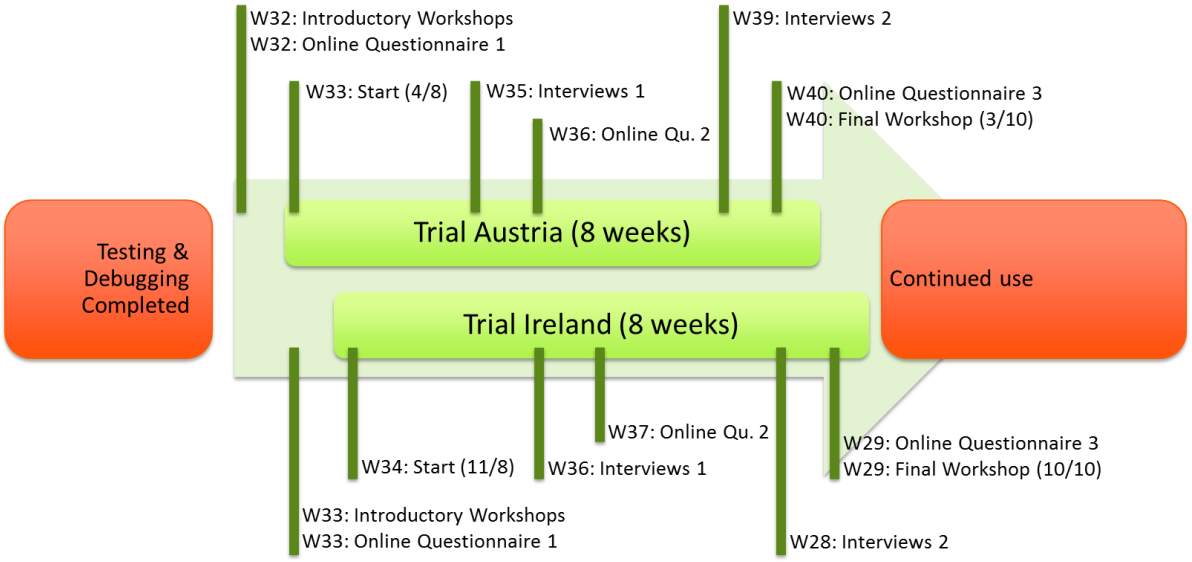

Figure 1: Timeline (calendar weeks) of the second PEACOX field trial

3.9 Risk Management & Support Strategy

In this section the risks related to the PEACOX field trial are presented and the risk management and mitigation strategies that were undertaken during the field trial are introduced.

3.9.1 Risk of Damage of the Devices Used in Field Trial

PEACOX prototypes are standard Android applications that do not pose any particular danger to the users' private devices. However, to avoid any claims for indemnification users waived any rights for such claims as part of the informed consent they signed.

3.9.2 Risk of Financial or Physical Harm for Participants

Using the PEACOX applications causes no particular risks to the participants. However, users were advised to follow general traffic safety rules and not to interact with the application while driving. They also waived any rights for indemnification for physical harm.

Financially, users were required to have a data plan with sufficient data limits (more than 500MB/month). They were informed about the average data consumption of the application and were advised that they cannot be compensated for any costs arising from exceeding their data plan limits or data roaming when using the system outside of Austria or Ireland respectively.

3.9.3 Dropout Risk Avoidance

Considering the long period of the trial the following dropout avoidance strategies were applied:

Balanced Study Workload: The amount of workload required by the primary users during the field trial such as questionnaires or interviews was arranged so that it does not cause frustrations and therefore dropouts.

Voluntariness of Participation: Participation in the PEACOX field trial was voluntary and participants could terminate their participation anytime without having to give a reason.

Buffer Strategy: Buffer participants were contacted before the start of the PEACOX field trial. In case a participant would terminate the participation not later than week 2, a buffer participant would replace the participant that dropped out. If the drop-out occurs later than week 2, this participant would not be replaced.

3.9.4 Support Strategy

During the field trials in Austria and Ireland AIT was be the first contact and responsible for solving problems that occur and giving support to the participants. Each participant had the possibility to call a helpline or write to a dedicated e-mail address. Irish users received an Irish number at TCD that would collect the issue and forward it to AIT to avoid roaming costs. Upon receiving a call or an e-mail, an AIT representative would contact the user and try to solve the problems. Hardware or software problems that cannot be resolved would be forwarded to Fluidtime, who would try to solve the issue or forward it to the responsible technical partner. Each technical project partner (FLU, TMX, ETHZ, ICCS, TCD) provided a contact person with phone number, e-mail address, times the person will be available, and if necessary, a substitute during times of absence. The goal of this process was to respond quickly to system outages or other unexpected failures that might occur during the course of the trial.

4. Results

4.1 Data Analysis

The data that was collected through the various means described in Section 3 was analysed using quantitative and qualitative methods. Quantitative data, i.e. survey and logging data was analysed using different software packages (SPSS, PSPP, Matlab)

Recordings from the interviews and focus groups were transcribed and then analysed using an open coding approach. Statements were coded so that their content is conveyed in a short phrase or single word. Codes were clustered into larger groups or themes they concern. These themes largely match with the structure of this chapter.

In a final step, quantitative and qualitative data were aligned. The following subsections therefore include insights from various empirical methods. When quantitative and qualitative data support or contradict each other, this is particularly highlighted.

4.2 User Sample

As outlined above participants were recruited from a database of people interested in taking part in usability and user experience studies and by open calls for participation promoted in university lectures and university mailing lists. Altogether 37 participants (14 female, 23 male; 20 from Vienna, 17 from Dublin) between 19 and 69 years (mean=32.92, SD=12.48) finished the study. Table 3: Overview of Participants Demographic Data below provides a detailed overview of the participants' characteristics.

Table 3: Overview of Participants Demographic Data

City	Sex	Mean Age	STD Age	Number Participants
Vienna	female	37,6	10,3	9
Vienna	male	42,0	14,8	11
Dublin	female	25,6	6,1	5
Dublin	male	24,2	3,6	12

Education level of participants was higher than the average in both trial cities. In Dublin 12 of the users had third level education, and 5 secondary education (senior cycle). In Vienna 8 participants had a third level education, and 6 secondary education (senior cycle) and 6 apprenticeship/professional training.

In both countries the majority of participants lived in the capital city (Vienna: 17 out of 20, Dublin: 12 out of 17). The distribution among household sizes can be found in Table 4: Household Characteristics below:

Table 4: Household Characteristics

	Numper of persons in household				Number of children in household		
	1	2	3	4+	0	1	2
Vienna	6	8	2	4	13	4	3
Dublin	3	3	4	7	16	0	1
Sum	9	11	6	11	29	4	4

Table 5: Main Occupation of Participants provides the breakdown for the two trial cities regarding the main occupation of the participants.

Table 5: Main Occupation of Participants

Occupation	Vienna	Dublin	Total
Student	3	9	12
(Self-)Employed	11	8	19
Parental Leave	2	0	2
Unemployed	1	0	1
Retired	3	0	3
Sum	20	17	37

Distance to work was in both cities in similar ranges: In Vienna the Mean distance was 8,55 km (STD 5,7), in Dublin 7,53 (STD 5,8).

The most frequently used travel mode for work and education was distributed as follows:

Table 6: Distribution of Most Frequently Used Travel Modes

	Work and Education			Private Trips		
	Vienna	Dublin	Total	Vienna	Dublin	Total
Car/Motorbike	1	5	6	4	5	8
Bicycles	4	2	6	3	2	5
PT	7	4	11	3	5	8
Walking	5	0	5	7	0	7
No data	3	6	9	3	6	9
Sum	20	17	37	20	17	37

Users were also asked regarding their experience and usage of navigation devices for cars ("Which statements describe your use of an in-car GPS navigation device?") The detailed results are summarized below:

Table 7: Experience and Usage of Navigation Devices

	Vienna	Dublin	Total
I have never had one.	6	5	11
I own one, but I never use it.	0	0	0
I used to use one, but not anymore.	1	0	1
I use it just for exceptional trips (e.g. holidays).	4	6	10
I use it whenever I go to an address I don't know.	10	6	16
I use it for most trips, including commuting.	2	1	3
I use it for virtually every trip.	3	0	3

A majority of users already used a journey planning app on their smartphones prior to the study: 14 (of 17) in Dublin and 15 (of 20) in Vienna. The apps used on the smartphone were the following:

Table 8: Usage of Smartphone Journey Planning Apps

	Vienna	Dublin
Google Maps	15	14
Apple Maps	0	1
TomTom	1	1
Garmin	0	0
Qando (Austria) / Journey Plan (Ireland)	6	2
AnachB (Austria) / Hit the Road (Ireland)	0	2
Scotty (Austria) / Dublin Bus (Ireland)	2	8
Irish Rail (Ireland only)	n.a.	5
Other	2 (Öffi, VOR)	0

Also attitudes towards different transportation modes (Car, Public Transport, Bicycle, Walking) was surveyed at the beginning of the trial. Our sample is characterised by the distribution shown in the table below. Scales range from 1 (low – negative) to 5 (high – positive). The detailed items of the different scales can be found in Annex D.

Table 9: Attidudes towards different travel modes collected before the start of the trials

Scale	Country	Mean	N	STD
Attitudes towards Car	Austria	3,08	20	1,07
	Ireland	3,46	17	0,48
	Total	3,26	37	0,86
Attitudes towards Public Transport	Austria	3,18	20	0,84
	Ireland	2,65	17	0,49
	Total	2,94	37	0,74
Attitudes towards Bicycle	Austria	3,8	20	0,89
	Ireland	3,6	17	0,56
	Total	3,71	37	0,75
Attitudes towards Walking	Austria	3,56	20	0,56
	Ireland	3,21	17	0,43
	Total	3,4	37	0,53

4.3 Application Use

4.3.1 Trip Planner App

(cp. Research questions UX5 section 3.6.3)

An analysis of the usage logging data revealed a very diverging activity between users. Some users were very active and requested a high number of routes, whereas others used the app only occasionally. Figure 2 shows the number of screens logged for each user. The user with the highest interaction with the app was user 411, s/he had a total of 1.235 screens displayed.

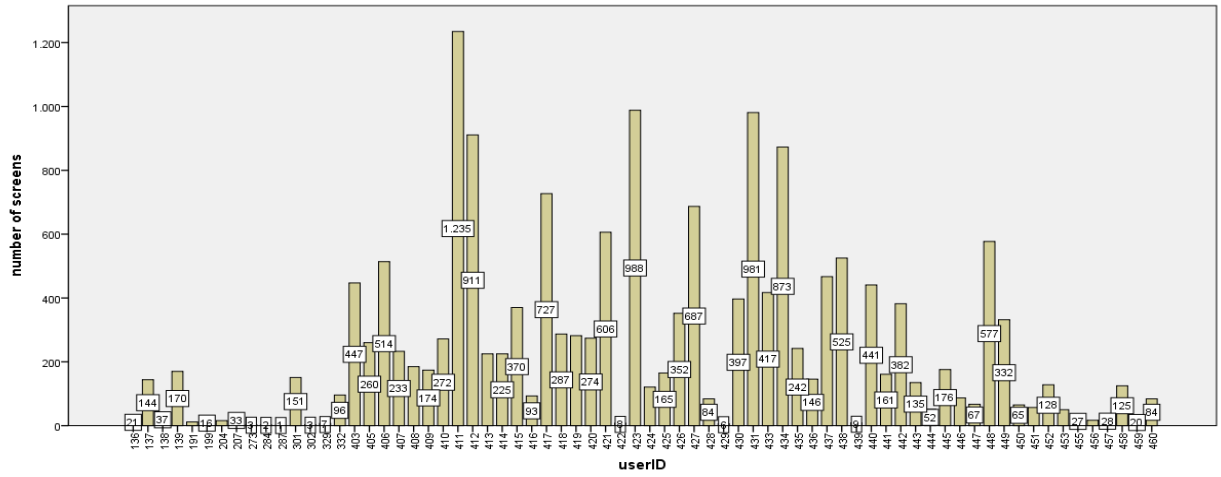

Figure 2: Number of screens per user ID

Figure 3 shows the percentage of screens that were displayed to the users over the trial period. Naturally, the launch of the app has the highest percentage, as it precedes every other interaction with the application. In about 15% of all interactions, a route was requested; this is a total of 2.710 route requests.

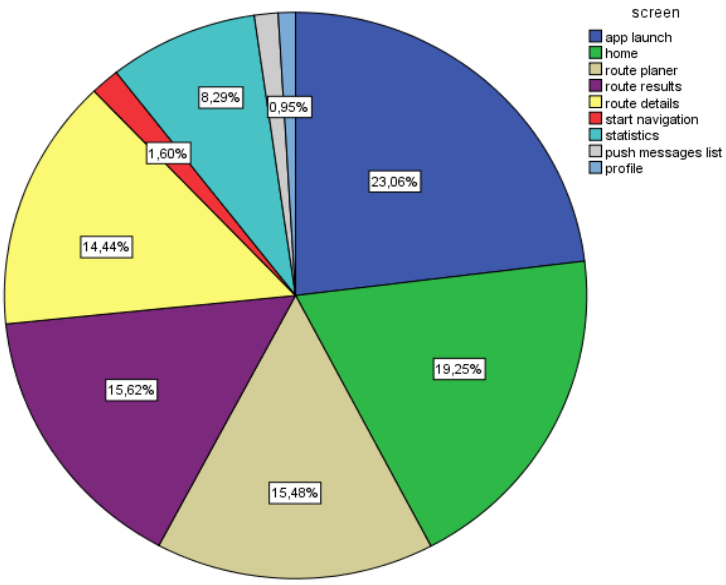

Figure 3: Percentage of screens displayed

App usage decreased over the trial period. In the first weeks of the trial in August, there was much higher activity in terms of frequency of usage on the user side than in the end of the trial. Figure 4 shows the activity (number of screens) per trial week.

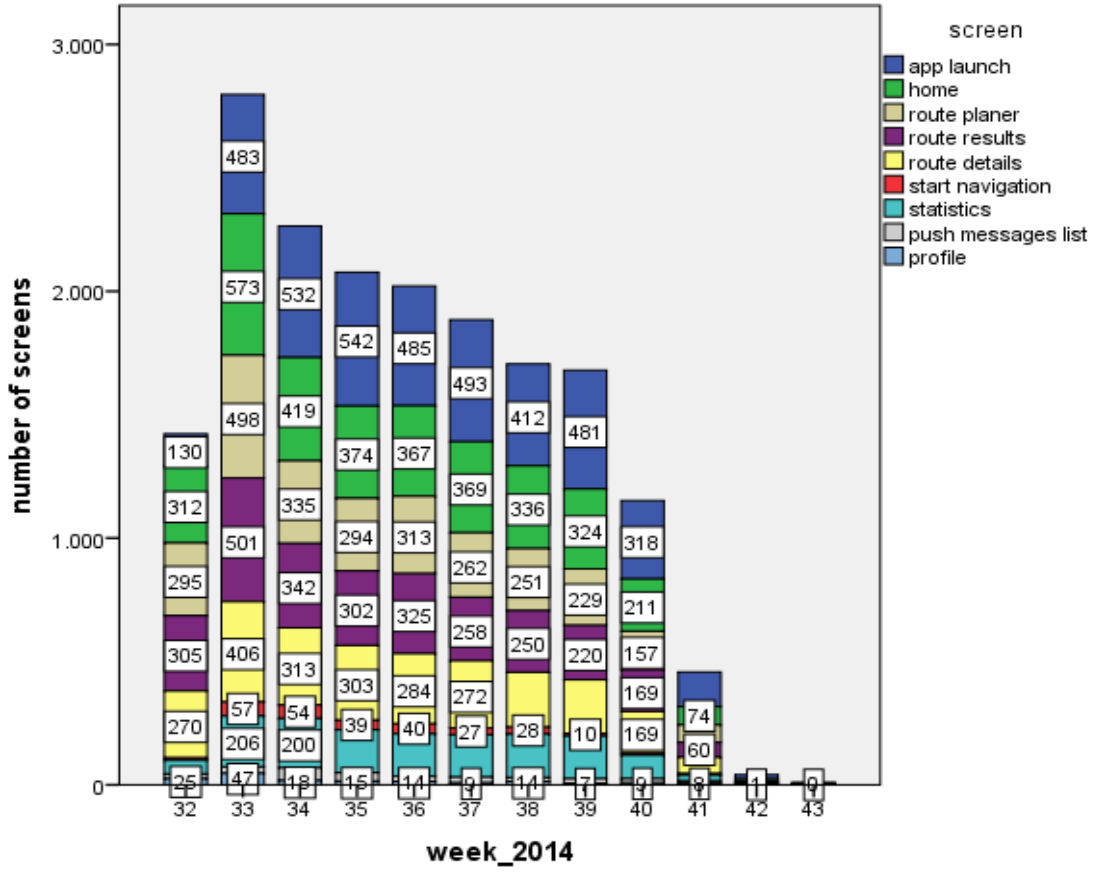

Figure 4: Number and type of screens displayed per trial week. In August there were a total of 8.560 screens displayed, in September a total of 7.643 screens and in October a total of 1.308 screens.

There was a number of challenges the users could accept and participate in. Figure 5 shows how active users were regarding these challenges. The higher the number of push messages sent to the users, the more often they participated in challenges.

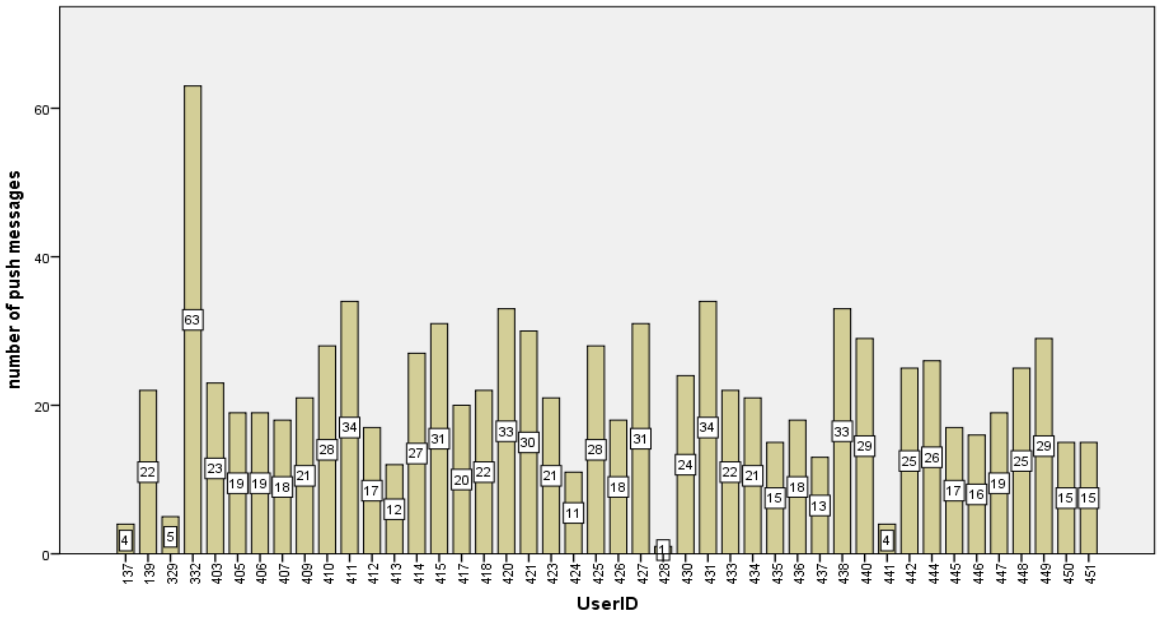

Figure 5: Number of push messages (challenges) given to each user

There were three kinds push messages: Firstly, messages inviting the user to participate in a challenge and the challenge itself (message type “received challenge” and “challenge”). Secondly, messages containing information about the challenge (message type “received info” and “info”). Thirdly, messages about the completion of the challenge (message type “received achievement” and “achievement”). Messages containing information were the most frequent, as can be drawn from Figure 6. Challenges were suggested 230 times in total and followed in 133 times (57.8% acceptance rate).

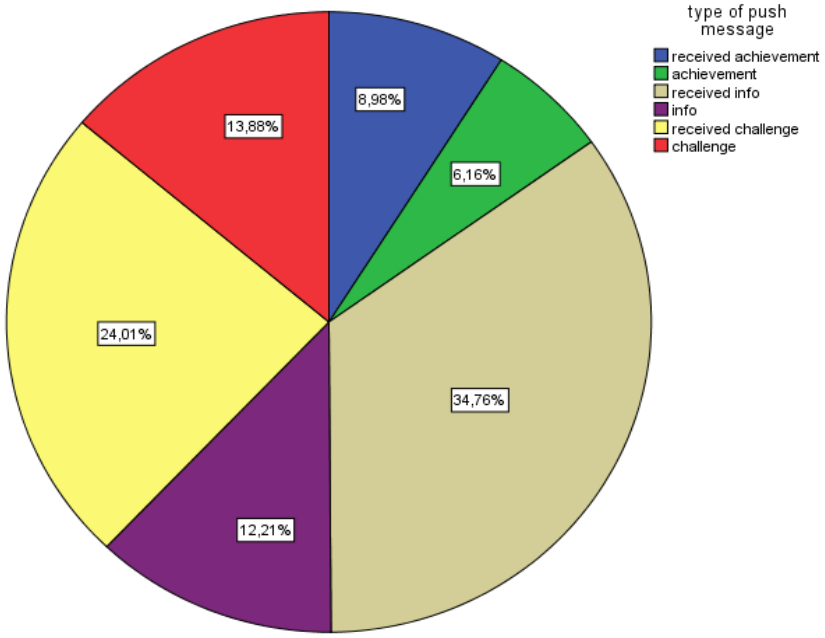

Figure 6: Percentage of types of push messages

Most challenges were suggested and accepted in September (in total 504 push messages). In August, 335 push messages were sent and in October, there was a total of 119 push messages. Figure 7 shows the distribution of push messages per trial week.

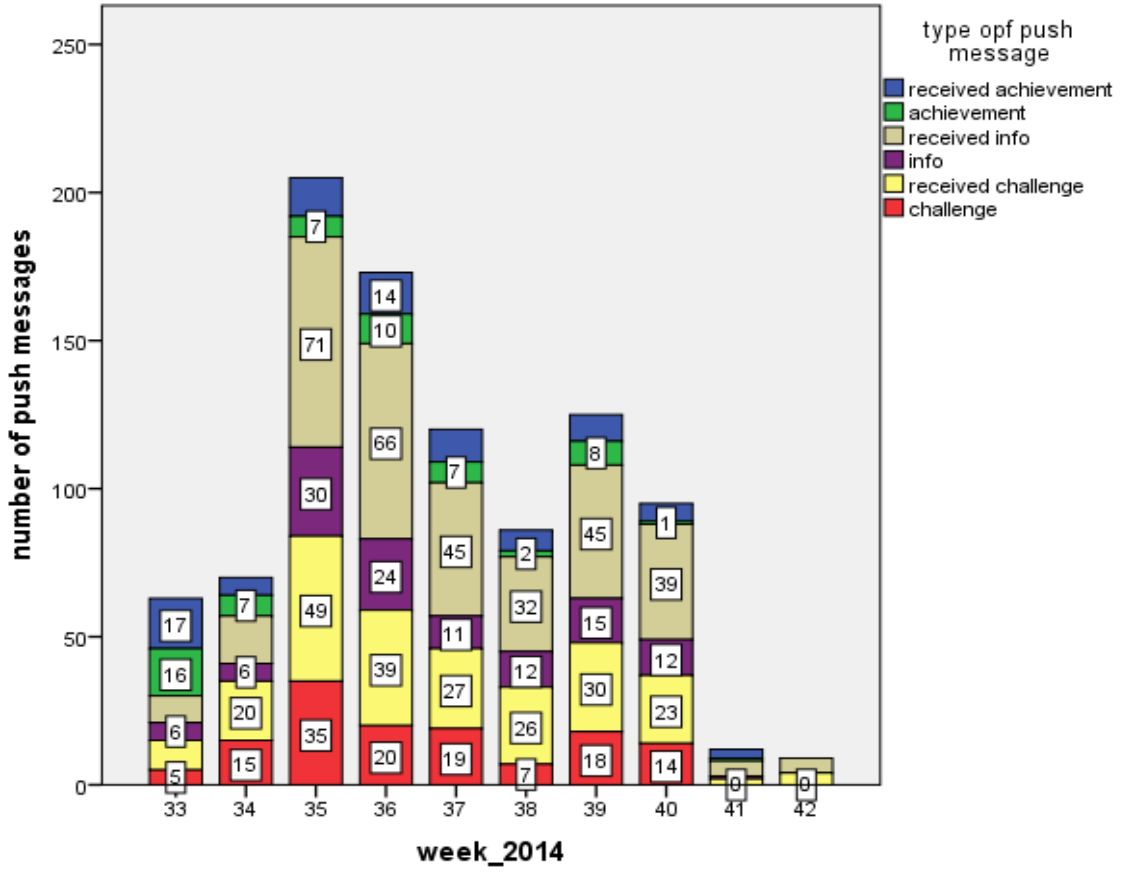

Figure 7: number and type of push messages per trial week.

During the first interview we were asking participants to report in which situations they were using the PEACOX app. Most people reported that they had the app running in the background most of the time. Most common reported active use was when users planned a route. Users were interested in reviewing different transport options and their respective routes and travel times, in particular when using public transport. 65% of our participants reported using the app when traveling by public transport. Still 32% reported using the PEACOX trip planer when driving. 21% used it when cycling and 9% reported using it when walking. As the first interview took place after about 2 weeks of usage, at that time the app was more frequently used for known routes (57%) than unknown routes. Especially in the beginning, users were also testing the app with routes they already knew. Another commonly used feature was the CO_2 information presented along each route results. Participants compared the emissions of different route alternatives, such as car and public transport.

In the first interview we also asked the participants in which situations they are using the app. Here, the majority were trips to or from work (33%), which corresponds with the fact that most trips were known routes. Another frequent situation is leisure or recreational trips, such as visiting friends or going to the country side (31%). Business related trips were also mentioned (8%). Other types of situations, such as picking-up/dropping-off or shopping, were rarely reported. Remaining trips were unspecified.

We looked again at reasons behind app usage in the second interview, which took place after about seven weeks, so just before the end of the study. After this considerable amount of time 51% of the users reported that they use the app frequent and integrated it into their daily routines. 32% reported occasional use, mostly when in unfamiliar situations. However, about 16% of our participants stated that they are hardly ever using the app anymore.

Users that used the app frequently used it for most of their trips, both unknown and known routes. Those users, who searched for unknown routes (38%) wanted primarily to know how to get to the destination, but also liked to compare the different options, mostly just to see the differences, but also to explore new options, e.g. trying the bicycle instead of the car (this aspect will be addressed in more detail in Chapter 4.6). Compared to the first interview, the number of users that reported they were using the app for routes they already knew dropped by 11% to 46%. Those users that did not search for known routes anymore stated that this has little value, as they tried it out in the beginning and they don't need PEACOX to show them how to reach their destination. Of those users who did search for known routes, 41% stated they wanted to test if the route they are taking is showing up in PEACOX, similar to the statements in the first interview. Another 35% stated they were entering also known routes because they wanted the trips to show up in their statistics. This was not necessarily done before or while traveling, but also afterwards, just to keep the trip log up to date.

Interestingly, when asked why they were using the PEACOX app, 24% of all participants stated that they were doing it because they take part in this study. Some added, that they would normally not continue using the app. A major reason for this consideration was the problem with battery life, an issue that will be discussed in Chapter 4.4.4.

There were a few participants that lost interest in the CO_2 information (8%). This was mainly due to the fact that they were unable to change anything in their mobility behaviour, be it that they move already very eco-friendly (cycling or using public transport) or that they depend on their car for various reasons. A large percentage (32%), however, stated

explicitly, that the CO_2 information presented along the route options is interesting and a reason for them to use the app. This does, in any case, not necessarily mean participants were basing their decisions on this information. This issue will be addressed in Chapter 4.7.

4.3.2 Navigation App (Dynavix)

(cp. Research questions UX5 section 3.6.3)

Analysis of the logging data of the Dynavix navigation application again revealed a very diverging activity between participants. Figure 8 shows the number of screens for each participant. While some participants used the application very consistently other seem to have tried it only once.

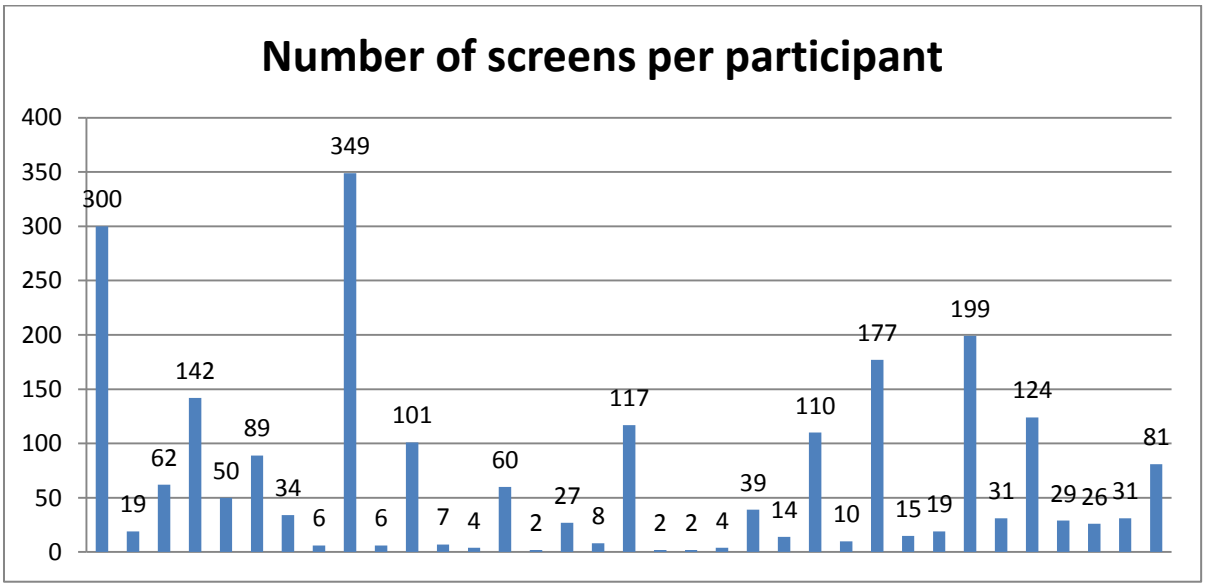

Figure 8: Number of screens per participant for the Dynavix navigation application

The general usage of the app over time declined with the course of the field trial. However, there were some variations in relation to the other activities in the field trial. Peaks occur shortly after the first and second round of interviews, as Figure 9 shows.

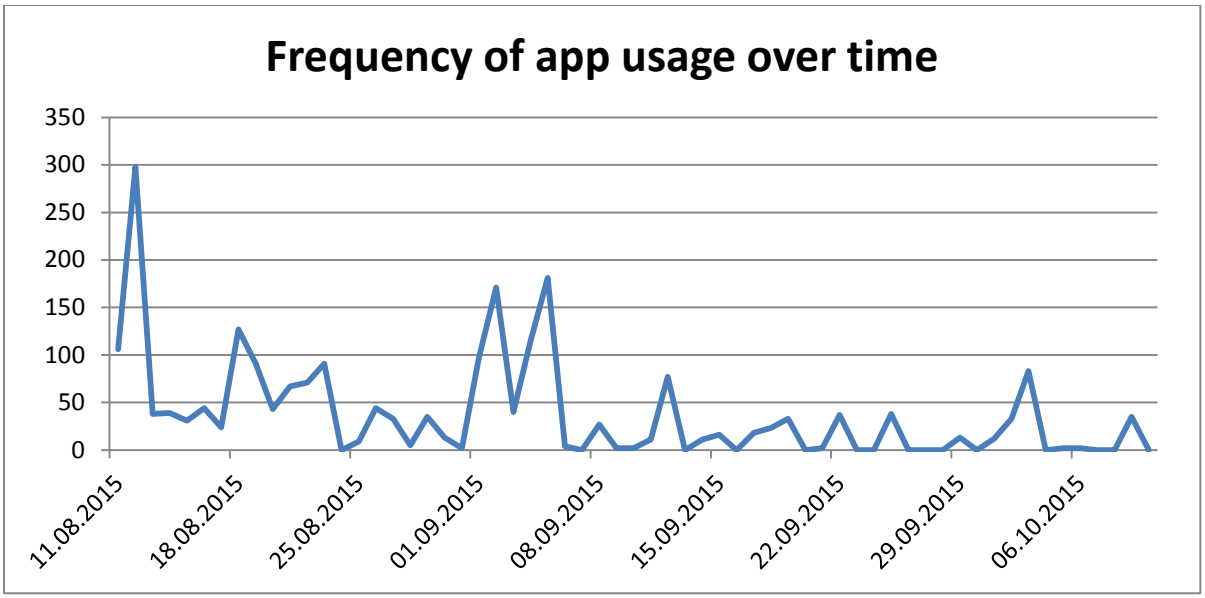

Figure 9: Frequency of the Dynavix navigation app usage over time

Some screens, such as the map view, the main application menu, and the root menu for target finding, were used very frequently, whereas others were only used once (compare Figure 10).

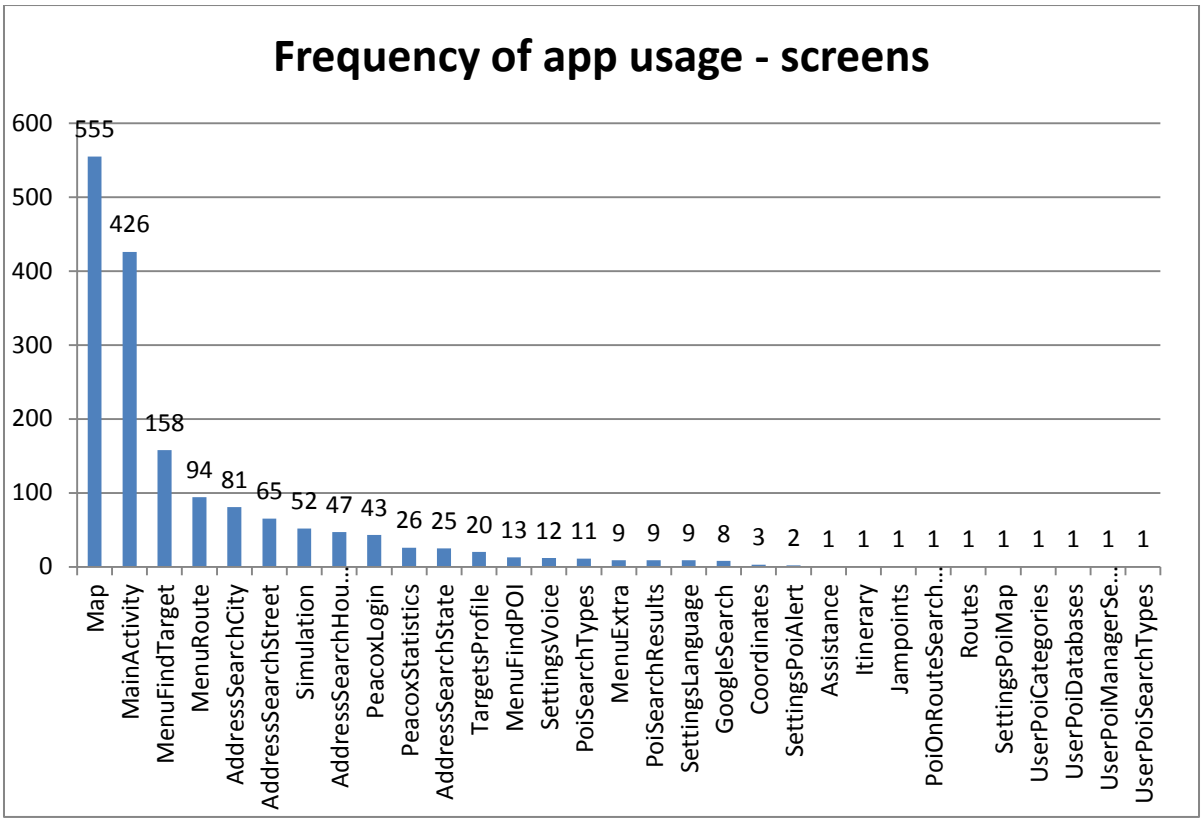

Figure 10: Frequency of screens used in field trial II

Comparing the first and second interviews, usage uptake of the PEACOX navigation app (Dynavix) was slower than for the PEACOX route planner app. While at the time of the first interviews, 50% of the participants stated they have not yet used the app, during the second interview still 27% of the users were not or only rarely using the navigation app. 55% of the users have tried using the app on several occasions. The main reason for little use of the app were technical issues related to downloading and installing the app or language issues (48%), followed by simply not having the need for navigation (41%). Those users either stated that they know their way around the city or that they don't drive so the PEACOX route planner app covers their needs. All the users that used the app frequently or when driving (18%) said that they needed turn-by-turn instructions and used the app for this purpose.

4.3.3 Trip Diary

During the introductory workshops it was recommended to have a look at the trip diary app every day as memory is still fresh and it is therefore easier to assess if recorded trips are correct. Despite this request, only a few users stated explicitly during the interview that they use, or at least try to use the prompted recall app every day. Some use it once a week. Others did not use it at all within the first two weeks of the trial. During the 8 weeks of trial, in total 10322 stages were detected. Users made corrections in 41 % of all cases. However, there is evidence that even more corrections are needed. First, only 51 % of the days were confirmed by users. Second, 6.5 % of all detected stages are marked with mode 'unknown'. And third, 24 % of all stages were corrected to be no trips at all, and of those 68 % are stages detected as bike. Even when removing all 'no trip'-stages a bike share of 27.5 % remains which seems too high, even though the study encourages green behaviour.

In Figure 3 the detection accuracies are shown per user, ordered by the share of correctly detected transport modes. Six user have 100 % accuracy which indicates, that no corrections were made. Again it is clearly visible that activity type detection performed better than mode detection which was either more influenced by the quality of the segmentation, or participants tend to correct modes but not activities.

Figure 4 shows that 30 % of corrections were done within one day, and the majority within one week. But several entries were corrected more than 3 weeks after collecting the data.

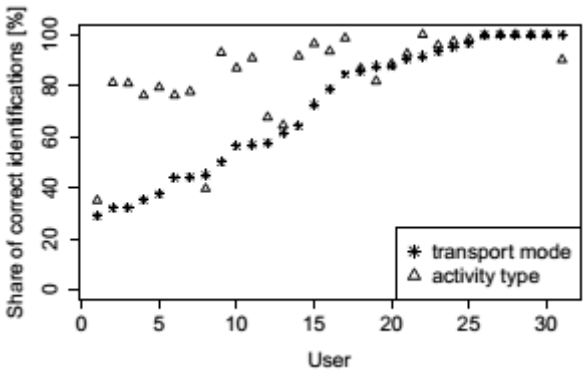

Figure 11: Detection accuracy per user (based on corrections of smartphone-based diary)

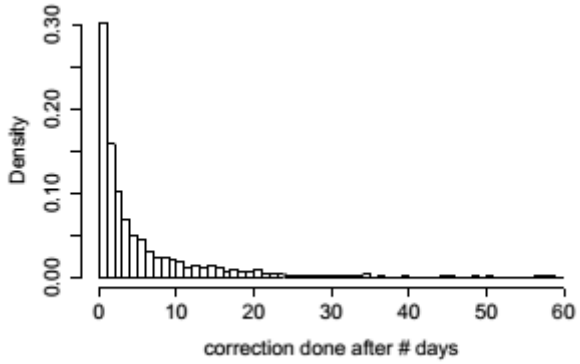

Figure 12: Number of days passing before corrections are done

4.4 Usability and User Experience

Perceived usability and usefulness of the PEACOX system was surveyed in the middle and after the end of the trials. Usability and usefulness were measured on a scale from 1 to 5 with higher values meaning better. The overall perception by the users was rather good, and improved from the first measurement in the middle of the trial to the final measurement after the end. Table 10: Overall Usability and Usefulness below provides the detailed values.

Table 10: Overall Usability and Usefulness

Middle of Trial		End of Trial	
Usability	Usefulness	Usability	Usefulness
3,56(±1,09)	3,73(±0,96)	3,95(±0,81)	4,02(±0,69)

4.4.1 Trip Planner App

When asked during interviews and in the online questionnaires what they like about the PEACOX trip planner app as an open question, users overwhelmingly stated that the multimodal trip feature and the comparison of CO_2 emissions of different route alternatives are the most important features of PEACOX. They also liked the simple and intuitive use of the app and the clear and friendly design of the user interface. Obviously, the possibility to compare travel times is also very useful for many users. Several users also highlighted the tree as a quick and easy way to know your CO_2 "status" at a glance. They also appreciated the overall idea of motivating people to save on carbon emissions and in particular that the app helps to raise awareness of one's personal emissions. The statistics, including the leader

board, the challenges, and the persuasive messages in the route results were mentioned by some users, but less frequent than the other features. A few users also highlighted little gimmicks that did, however, improve their user experience considerably. Here, two features were mentioned: first, in the map view, the trip segments that were colour coded by mode of transport, and second, that the app remembers recently searched for addresses and trips und thus avoids that users have to type in frequently used addresses over and over again.

For analysis of the open questions in the online questionnaire, participants' respondents were clustered into groups. Table 11 lists the groups and how often an aspect was mentioned. This question was asked twice, at t_2 and t_3, so the number columns include answers from both times. If the same respondent mentioned the same aspect twice, it was only counted once. Only aspects that were mentioned by at least two users are listed.

Table 11: Positive aspects of the PEACOX trip planner app as mentioned by users

"What do you like about the PEACOX trip planner app?"	**Number (total)**	**Number (Vienna)**	**Number (Dublin)**
multi-modal route comparison	15	10	5
CO_2 comparison	15	11	4
simple and intuitive use	12	6	6
design / clear arrangement of UI	12	7	5
time comparison	7	3	4
CO_2 tree	8	3	5
raising awareness	6	4	2
statistics	3	2	1
competitions / challenges	3	2	1
leader board (CO_2 ranking)	4	1	3
colour coded trip segments in map view	2	1	1
general idea of PEACOX	2	1	1
recently used locations	2	1	1
route recommendation messages	2	2	0

On the other hand, participants were also asked what the dislike about the PEACOX trip planner app. Despite a thorough testing phase prior to the start of the trial, bugs and app crashes were the most common annoyances for users. As PEACOX is nevertheless a research prototype, such problems are, however, not surprising. The most common complaints were that some trip customisation settings were not saved permanently or did not seem to have an effect on the routing results. Also, there were some multitasking issues, i.e. if the user switched away to another app and then back to PEACOX, sometimes the app did not preserve the last state but showed the start screen instead. Finally, the link to the navigation app (Dynavix) app via the "Start Navigation" but did not work for all users all the time.

Another big problem for many users was the considerable battery consumption caused by the almost permanent GPS logging in the background. However, this issue is not directly related to the trip planner app but the system as a whole.

Feature-wise, users would have wished greater variability in route results. In particular, for modalities other than public transport, the app was just showing one route. The users expected here more alternatives to choose from. This particular aspect was however, a limitation of the search engine, and beyond the means of the project to influence. Also, some of the multi-modal routes, especially those combining driving and public transport, turned out be cumbersome and too inconvenient for users to be of practical value. This problem can also be attributed to the route search algorithm. This is again true for the issue of missing addresses in the database, which some users noticed.

Due to the complex querying mechanism including CO_2 calculation and recommendation engine, a route request may take longer than expected from such an app. While the request time was indeed improved significantly compared to the first prototype, some users found the delay still unsatisfying. A few users criticised that for some routes their desired mode of transport is missing, that trip customisation options are not fine-grained enough, and statistics are limited. Also, a few users wished to have trip cost information included in the search results. While for all trips travel time was included, a few users also wanted the length of the trip in kilometres. For some again, the travel time estimations were not accurate enough. Also, a two users wanted a button to swap start and destination entries when searching for a route. As mentioned above, we got very positive feedback from most users regarding the user-friendly design and that the app raises awareness. Still, a few

participants found it not easy to use and that it does not encourage them to take green transport options.

Table 12 lists these negative aspects and how often each was mentioned in the online questionnaire. Counting of responses followed the same logic as for the positive aspects described above.

Table 12: Negative aspects of the PEACOX trip planner app as mentioned by users

"What do you dislike about the PEACOX trip planner app?"	**Number (total)**	Number (Vienna)	Number (Dublin)
bugs	11	9	2
battery use	9	5	4
only one route for cycling/walking/driving	8	6	2
cumbersome multimodal routes	8	6	2
slow search requests	5	3	2
not all addresses found	5	3	2
desired mode of transport missing	3	1	2
route customisation insufficient	3	3	0
statistics limited	3	2	1
cost information missing	2	0	2
trip length in km missing	2	2	0
crashes	2	2	0
time estimations inaccurate	2	1	1
no button to swap start and destination	2	2	0
Not easy to use	2	1	1
Not encouraging to take green options	2	0	2

4.4.2 Navigation App (Dynavix)

As pointed out before the PEACOX navigation app Dynavix was used less frequently than the PEACOX trip planner app, as some users did not had the need for turn-by-turn instructions and thus regarded the app as less important to them. Due to this fact, there were also fewer responses regarding the app's user experience. When users were asked which aspects of Dynavix they like, most frequently they cited the app's user friendliness. They also liked how route information is presented and that useful points-of-interests (POIs) are displayed along with routes. Also the 3D map view was received positively. User in general liked the app's design and functionality. They highlighted the accurate turn-by-turn instructions and the voice feedback. They also liked the possibility to use Google Search to look for target destinations. Some users compared the app directly with Google maps, of which some preferred Dynavix, others preferred Google maps. Those who preferred Google maps found it more modern. Those who preferred Dynavix liked the well-structured design that resembles the layout of traditional in-car satellite navigation systems.

Users were asked about positive and negative aspects of Dynavix in the online questionnaires. Table 13 lists the positive aspects and how often each was mentioned. Counting of responses followed the same logic as for the PEACOX app described in the previous section.

Table 13: Positive aspects of the PEACOX navigation app (Dynavix) as mentioned by users

"What do you like about the PEACOX navigation planner app (Dynavix)?"	**Number (total)**	**Number (Vienna)**	**Number (Dublin)**
user friendly	6	2	4
route information and POIs	5	3	2
3D map view	5	4	1
design of user interface	4	2	2
precise navigation	4	3	1
link to Google search	2	1	1

Those users that did not use the app frequently were also less satisfied with its design and operation. It appears that users either really liked the app or they did not. While the user friendliness of the app was the most frequent positive aspect, the app's unintuitiveness was

also the most common negative aspect. The other complaints generally related to technical problems and bugs. Some users found the app unable to find the addresses they wanted to go to. This problem seems to be an issue for Irish users only, however. Others had problems setting the app's user interface or voice output language to German or English respectively. A few user's did not see any advantage compared to Google maps. The time the app takes to calculate a route was also criticised by a few users. The battery drain was also mentioned, however, this is most likely falsely attributed to Dynavix. Instead, the battery drain is caused by the logging component of the PEACOX system, an issue that will be discussed in Section 4.4.4. While other users highlighted the POI functionality, a few users did not find them useful or stated it was missing. Also, a few users wished multi-modal route capabilities despite the app being able to search not only for car routes but for public transport and walking routes as well.

Table 14 lists the negative aspects of Dynavix and how often each was mentioned in the online questionnaire. Counting of responses followed the same logic as for the positive aspects described above.

Table 14: Negative aspects of the PEACOX navigation app (Dynavix) as mentioned by users

"What do you dislike about the PEACOX navigation planner app (Dynavix)?"	**Number (total)**	**Number (Vienna)**	**Number (Dublin)**
not intuitive interface	5	3	2
doesn't find addresses	4	0	4
language problems (UI, voice instructions)	3	3	0
no advantage over Google maps	2	0	2
slow route finding	2	2	0
battery drain	2	1	1
no POIs and other en route information	2	2	0

4.4.3 Trip Diary

Overall users were pleased with the handling of the trip diary app. They described it as easy to use and user friendly. At least one user found the app also interesting for private use to check on the routes one did during a day. For another user on the other hand it was not clear that the diary is prepopulated with trips. A few users reported minor bugs and usability issues, some of them could be solved during the field trials.

Problems with the data quality of course also affected the user experience. Users were informed at the start of the study that detection accuracy rates of 60-80 % can be expected. However, at least one user expressed disappointment with the app, s/he would have expected more accurate results.

In some instances the predefined activity categories were not clear to users. There were a few grey areas. For example, it was not clear for some users, if they should categorise 'going for lunch' as 'leisure', 'shopping', or 'other'. Additional explanations or more activity types to choose from would have been beneficial for them.

4.4.4 Battery Life Issues

A common issue with constant GPS logging is a considerable drain on the mobile phone's battery. In order to reduce impact on battery life, a scheduling mechanism was implemented that stopped any logging activity between 22:00 at night and 06:00 the next morning. However, several users reported that this did not work and that they had to turn the logging off manually at night.

In the introductory workshop, participants were advised to keep GPS antenna, the Google location services, WiFi and the PEACOX sensor logging on whenever possible. They should only turn off the background logging service, if the battery was low. Most participants stated that they followed these instructions. Users were already concerned about battery in the introductory workshops, the consensus was that it is acceptable to turn off logging when not moving for some time, e.g., at home or in the office as long as logging is turned on again when leaving the building. Several users implemented this strategy. Still, some users had to turn the logging off a few times (generally 1-3 times), in particular when the phone was used more intensively for other purposes or they knew that they will need the phone later and no power outlet is available.

Also, at the start of the study, participants were given the advice to always carry a charger with them and recharge their phone whenever possible, e.g. in the office (many users did that) or in the car (users reported that this was not always sufficient, depending on the length of the trip). One user even regularly asked customers permission to charge the phone there. Two users used a second battery or a mobile charging device.

Generally battery drain was described as quick and a problem especially when at a place with no charging options, such as on the go or outdoors. Some users reported that they 'could watch the percentages dropping', another user described an up to '2 % drop per minute' when actively using the phone. A few users had to charge their phone several times a day, or even almost constantly plugged in. But still, there were a few users that they did not have to recharge their phone during the day, only once, or only if they use it a lot for other purposes.

One user dropped out of the study because of the battery problems, as the phone was needed for job reasons and s/he was on the move a lot without opportunity to charge the phone.

4.5 Attitudes towards Environment and Sustainable Traffic

At be beginning and after the conclusion of the trial we collected measurements on three scales that target attitudes towards the environment: we measured general environmental concerns, the perceived locus of control (regarding environmental issues) and the attitudes towards sustainable traffic. The detailed items of the different scales can be found in Annex D.

Repeated measures t-tests were performed on these scales in order to quantify whether any statistical significant changes did occur as a result of the PEACOX system. Table 15 below provides a summary of the test results. In order to not increase the family-wise error rate of statistical testing we applied Bonferroni corrections for using multiple tests using the same sample resulting in a critical p-value of 0.05/3=0.01666.

Table 15: t-test results for different scales measuring attitudes towards environment and sustainable traffic

	Difference Mean (t0-t2)	STD	t	df	p
Attitude towards sustainable travel	**-0,13**	**0,25**	**-3,18**	**36**	**0,003**
Locus of Control	-0,07	0,55	-0,79	36	0,432
Environmental Concern	-0,07	0,37	-1,19	36	0,242

Using the p-cut-off defined above attitudes towards sustainable transportation significantly improved over the course of the trials, whereas no significant difference was measureable for general environmental concern and the perceived locus of control. In order to better understand the reasons for these results we next look at the qualitative comments on attitudes and attitude changes.

Self-reported attitude changes were asked during the second interviews. Results also indicate that PEACOX had indeed a positive impact on participants. Attitude changes reported by users can be clustered into three groups. First, there are users that did not report any significant changes. Second, a group of users reported slightly improved attitudes and increased awareness. Third, there are users that reported a significant change in attitudes towards sustainable transport modes and the environment in general.

Nine participants or 26% reported that their attitudes towards sustainable transport modes and the environment stayed largely the same. Of those users, eight stated the reason why they stayed the same is because they were already very positive. They already knew beforehand that driving a car is “bad” and walking is “good”. Some still acknowledged that the app reinforced their attitudes or made them more conscious about attitudes that existed

already before but were less reflected upon. One participant, for example noted that s/he of course know that cars emit more than public transport, but that the difference was that big she did not know. In most instances, car trips had emissions about 10 times as big as public transport.

Those participants already try to act environmentally friendly. They walk a lot and use public transport. Most of them don't own a car or only use it in emergency situations. Still there was one user that acknowledged their regular car use and the negative impact this behaviour has. While the app succeeded in making this impact more conscious by displaying the emission numbers, this did not affect their attitudes. S/he justified their car use by pointing out time factors and costs.

The majority of users, in total 15 participants, or 44%, reported some changes in their attitudes. The main difference was that the various forms of CO_2 information created awareness of their individual impact. The multimodal route planner also made participants aware of specific alternatives. While one might know in general that it is possible to cycle a given route, seeing cycling instructions displayed on the screen can make a big difference. Additionally, seeing a comparison chart with the emissions caused by different modes of transport made many users to reflect upon their choices. Obviously, cycling as such causes no emissions compared to driving, but seeing the numbers on the screen made participants reconsider. Furthermore, while public transport generally is considered environmentally friendly, it is not emissions free. PEACOX pointed that out clearly and made some users consider cycling over public transport. The time comparison helped too, as it demonstrated in many cases that cycling was comparable or even faster than public transport or not much slower than driving.

The CO_2 comparison also showed that different modes of public transport, such as train, bus, or metro also have different emission factors. Most participants were not conscious about this fact and that their decision whether to take a bus or a tram can make a difference in the long run by shifting passenger loads to more sustainable modes of public transport.

Several participants pointed out that if time does not play a major role it was easy for them to take the environmentally friendly option. However, even if participants were not able to always to follow the recommendations they were still actively thinking that they could do different. Here, statistics, leader board and challenges played out well, as they allowed participants to compare themselves with others. Several users were asking themselves how

participants on the top of the list are travelling to achieve such low emissions. These gamification elements of PEACOX also helped users to more continuously use the system, which kept environmental impacts in their attention. This worked particularly well for more competitive participants. Other participants, however, disliked these competitive elements.

At least one participant reported that the fact that s/he is being monitored makes her choices which mode of transport to take more conscious. When GPS tracking was on, s/he was more likely to choose bike or walk. In this particular case, but also in general, long term effects remain unclear, as it might happen that when monitoring is no longer happening, the person will return to previous behaviour patterns. We will discuss this question in Section 4.7.4.

Finally, ten participants, or 29%, reported a considerable change in attitudes. Similar to rest of the users, they saw in PEACOX an educational tool that informed them about both the CO_2 emissions of different transport options and about their personal impact. The changes compared to before the study were, however, stronger. Some users said that before the study they didn't know about alternatives to driving or even if wouldn't have considered them. PEAOCX made them aware about more options to travel and the reduced CO_2 emissions, increased convenience, and lower costs, even though the app did not display travel costs.

The key difference that PEACOX made in terms of attitudes was the following: First, the apps made the participants actively consider alternative ways of travelling as a valid option. Furthermore, being able to track one's emissions over the course of several weeks allows users to reflect about their choices. This is in particular interesting, as travel preferences are generally very habitual and thus hard to change. PEACOX successfully functioned as a "critical life event" that (temporarily) breaks habits and made participants reconsider.

Most participants could name specific features were key for this event to happen. However, for some it was no feature in particular but the overall fact of using the app and taking part in the study. Not surprisingly, the multimodal route comparison with CO_2 information was for many users the most influential feature. The trip logging component paired with statistics was the second most important feature. As for the group that changed attitudes slightly, the comparison and competition with others was also mentioned for some to be motivating, as it introduces the element of fun. A few users also explicitly mentioned the messages

sometimes shown next to route options, such as “Take the bike, it’s not that far” as motivating to reconsider their choices.

Many of these users considered them already environmentally friendly, but PEACOX gave them the little nudge that was missing. Visualising usually mostly invisible carbon emissions provided that nudge when participants were indecisive or by their own definition overly convenient. Overall, those users felt encouraged to improve their environmental impact by taking action, as we will discuss in the next section. Again, this does not only mean less driving, but also reflecting on the impact of the public transport system and consider walking or cycling more often.

4.6 Mobility Behaviour

4.6.1 Main Mode of Transport

Besides analysing attitudes we also asked users for their main use of transportation, and compared whether the stated main transportation medium change over time. For this purpose we especially focused on the question “Which mode of transport do you use most of the time for your daily commuting trips?”. Answers were coded starting from the most emission intensive modality (car, motorbike = 1) through intermediate levels (public transport =2, cycling = 3) to the environmentally most friendly (walk = 4). Using repeated measures t-test on this score we find that the mean very slightly moved towards more environmental friendly modes: Mean answer was 2.3(±0.99) bevor the trial, and 2.48(±0.94) after the trial, however this change is very small and not statistically significant (p=0.134).

4.6.2 Reported Changes

During the second interview, users were also asked explicitly if their mobility behaviour had changed over the course of the study. As expected, changes were not as frequent as attitude changes. Nevertheless, more than half of our users did in fact change their behaviour. Again, behaviour changes were split into three groups. First, there are those users that did not report any changes. Second, there is a group of users that reported a few small changes due to PEACOX and third, there are those participants that did state they changed a significant aspect of their travel behaviour.

About 47% of our users (16 in absolute numbers) stated they did not make any changes in their mobility behaviour. One user simply stated that s/he is already settled in their routines and knowing the emissions does not change them. However, their routines were taking the bus to work. For another user, carbon emissions were still intangible, despite seeing the numbers or the tree visualisation. Actual effects might only become visible in the next 30 years, but money is more sudden and affects them directly, so s/he does not want to pay for public transport.

About half of the remaining users, however, made the conscious choice not to change their mobility behaviour, because they see no other options. Those users that continue driving largely felt that they have good reasons to do so. For example, public transport or cycling options that are available are simply not attractive enough for them. In most cases this means that the distance between home and work was to long for participants to consider cycling or public transport or the trip would last considerably longer compared to driving due to a bad connection with public transport. In one case the user had a non-working bicycle but did not find the time to look for a new one. The user also preferred spending the money that would be needed on other things that are more important to them. Also in winter bicycles are obviously a less attractive option. One user also had safety concerns regarding cycling.

The other half of users that did not change their mobility behaviour did so because they felt they are already moving “green”. For some of those this was not necessarily because of environmental concerns, but simply due to the fact that they did not have other options than a train, cycling, or walking available to them. One user, for example, said that s/he as a student cannot afford driving anyway so s/he is walking to university anyway. Other explicitly stated that they feel they do what they can to move sustainably and they wouldn’t know how to improve it even further. In these cases the recommendations given by PEACOX largely align with existing transportation habits. Some of these users were occasional users of a car, but only when “there is no other option”. The increased awareness of emissions caused at least one of them though to have a bad feeling when driving.

Of all the users that participated in the interviews nine, or 26% reported small changes in their mobility behaviour. Interestingly there seems to be a difference between Irish and Austrian users. Irish users tended to increase their cycling whereas Austrian users changed their public transport behaviour by using different modes or walking a few stops.

Increased cycling by Irish users came along with less driving or reduced public transport use. One user reported that s/he replaced mainly short trips s/he would normally do by car with the bicycle. Longer trips, where the time difference has a bigger impact, s/he would still do by car. Another user reported that s/he tried to walk and cycle in the first weeks, but with bad weather that was coming up for a longer period it was too much of a hassle to get to college. Weather conditions are a big influence for this group of users in general, as several other users reported. Features that influenced users most were the trip planner, the tree and the leader board.

Austrian users mainly reported changes in their use of public transport. Some users stated they wouldn't take the bus or tram for a couple of stops and walk instead. Others said that if there are several public transport options available, such as bus, subway, and train, they would take the one with fewer emissions.

Again, the trip planner that makes it easy to compare CO_2 emissions of different routes was the key feature that caused users to reconsider and sometimes use a different means of transport. This was, however, only the case when other factors, such as time constraints were less important.

Another nine users (26%) reported a significant change in their mobility behaviour. In this group, drivers generally reported that they use the car less and more public transport and the bicycle. Public transport users also changed towards more active forms of mobility, such as walking or cycling. While the split between Irish and Austrian users regarding what changes they performed was present, it was not as clear as for the group of users that changed their behaviour only slightly.

Increased bicycle use was the biggest change overall. For several users PEACOX was the final nudge they need to start cycling. These users had the intention to try cycling but kept putting it off. The app made them not only aware of their impacts but also made cycling easier as it showed convenient cycling routes. Besides the positive environmental impacts, users also highlighted the financial incentives and the physical benefits they experienced. One user did, however, express uncertainty whether s/he will keep up cycling when the study is over.

Next to increased cycling, participants also reported a more conscious use of public transport. Similar to the second group, among different options of means of public transport they chose the one with fewer emissions. One user also reported that s/he used to drive to

get to the city. Since using PEACOX s/he drives to the city limits, parks the car there and continues using public transport. For short trips, like going shopping, several users reported that they are now using the bicycle more often. When driving, at least one user stated that s/he tries to drive more fuel-efficient because of the app.

Another interesting aspect was reported by at least one user: Because of their participation in the study s/he was talking to colleagues at work and tried to convince die-hard car drivers to switch to public transport. While their efforts might not have been successful this time, this example shows the social effects a system like PEACOX can have beyond its direct user base.

The features that affected participants most were, as with the other user groups, the CO_2 comparison when planning a trip, the tree as a quick reminder of one's status, the comparison with other users via the leader board, and the individual statistics.

4.6.3 Types of Trips

During the final focus groups we collected situations in which participants felt they changed their behaviour and situations in which they did not. The following will give an overview of these situations.

Short trips are one type of trip where participants felt they changed their behaviour. Before using the app, some participants said they were just using the car out of habit. Due to the app they realised that short trips are easily covered by walk or cycling. Time constraints or if they need to transport things of course affect these decisions. One participant did, however, point out that for short trips s/he is often faster walking because s/he doesn't have to look for a parking spot anymore.

A subgroup of this type are *daily errands.* Participants got started to walk to the post office or grocery store. Usually these places are just around the corner and participants wouldn't need the trip planner app to find their way, but just the participation in the study motivated them. In particular if the bicycle has transportation capabilities (e.g. a basket) it was an attractive choice as well. Good weather was obviously a precondition for most users.

Another situation where participants changed their mobility behaviour are *trips from the suburbs or countryside into the city*. Considering traffic jams, search for a free parking spot, and parking fees, some users decided to use public transport instead. Again, a comparable travel time was a key reason for this choice.

Commuting to and from work was also a type where some participants changed their habits. As they usually take place during rush hour, in particular drivers got motivated to switch to public transport to avoid traffic jams and searching for a parking spot. Other users started cycling to avoid crowded trains and busses and described this as a pleasant experience.

All these situations show, however, that in general users reconsidered their choice for trips where *travel time* proved to be shorter or equal. This illustrates that travel time is still a very important decision factor, despite the influence of environmental factors.

Another type of trips are *leisure trips*. Here, travel time is generally a subordinate factor. One participant in particular reported that s/he was surprised how easy it was to travel on public transport instead of by car with children and a dog, including a pram and toys. Public transport turned out to be a more entertaining experience for the children and thus more comfortable overall. Other users started using the bicycle to get to places where they do physical exercises, e.g. the gym. While they might have used the car or public transport before, they see cycling now as an extension of their training.

On the other hand, there were several types of trips, which the participants were not able or willing to change. Although some users said that they changed their *commuting* habits, there were also several participants that stated they cannot. One reason is that they constantly need to carry along things they need for their job. The car provides a comfortable way of doing so without the need of much advanced planning as it is not necessary decide which things are actually necessary to take along on a given day and what could stay at home. One user also felt that s/he has to be dressed nicely for the job and therefore doesn't want to cycle or stand in a crowded subway. Another reason why some participants continue to drive to work is that they can use a company car and therefore don't have to pay for it.

Another situation where participants had troubles changing their mobility behaviour are again *leisure trips*. In particular trips to destinations that are hard or impossible to reach with public transport, e.g. to go hiking in the mountains, a car is seen as essential. This is also the case for sports activities that require heavy gear, such as kayaking or mountain biking.

The car is also an attractive means of transport for *combined trips*. When multiple destinations need to be reached, driving is often the quickest way to reach all of them. If the activities that happen at the respective destinations are additionally very different from each other, e.g. work and then sports training, the car is even more convenient, as different outfits and gear can easily be taken along. Some participants drop off their children at school

on their way to work. They find using a car a less stressful option to do this. *Shopping* trips are often combined with other trips, but even if not many participants prefer the car to go shopping, in particular when they have heavy goods to transport.

Finally, for *longer trips* in general many participants don't want to use public transport, as they tend to be considerably slower than with a car. Also, for mid-range trips around 15 km cycling is not an option if one cannot afford to arrive at the destination sweaty.

4.7 Perception and Impact of Persuasive Strategies

4.7.1 Route Planner

CO_2 information in trip planner: PEACOX displays CO_2 vales along the different route options to inform the user. Several questions in the survey addressed the CO_2-information in the trip planner. Table 16 below provides the summary of the response by the trial participants.

Table 16: User Opinions regarding CO2 feedback

		The CO2 emission data presented along the route information is very useful.		**The CO2 emission data had an impact on my trip decisions.**	
	Value	Count	Percent	Count	Percent
totally disagree	1	1	2,7	1	2,7
rather disagree	2	1	2,7	11	29,73
neutral	3	6	16,22	5	13,51
rather agree	4	15	40,54	14	37,84
totally agree	5	14	37,84	6	16,22
Total		37	100	37	100

As pointed out in Sections 0 and 4.6, the CO_2 vales that PEACOX displays along the different route options turned out to be the most important persuasive element. It helped users to become at least aware of the impact of the different modes of transport. Although not designed with this intention, some users felt guilty when the saw the high emission number and were still driving. Driving in many cases had emission numbers that are by a factor of 10 higher than public transport. This significant difference alone made an impression on participants. Also the differences in emissions among public transport alternatives were new

to many users and made them aware that also public transport is causing CO_2 emissions. All in all, the CO_2 values allowed participants to make more conscious travel mode and route decisions. It triggered them to question the "normality" of their and other's transport choices.

While all participants noticed the display of emission data, not all were influence by it. As discussed earlier, other factors, in particular travel time, costs, comfort, and weather conditions were in many situations more important. Other participants stated that they made up their mind on which mode of transport to take prior to looking on how to reach their destination. Therefore the numbers had little impact on their decision.

Although the numbers were informative for most users, at least one user wanted to see how they relate to actual impacts on the environment. While this is of course hard to calculate precisely, the participant wanted the information to be displayed in a more figurative manner.

Of course, in some cases the numbers had no influence on users because they are already taking public transport, cycle or walk. In particular if participants had already paid for a travel pass they saw little reason not to continue using public transport.

On the other hand, several users were convinced by the CO_2 information to change their usual transport choices. This decision was, nevertheless, not only based on the carbon data, but also on the travel time information. As discussed, when travel time was comparable, the lower CO_2 values persuaded participants to take public transport, cycle, or walk. For those users there were inclined to cycling, less the travel time but the weather was a mediating decision factor.

Persuasive Messages: Sometimes a short message as described in Section 3.5.1 was displayed alongside the route and emission information. The messages were a subtle nudge to promote sustainable options that would be particularly attractive to use, e.g. when travel time is short overall, or comparable to less sustainable modes, or the weather is good.

Table 17 below provides the summary of the opinions of the trial participants captured by the online questionnaire after the finalisation of the trial. Analysing the numbers one can conclude that the recommendations were perceived as rather interesting and relatively simple to understand.

Table 17: User Opinions regarding the Short Recommendations

The short recommendations next to a	**The short recommendations were**

	route option were interesting.			simple to understand and provided specific suggestions.		
	Value	Count	Percent	Value	Count	Percent
totally disagree	1	2	5,41	0	0	0
rather disagree	2	6	16,22	2	4	10,81
neutral	3	10	27,03	3	12	32,43
rather agree	4	15	40,54	4	15	40,54
totally agree	5	4	10,81	5	6	16,22

As the messages were placed not too prominently in the user interface and also not shown all the time, at the first interview (after two weeks of using the apps) a considerable amount of users had not noticed the messages yet (50%). Only after directly asking them some realised that they did see them but paid no further attention. At the second interview all participants were aware of the feature.

Of those users that did consciously noticed the messages, about 15% felt the messages do not always match with their current situation. Sometimes the invitation to walk or cycle was not applicable as the user had to transport goods or had to take children along. Also, sometimes weather data was not accurate enough and the app recommended cycling because it was sunny, although in reality it was raining at that particular moment.

Another 15% of users did find the recommendations realistic and useful, but nevertheless did not find them influencing their travel decisions. For those users, the messages made a positive impact, but they found other features, in particular the CO_2 information more important.

The remaining 20% of users considered the feature meaningful and also changed their decision at least a couple of times. For example, a user got convinced the try cycling a particular route s/he was searching for in the PEACOX app, as the message told him that the destination is not too far away. It made him realise that 30 minutes of cycling was in fact “not too far”. In general users found the feature entertaining and made them smile. They appreciated the direct approach, as the user is addressed personally by the app.

Overall, the route planner, in particular the CO_2 information, turned out to be the most important of all persuasive elements of PEACOX. Displayed the raw number of grams of CO_2 instead of a graph or abstract representation had additional persuasive power. The visualisation of the impact of emissions on the other hand could be improved.

4.7.2 Tree

(cp. Research questions B4.2)

The table below provides a summary of the stated perception of the tree in the port-trial questionnaire:

Table 18: Perception of the Tree

	How often did you look at the tree and check your CO2 balance?			**How often did you adjust your travel modes in order to help your tree to grow some more leaves?**		
	Value	Count	Percent	Value	Count	Percent
never	1	2	5,41	1	13	35,14
once, so far	2	1	2,7	2	2	5,41
once a month	3	3	8,11	3	3	8,11
once every other week	4	2	5,41	4	6	16,22
once a week	5	9	24,32	5	7	18,92
several times a week	6	12	32,43	6	5	13,51
every day	7	8	21,62	7	1	2,7
Total	0	37	100	0	37	100

As the tree was placed very prominently as the default screen that is displayed when the app launches, all the participants noticed it. Most of the users also paid active attention to what the tree is showing. Only 4 participants (11%) largely ignored the tree. Most of those couldn't give a particular reason why. Only one participant felt that s/he wouldn't want to base here travel decisions on the wellbeing of the tree. When s/he has to take the car, s/he has good reasons for that.

The remaining 89% of participants felt positive about the tree. They liked the overall idea of presenting one's environmental status as a living, growing entity, even if it's just virtual. Many users highlighted the design and visualisation of the tree as a positive and engaging aspect of the app. They felt stimulated to cycle and walk more to help the tree growing, although they would go as far as to be active just to make the tree grow. The tree simply worked as an additional incentive to move around environmentally friendly. Another positive aspect was the temporal dimensions of the tree. Participants saw the link between their behaviour and the changes this caused in the behaviour of the tree.

The tree was successful in creating an emotional response to its growth or shrinking. Many participants hoped that their efforts are reflected in the tree, and if, for particular reasons, this did not happen, they felt disappointed. Some participants, for example, said it made them feel guilty, as it was shrinking at the moment, but they didn't frame this as a criticism of the app itself. Another participant explicitly stated that s/he "loves their tree" and checks its status several times a day. The tree for them is a confirmation that their behaviour is environmentally sustainable. S/he was also showing the tree to friends and talked about it. It needs to be considered though, that most other participants did not feel that strong about the tree. While they appreciated its presence, it did not influence their routines as such.

Most users did continue to monitor the progress of the tree throughout the study period. Those users that had a fairly green tree felt confirmed in their travel behaviour. They speculated which actions on their side helped the tree grow. While for some their behaviour and a growth of the tree was coincidental, others stated that they actively try to make it grow. In both cases the tree served as a justification to one self and to others that the individual behaviour is on right track. During the second interview participants often expressed this as "doing well". This also illustrated the game-like elements of the tree, as users who scored high felt rewarded by a full tree.

Overall, the tree can therefore be characterised as an unobtrusive and engaging way of keep participants interested in the app. While its persuasive impact should not be overestimated, it serves as personal and emotional reflection of one's actions and can create feelings of connection and responsibility towards its "wellbeing". This way, it can indirectly facilitate the use of other features.

4.7.3 Statistics

(cp. Research questions B4.2)

The following three tables provide a summary of the users opinions regarding the statistics as collected by the online survey after the field trials.

Table 19: Statiscs Usage

	How often did you access the statistics?		
	Value	Count	Percent
never	1	1	2,7
once, so far	2	1	2,7
once a month	3	8	21,62
once every other week	4	7	18,92
once a week	5	12	32,43
several times a week	6	3	8,11
every day	7	5	13,51
Total	0	37	100

Table 20: Statistics Preference

	Which type of statistic did you prefer?		
	Value	Count	Percent
Individual statistics	1	9	24,32
Comparative statistics	2	10	27,03
I like both kinds the same	3	18	48,65
Total	0	37	100

Table 21: Comparison to known/unknown Persons

	With which people do you prefer to be compared?		
	Value	Count	Percent
	0	1	2,7
With known people	1	19	51,35
With unknown people	2	2	5,41
With known and unknown people the same	3	15	40,54
Total	0	37	100

Participants were also asked during the interviews about their opinion of the statistics. We will first discuss the features that focus on the individual, e.g. the overall CO_2 emissions of a person and the bar charts that allow a detailed look when which mode of transport mode was used and how many emissions this caused. Second, we will address the features that allow comparisons among users, e.g. the pair-wise comparison between two users and global ranking called the “leader board”.

Individual statistics: A few users (11%) did not use the individual statistics at all. The reason for this was mostly that they simply were not interested or felt it would tell them anything they don't know already, as their travel habits are very stable. About 68% or our participants at least looked at the statistics occasionally or about once a week. One motivation to do so was to get an idea one's trip history, to see the share of different modes of transport. Additionally participants were interested in their CO_2 beyond just one simple value. The statistics provided them for example with information on how much emissions they cause per mode of transport or across different timeframes. Some users expressed interest in a similar direction, but were less interested in numbers. They simply used the data, for example their mode share, as a source for reflection on their transport behaviour. A few users also just tried the statistics out of a technical interest in what it can do.

Similarly to the group of non-users, a few of those users that tried the statistics in the beginning stopped using it, because they didn't find they would learn something they already know. A major reason why several users just used the statistics only a few times was the fact the statistical data shown was based on the manually logged trips and not on the automatically recorded GPS data. This decision was made due to the fact that the GPS recordings required manual clean-up before they could be analysed meaningfully. This aspect led, however, for many participants to the conclusion that the statistics present an incomplete picture of their trip activities, as they do not enter each and every trip into the route search interface to log it. Therefore the statistics were less relevant to them.

The remaining 46% of users stated they used the statistics frequently. The majority of those users were actively interested in their trip history. The mode share combined with emissions information proved to be particularly useful for these users, especially for car drivers as it demonstrated the dimensions of personal emissions. This in turn caused reflection on which trips are done using which mode of transport and if the choices could be rethought.

Comparative statistics: The comparative aspects of the statistics attracted considerable more attention, with only two users (5%) not interested in them. The reason these users were not interested is that they did not like the competitive aspect of the leader board. Almost half of the users (41%) did use the comparative features occasionally. The main reason to do so was – not surprisingly – to compare themselves with the other users. While for some users this comparison was simply a way to see where they stand in relation to others, for many the competitive element of leader board was encouragement to try to

improve their emission statistics and get to the top of the list. For some, the competitiveness did, however, have a demotivating aspect, as after several weeks they realised that they are not improving, as their options available to change to save emissions are limited.

The majority of users (54%) used the comparative features of the statistics frequently. The main motivation was of course again to compare with others. One aspect of importance regarding the comparison is the question whether participants knew each other personally or not. As participants were mostly recruited via a database or mailing list (cp. Sections 3.2 and 3.3), they usually did not know each other before. Two participants did, however, by incident know each other. In the interviews both of them expressed independently that they are most interested in how the other one is doing, and don't care much about the rest of the users. A few of this rest of the users also expressed the concern that the comparison is less relevant to them, as they don't know anyone personally. The majority did, however, not explicitly share this opinion. It can, nevertheless, be reasoned that competitive persuasive elements have greater relevance when users know each other personally. The comparative features still turned out to be very attractive to users. As the leader board was constantly changing, users regularly checked back to see their standing. This way this feature served as another driver to keep using the application.

Overall, the statistics had a positive persuasive effect. As they are post-hoc in nature, they do not directly contribute to the decision making process when planning a trip. They help, however, to gain a more detailed picture of one's travel behaviour and carbon emissions, both in absolute terms (individually) and in relation to others (comparatively). Thus, they have the potential to impact decision making in the long term.

4.7.4 Long Term Impact

The 2nd PEACOX field trials lasted for 8 weeks. This length was sufficient to study use and impact of PEACOX beyond the novelty effect, which generally causes increased interest and use of a system in the first days or weeks of exposure. The usage data and self-reported usage behaviour displayed a trend from high use in the beginning to a normalised use after a few weeks. However, persuasive technology is no end in itself, but should encourage behaviour change. Therefore, a decline in use of the PEACOX app is not necessarily a sign of failure. Instead, the uptake of new behavioural patterns can very well go along with abandoning the persuasive technology that triggered them, as it is not necessary anymore.

As we discussed in Section 4.6, PEACOX triggered a number of behavioural changes among its users. We also reported in which situations change could easier happen, and in which it was harder or impossible. During the final focus groups, we asked the participants if they believe they would keep their new behaviours or think they might fall back into old patterns.

Of all the workshop participants, 25% felt that their mobility behaviour is already fairly "green" and they did not make any changes. Therefore, there is also no risk in becoming less green.

About 40% believed that they will not reverse their changes. Some of them were convinced that they have already adapted the new pattern and there is thus no risk of falling back. For others the advantages they discovered (e.g. no looking for a parking spot) are to convincing to return to the old pattern. Those participants that took up cycling more felt that the training effect is positive enough to keep them engaged.

A number of participants (20%) stated that, while they are not sure about their behaviour, they will at least stay aware of the environmental impacts they have, particularly when driving. The expect them to consider more carefully if they actually need the car for a given trip. Some of those participants mentioned in this context that people in general would need the occasional wake-up call to stay engaged.

As the trials took place in summer, weather conditions were generally good for cycling and walking. About 15% of our users expressed concerns that when the cold season is coming they might stop using the bike.

As a follow-up to these considerations, workshop participants were asked to create their own little reminder that they believe would help them to keep up their new behaviours. Using coloured paper, cardboard, pens, adhesive tape, play dough, and similar craft supplies, each participant should make such a reminder for themselves. The following images show several examples of reminder tools that were created.

Figure 13: Examples of reminder tools created by participants

It remains, however, unclear how and if these reminders themselves will be continued to be used and if and how they are able to convince participants to keep their new behavioural patterns or develop new ones. In summary, the effects of the persuasive strategies deplayed in the PEACOX prototype look promising, but cannot be fully answered. Long-term behavioural change is difficult to determine, but participants' statement indicate the willingness to adapt the new patterns. A follow-up study that is currently planned will contact trial participants again about 12 months after the first trial to ask them about current their travel behaviour and the effects of the PEACOX study.

5. Conclusions

In this document we described the second evaluation study that took place in summer 2014. We reported the study setup, methodology, procedure, results and conclusions of the second trial with the PEACOX prototypes. Specifically we assessed user experience, acceptance, satisfaction with the quality of the service and impact of the implemented persuasive strategies on attitude towards mobility. Our main findings suggest that the developed persuasive approaches have the potential to influence users' attitude towards sustainable mobility, and that people start reflecting on their mobility practices. Based on these results we think that it is worthwhile to further explore persuasive approaches, and want to guide the reader specifically towards Deliverable D5.2 (in which we provide recommendations on how to use persuasive strategies and methods), and Deliverable D5.3 (in which we discuss future directions of research).

6. References

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Appendix A. Informational and Legal Documents

A.1. Informed Consent

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Fehler! Textmarke nicht definiert.

Informed Consent

Title of the Project:	PEACOX – Persuasive Advisor for CO2-reducing cross-modal Trip Planning
Website:	www.project-peacox.eu
Project Number:	288466
Project Duration:	42 Months
Project Start - End:	October 2011 – March 2015
Financed by:	EU
Programme:	FP7-ICT-2011-7
Coordinator:	Prof. Manfred Tscheligi, AIT
Leading Local Investigators:	Sebastian Prost, Elke Mattheiss, AIT
Institution:	AIT (Austrian Institute of Technology) in cooperation with CURE (Center for Usability Research and Engineering)
Contact E-Mail for Study:	peacox-support@cure.at
Hotline for Study:	01-8962534

The study described in this document is part of the research project PEACOX. The European Union (EU) finances this project under the Framework Programme 7 (FP7).

This informed consent document may include words that you do not understand. If this is the case, please ask the contact researcher or any other member of the study to fully explain the meaning of the word or piece of information you do not understand accurately. At all times, we assure the compliance with the current legislation.

I. INTRODUCTION
You have been invited to take part in a research study. Before making a decision on whether you want to participate or not, please read this document carefully. Please ask all the questions you may have so you can be completely sure to understand all the proceedings of the study, including risks and benefits.

II. PURPOSE OF THE STUDY/PROJECT
The general objective of the *PEACOX* project is to develop a mobile route planner that does not just help to find the optimal route but also gives detailed information about your CO_2 emissions and allows you to participate in challenges to promote eco-friendly travel behaviour. The mobile route planner application is completed by two additional applications: A mobile navigation client and a trip diary application to verify automatically recorded trip data.

You are expected to use and evaluate all three applications. Please note that the applications are prototypes, that means they are not market-ready and solely for resarch purposes. Your feedback on the functionality and design of the applications has therefore high value for future development.

III. PARTICIPANTS IN THE STUDY AND POSSIBLE PARTICIPATION
We kindly request your voluntary participation in this research study. You have the right to withdraw at any time or omit individual resposes without penalty.

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In order to participate in this study you must be 18 years or older, be fluent in English or German, live and work/study in the Dublin metropolitan area, and not stay outside of this region for more than one week during the course of the study. Addtionally, you must be user of an Android phone for at least 3 months, with operation system version 4.0 or higher, and a mobile data plan with at least 500MB per month included.

At the end of the study you will receive a financial compensation for your time spent and your valuable input in the amount of 150 EUR.

IV. SCHEDULE OF THE STUDY
The PEACOX field trial will run for 8 weeks from August to October 2014. In the start phase, an introductory workshop will introduce you to the PEACOX applications and the study. Before you will start using the application, you will fill in a first online questionnaire. After approximately three weeks of using the applications we will conduct a telephone interview to collect your experiences and impressions. After four weeks, a second online questionnaire will be sent out. Finally, towards the end of the study, another questionnaire will be sent out. Also, a second round of telephone interviews will be conducted. At the end of the 8 weeks, we will invite you for a final focus group (group discussion). All sessions will be audio and/or video recorded for backup and analysis reasons.
During the course of the 8 weeks of the study, you are expected to use the PEAOCX trip planner and navigation client applications whenever you find they might be useful.

V. RISKS OR INCONVENIENCES
No risk is foreseen. You are only requested to be available to participate.

VI. BENEFITS
Besides learning more about your travel behaviour, it is likely that you will not personally benefit from your participation in this study. However, the data collected in this study will lead to a deeper and better knowledge and understanding of mobility behaviour and needs of the urban population. With your participation you will make a substantial contribution to understanding how the system can be adapted to the needs collected and in turn make future technology easier to understand and user-friendlier.

VII. PRIVACY AND CONFIDENCIALITY
As long as the PEACOX trip planner application is running in the foreground or background of your smart phone, the following personal data will be automatically logged:

- Search requests for routes (start, destination, time, modes of transport)
- The route you chose from the presented alternatives
- Position and movement data (GPS [Global Positioning System] and accelerometer data from your mobile phone)
- Times you access the application and its different sections
- Challenges you receive and commit to

Addtionally, responses you give in the online questionnaires, interviews, workshop and focus group will be recorded. Your recorded data will not include any personal identification; hence it will not be possible to identify you afterwards.

For providing a platform for the PEACOX challenges, the test facilitators will create a Facebook account. You agree to use Facebook for the duration of the study and to connect your account with the test facilators' account, which means you accept the friendship request and join a

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challenge group. At the end of the study this connection is deleted and the test facilitators' account is deactivated.

Information will be processed during the phase of data analysis and will be shown in project reports. It will not be possible to identify the source of the information. The results of this investigation may be published in scientific journals or conferences and may be used in further studies. None of the provided personal data will be handled out to third parties.

The authorization for the use and access to this information is valid until the end of the study unless you decide to cancel it before. If you should decide to deny your consent, please contact the leading investigator and let her/him know of your intention of leaving the study. Contact details can be found below. From the moment you withdraw from the study, your data will not be used in any further phase of the investigation project. However, documents that have already been published or parts of the study that have been finished will not be able to be altered.

Your decision to whether or not give your authorization for the use and diffusion of the information provided by you is completely voluntary. However, if you do not provide us with your authorization now or if you cancel it in the future, you will not be able to participate in this study.

VIII. CONTACT PERSONS

For further information about your rights as a participant in the investigation, or if you have any question or complaint during the investigation, please contact the leading investigators:

Sebastian Prost & Elke Mattheiss
AIT Austrian Institute of Technology
Modecenterstraße 17 / Objekt 2
1110 Vienna
Austria
Support Hotline: 01-8962534
peacox-support@cure.at

IX. CONFIRMATION

Your participation in this study is only possible if you freely and independently sign this consent to authorize us to use the data you provide. If you do not wish to do so, please do not participate in this study.

I herby declare,

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.

- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation have such recordings destroyed (except in situations such as above).
- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the current researchers/research team.
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
- I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
- I understand that my participation is fully anonymous and that no personal details about me will be recorded. Any personal details necessary to contact me or other adminstrative tasks will be stored in a location different from survey data.
- This research involves viewing materials via a computer monitor. I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.
- I understand that using a mobile phone while driving or cylcing is dangerous and/or illegal. I hereby waive any indemnification claims that relate to incautious use of the PEACOX applications in traffic.
- In the event of damage to my mobile phone during or after this study, I hereby waive any indemnification claims.
- I have received a copy of this agreement.

.....
Name and surname of participant

.....
Place, date and signature of participant

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

.....
Name and surname of the researcher

.....
Place, date and signature of the researcher:

A.2. Picture, Video and Audio approval

X. PHOTO, VIDEO AND AUDIO RECORDINGS

As part of this research project, photographs, video and audio recordings will take place during the participation in the study.

I have received a thorough description of the purpose and procedures for these recordings and I give my consent to allow AIT to record during my participation, process and use of the recordings or parts of the recordings for analysis, related studies and project results, as well as for marketing and PR purposes of the research project *PEACOX*. I understand that all information will be kept confidential and will be reported in an anonymous way.

.....

Name and surname of participant

.....

Place, date and signature of participant

.....

Name and surname of the researcher

.....

Place, date and signature of the researcher

A.3. Information Sheet

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INFORMATION SHEET FOR THE PEACOX FIELD STUDY

Schedule of the field study:

11.+12.8.	Introductory workshops	Introduction to study and apps, Signing of informed consent.
13.8.	Mailing of 1st online questionnaire	Fill in questionnaire until the end of the week.
18.8.	Mailing of link to download PEACOX apps	Install 3 apps: PEACOX trip planner, navigation client, and trip diary.
18.8.-10.10.	Apps Use	Use apps whenever you feel they could be useful. Use trip diary daily to verify trips.
1.-5.9.	1st telephone interview	Approx. 30 mins, individual appointments arranged during introductory workshop. My appointment: _____
8.9.	Mailing of 2nd online questionnaire	Fill in questionnaire until the end of the week.
29.9.-3.10.	2nd telephone interview	Approx. 30 mins, individual appointments arranged during first interview. My appointment: _____
6.10.	Mailing of 3rd online questionnaire	Fill in questionnaire until the end of the week.
9.+10.10.	Final group discussion	Possible appointments: Appointments arranged during second interview. 9.10. 15:00-17:00 18:00-20:00 10.10. 15:00-17:00 18:00-20:00 My appointment: _____
10.10.	End of field study	

Important Notes:

- This study is conducted by AIT in cooperation with CURE.
- You were invited to participate in this field study to allow us to evaluate the PEACOX apps among people with different mobility behaviour. We are interested in your personal and honest opinion.
- Do not participate if you are not 18 years or older and competent to supply consent.
- Using the PEACOX apps can consume a lot of data. Please keep in mind that data consumption can be up to 500 MB per month and regularly check your data limits with your mobile provider. Please note that neither Trinity College Dublin nor AIT can

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compensate you for costs resulting from exceeding your mobile data plan or roaming fees. We recommend you to use a WiFi connection whenever available.

- The GPS sensor of your phone, which is accessed by the PEACOX apps, consumes a lot of energy. In order to reduce its impact on your phone's battery life, the PEACOX app will only keep it active between 6:00am and 10:00pm. Nevertheless, please keep in mind to charge your phone more often than usual. We recommend you to carry your charger with you at any time.
- The following data will be automatically logged during the study:
  - Search requests for routes (start, destination, time, modes of transport)
  - The route you chose from the presented alternatives
  - Position and movement data (GPS [Global Positioning System] and accelerometer data from your mobile phone)
  - Times you access the application and its different sections
  - Challenges you receive and commit to
- Any recordings, e.g. audio/video/photographs created during interviews, group discussions or other sessions, will not be identifiable unless prior written permission has been given. We will obtain permission for specific reuse (in scientific papers, talks, etc.).
- Your participation is voluntary and you can withdraw at any time without negative consequences.
- You can omit any questions (in questionnaires and interviews) if you do not wish to answer.
- You will have the possibility to receive a short debriefing and explanations about the study during the final focus group at the end of the study.
- During the study, you will be viewing video displays (your smartphone and a PC or similar device to fill in the online questionnaires). Please be aware that if you or anyone in your family has a history of epilepsy then you are proceeding at your own risk.
- In the extremely unlikely event that illicit activity is reported to us during the study we will be obliged to report it to appropriate authorities.

In case you have questions, concerns or technical problems, please contact the support hotline (01-8962534) or write us an e-mail (peacox-support@cure.at). You can reach the hotline from Monday to Friday from 09:00am to 4:00pm.

You can find further information about the PEACOX project here: www.project-peacox.eu.

A.4. Ethics Approval

School of Engineering
Research Ethics Application

CHECKLIST

The following documents are required with each application:

1.	• School of Engineering Ethical **Application Form**	
2.	• **Participant's Information Sheet** must include the following: a) Declarations from Part A of the application form; b) Details provided to participants about how they were selected to participate; c) Declaration of all conflicts of interest.	**Done** **Done** **N/A**
3.	• **Participant's Consent Form** must include the following: a) Declarations from Part A of the application form; **b)** Researchers contact details provided for counter-signature (your participant will keep one copy of the signed consent form and return a copy to you).	**Done** **Done**
4.	• **Research Project Proposal** must include the following: a) You must inform the Ethics Committee **who** your intended participants are i.e. are they your work colleagues, class mates etc. b) How will you recruit the participants i.e. **how** do you intend asking people to take part in your research? For example, will you stand on Pearse Street asking passers-by? c) If your participants are under the age of 18, you must seek both parental/guardian AND child consent.	**Done** **Done** **N/A**
5.	• Intended **questionnaire**/survey/interview protocol/screen shots/representative materials (as appropriate)	**Done**
6.	• **URL** to intended on-line survey (as appropriate)	†

Notes on Conflict of Interest

1. If your intended participants are work colleagues, you must declare a potential conflict of interest: you are taking advantage of your existing relationships in order to make progress in your research. It is best to acknowledge this in your invitation to participants.
2. If your research is also intended to direct commercial or other exploitation, this must be declared. For example, *"Please be advised that this research is being conducted by an employee of the company that supplies the product or service which form an object of study within the research."*

Notes for questionnaires and interviews

1. If your questionnaire is **paper based**, you must have the following **opt-out** clause on the top of each page of the questionnaire: *"Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to."*
2. If you questionnaire is **on-line**, the first page of your questionnaire must repeat the content of the information sheet. This must be followed by the consent form. If the participant does not agree to the consent, they must automatically be exited from the questionnaire.
3. Each question must be **optional**.
4. The participant must have the option to '**not submit, exit without submitting**' at the final submission point on your questionnaire.
5. If you have open-ended questions on your questionnaire you must warn the participant against naming **third parties**: *"Please do not name third parties in any open text field of the questionnaire. Any such replies will be anonymised."*

† Not yet available – paper versions included

6. You must inform your participants regarding **illicit activity**: *"In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities."*

UNIVERSITY OF DUBLIN, TRINITY COLLEGE

Faculty of Engineering, Mathematics and Science

School of Engineering

RESEARCH ETHICS PROTOCOL

When is Ethical Approval Needed?
Ethical approval is required before any studies involving human participants can commence. This requirement applies to studies to be undertaken by staff, postgraduate and undergraduate students. In the case of collaborative projects involving researchers from outside the School, ethical approval obtained from an external research ethics body may suffice – evidence of same must be submitted to the School of Engineering Research Ethics Committee prior to the commencement of the study (see procedures below). In the absence of such external approval, approval must be obtained as per this document. Additional ethical approval may be required if the project involves or is funded by an external body, for example, studies under FP7 automatically require such approval.

For the purpose of this document a "study" may be understood to involve a potentially staged series of different experiments to be conducted over a period of time. If substantive changes are made to a study following receipt of ethical approval, this will constitute a new study for which further ethical approval must be obtained.

Procedure
Completed application forms together with supporting documentation should be submitted electronically to the School of Engineering wahbk7@tcd.ie. To submit, if the proposal is from an undergraduate or postgraduate students, the **completed** application package must be presented to the academic supervisor who will sign after verifying completeness. These signed originals may be scanned and emailed. Please use TCD e-mail addresses only. When your application has been reviewed and approved by the Ethics committee hardcopies of the application form with original signatures should be submitted to the School of Engineering, Trinity College, Dublin 2.

The Committee will consider each application and normally provide a response within two weeks but not more than one month later. Applications that are considered not to have significant ethical implications may be evaluated by the Committee Chair without reference to the full Committee. Applications will otherwise be considered at a meeting of the School of Engineering Research Ethics Committee. When approval has been obtained from an external research ethics committee, and School approval is not required, a copy of the external ethical approval must be submitted to the School's Research Unit, prior to commencement of study, for noting by the School of Engineering Research Ethics Committee.

Please note that in signing the approval form one is making a commitment to review the provisions of the Data Protection Act, like legislation and College Policy on Good Research Practice. Please ensure that your study conforms to the standards of anonymity preservation and data retention set in those documents. Those provisions suggest a default proscription against making digital or photographic recordings of participants. A study which requires such records must include in the research ethics approval application a justification and documentation of the methods by which the statutory provisions and research practise guidelines will be met.

Note: These procedures may be amended from time-to-time following recommendation by the School of Engineering Research Ethics Committee and with the approval of the School of Engineering Research Committee.

Before seeking ethical approval researchers should:
- identify actual and potential ethical issues that might arise;
- reflect on how these will be addressed; and
- formulate procedures to deal with all such issues.

During the research project researchers should:
- implement the ethical procedures;
- obtain continuous feedback from participants about ethical issues;
- periodically review the ethical strategy in the light of feedback received; and
- if required, update their ethical procedures;
- retain copies of consent forms signed by the participants.

Composition of the School of Engineering Research Ethics Committee
The Committee will consist of a Chairperson/Convenor appointed by the Director of Research and two other experts – a member of the School's academic staff and external advisors. The internal and external members will be selected from a

panel approved by the Director of Research from time to time. Members will be selected on a case by case basis by the Chairperson subject to their availability. Researchers will be precluded from the Committee considering ethical approval for their study.

School of Engineering
Research Ethical Application Form

Part A

Project Title: PEACOX Field Trial II .....

Name of Lead Researcher (student in case of project work): Dr Brian Caulfield

Name of Supervisor: N/A .....

TCD E-mail: brian.caulfield@tcd.ie Contact Tel No.: 01-8962534

Course Name and Code (if applicable): N/A

Estimated start date of survey/research: 15 May 2014 .....

I confirm that I will (where relevant):

- Familiarize myself with the Data Protection Act and the College Good Research Practice guidelines http://www.tcd.ie/info_compliance/dp/legislation.php;
- Tell participants that any recordings, e.g. audio/video/photographs, will not be identifiable unless prior written permission has been given. I will obtain permission for specific reuse (in papers, talks, etc.)
- Provide participants with an information sheet (or web-page for web-based experiments) that describes the main procedures (a copy of the information sheet must be included with this application)
- Obtain informed consent for participation (a copy of the informed consent form must be included with this application)
- Should the research be observational, ask participants for their consent to be observed
- Tell participants that their participation is voluntary
- Tell participants that they may withdraw at any time and for any reason without penalty
- Give participants the option of omitting questions they do not wish to answer if a questionnaire is used
- Tell participants that their data will be treated with full confidentiality and that, if published, it will not be identified as theirs
- On request, debrief participants at the end of their participation (i.e. give them a brief explanation of the study)
- Verify that participants are 18 years or older and competent to supply consent.
- If the study involves participants viewing video displays then I will verify that they understand that if they or anyone in their family has a history of epilepsy then the participant is proceeding at their own risk
- Declare any potential conflict of interest to participants.
- Inform participants that in the extremely unlikely event that illicit activity is reported to me during the study I will be obliged to report it to appropriate authorities.
- Act in accordance with the information provided (i.e. if I tell participants I will not do something, then I will not do it).

Signed: ..... Date: 28/4/14
Lead Researcher/student in case of project work

Part B

Please answer the following questions.		*Yes/No*
Has this research application or any application of a similar nature connected to this research project been refused ethical approval by another review committee of the College (or at the institutions of any collaborators)?		*No*
Will your project involve photographing participants or electronic audio or video recordings?		*Yes*
Will your project deliberately involve misleading participants in any way?		*No*
Is there a risk of participants experiencing either physical or psychological distress or discomfort? If yes, give details on a separate sheet and state what you will tell them to do if they should experience any such problems (e.g. who they can contact for help).		*No*
Does your study involve any of the following?	Children (under 18 years of age)	*No*

	People with intellectual or communication difficulties	*No*
	Patients	*No*

School of Engineering
Research Ethical Application Form

Details of the Research Project Proposal must be submitted as a separate document to include the following information:

1. Title of project
2. Purpose of project including academic rationale
3. Brief description of methods and measurements to be used
4. Participants - recruitment methods, number, age, gender, exclusion/inclusion criteria, including statistical justification for numbers of participants
5. Debriefing arrangements
6. A clear concise statement of the ethical considerations raised by the project and how you intend to deal with them
7. Cite any relevant legislation relevant to the project with the method of compliance e.g. Data Protection Act etc.

Part C

I confirm that the materials I have submitted provided a complete and accurate account of the research I propose to conduct in this context, including my assessment of the ethical ramifications.

Signed: ..... Date: 28/4/14
Lead Researcher/student in case of project work

There is an obligation on the lead researcher to bring to the attention of the School of Engineering Research Ethics Committee any issues with ethical implications not clearly covered above.

Part D

If external ethical approval has been received, please complete below.

External ethical approval has been received and no further ethical approval is required from the School's Research Ethical Committee. I have attached a copy of the external ethical approval for the School's Research Unit.

Signed: ..... Date: .....
Lead Researcher/student in case of project work

Part E

If the research is proposed by an undergraduate or postgraduate student, please have the below section completed.

I confirm, as an academic supervisor of this proposed research that the documents at hand are complete (i.e. each item on the submission checklist is accounted for) and are in a form that is adequate for review by the School of Engineering Research Ethics Committee

Signed: ..... Date: .....
Supervisor

Completed application forms together with supporting documentation should be submitted electronically to wahbk7@tcd.ie. Please use TCD e-mail addresses only. When your application has been reviewed and approved

Appendix B. Workshops

B.1. Introductory Workshop Guidelines

Introduction (0' – 15')

- Introduction of workshop instructors
- General introduction and explanation of sequence of actions
    - Duration: 2h
    - Will consist of information presentations, Q+A, open discussion
- Introduction of topic
    - *Intro PEACOX: What is PEACOX?*
        - Environmentally friendly travel behaviour
        - Route planner + navigation apps
        - Environmentally friendly routes + CO2 feedback
        - Logging of trips – statistics
        - Challenges – motivation to try out environmentally friendly modes
    - *Aim of trial (test prototypes, their design and feature. Evaluate how well they support environmentally friendly transport mobility behaviour)*
    - *Schedule of this workshop*
        - *Presentation of Apps*
        - *Information on schedule of trial*
        - Discussion
- Introduction of participants: Participants are asked to introduce themselves and write their name on a nameplate.
    - First Name (Nameplate)
    - Which modes of transport are available to you? Which mode of transport do you use mostly? How often do you use it? Why do you use it? How satisfied are you with this situation?

Presentation of PEACOX Apps (15' – 30')

- Presentation PEACOX route planner
    - Login
    - Route planning + CO_2 feedback + messages

  - CO_2 feedback: tree + statistics
  - Challenges
    - E.g. reduce your CO2 emissions next week, cycle at least 3 times next week
    - Notification in app, link to facebook, there "join" to commit to challenge
    - Voluntary participation
    - Necessary: accept friend request from PEACOX study account, will be added to a study group
    - We will post updates and results in the groups – not visible to other facebook users
- Presentation PEACOX Dynavix navigation app
- Presentation of Trip diary app
- Additionally: GPS logger

General Information about the Field Trial (30' – 55')

- Technical Requirements on the smart phone:
  - High battery use: keep charger with you.
  - High data use: 200-500 MB per month, check data consumption levels
  - Logging only active from 6a.m. to 10p.m.
- Schedule
  - At the end: 150 euro voucher
- Q&A
- Hand out informed consent (2 copies per participant, pre-signed by principal investigator), answer questions, collect signed copies.
- Test installation:
  - Options: Send out e-mail with link, QR Code projected on wall, or Enter URL manually
  - Check if apps are running on all devices – if not note down bugs
  - Let participants explore apps.

--- Short break (5 min) ---

Test Scenarios (55' – 90')

- 20 sample routes
- Search, choose route
- Answer short question on paper

-

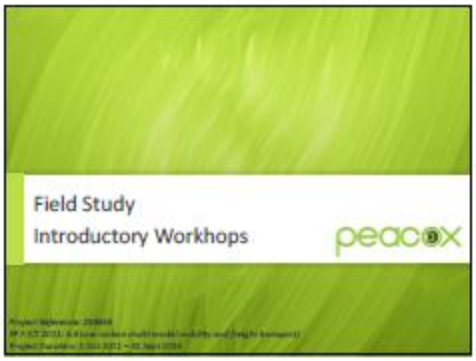
Discussion (90‘ – 110‘)

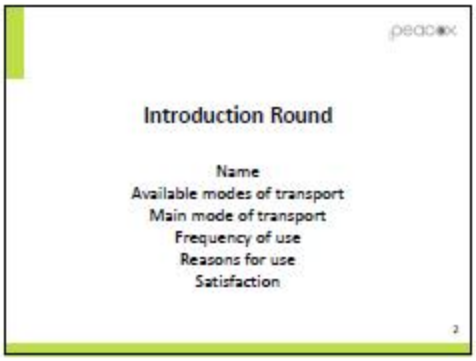
- When can you imagine using the applications? (at what times, in which situations, at which places)
- What are your personal requirements regarding a mobile route planner?
- What advantages could the PEACOX apps have compared to other existing apps, e.g. Journey Planner (Transport for Ireland), Dublin bus apps?
- What are your expectations for the trial?
- Do you have any goals for the trial? Any goals to travel more environmentally friendly?

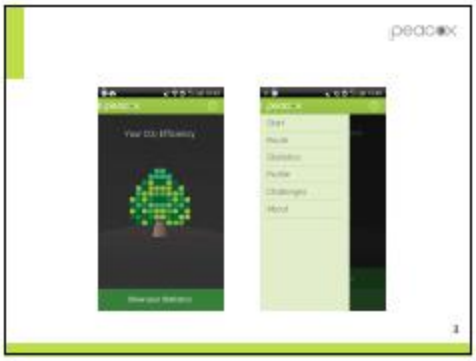
End and Appointments (110‘ – 120‘)

- Make appointment with each participant for interview
- Thank participants, summary & next steps

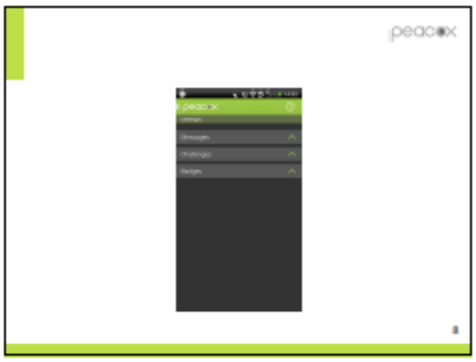
B.2. Introductory Workshop Slides

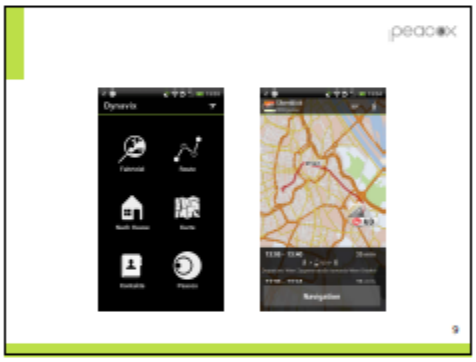


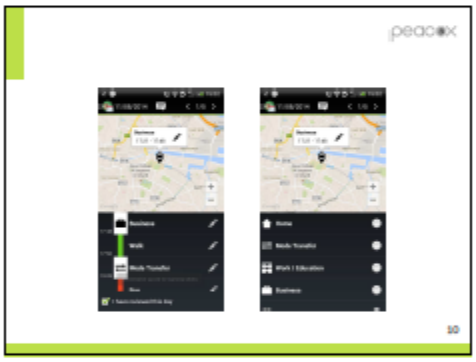




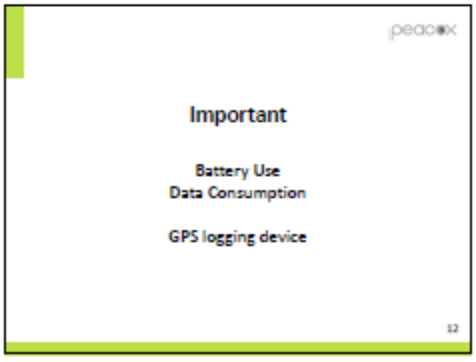

Challenges
Wannabe
Ray of Hope
Do-gooder
Green Activist
Eco Guru
7

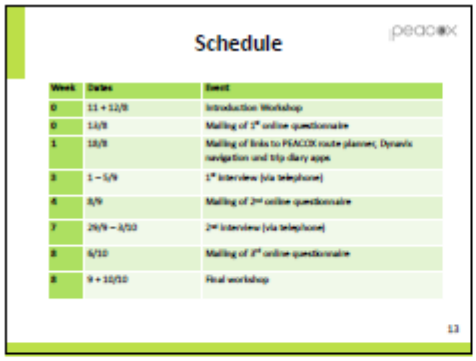

8

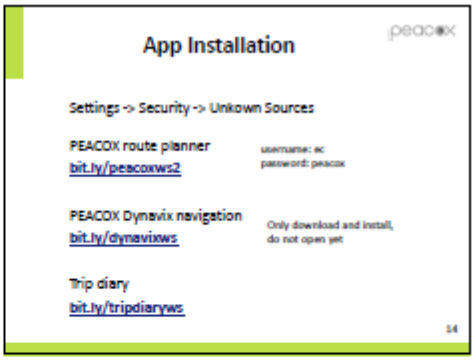

9


10

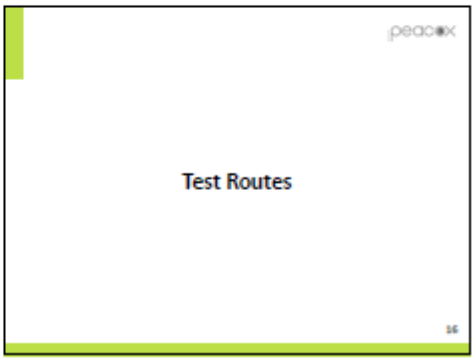

MobiTest
11


Important
Battery Use
Data Consumption
GPS logging device
12


Schedule
peacox
Week
Dates
Event
0
11 + 12/8
Introduction Workshop
0
13/8
Mailing of 1st online questionnaire
1
18/8
Mailing of links to PEACOX route planner, Dynavix navigation and trip diary apps
3
1 – 5/9
1st interview (via telephone)
4
8/9
Mailing of 2nd online questionnaire
7
29/9 – 3/10
2nd interview (via telephone)
8
6/10
Mailing of 3rd online questionnaire
8
9 + 10/10
Final workshop
13


App Installation
peacox
Settings -> Security -> Unkown Sources
PEACOX route planner
bit.ly/peacoxws2
username: ec
password: peacox
PEACOX Dynavix navigation
bit.ly/dynavixws
Only download and install, do not open yet
Trip diary
bit.ly/tripdiaryws
14


Test-Installation
peacox
bit.ly/peacoxtest
15


peacox
Test Routes
16

B.3. Final Workshop Guidelines

General Information

- Date & Time: 9/10/2014 18:00-20:00; 10/10/2014 18:00-20:00
- Location: Trinity College Dublin
- Participants: 9/10: 10x , 10/10: 8x
- Reimbursement: € 150 in vouchers
- [Ask about questionnaire]

Introduction (0' – 15')

- Welcome, Schedule
    - Duration: 2h
    - Part 1: Open Discussion, idea collection
    - Teil 2: creative, tinkering
- Introduction of Participants: Name plate.

Part 1: Changes in mobility behaviour (15' – 60')

Introduction (5 min)

I would like to talk about the use of eco-friendly modes of transport. Some of you reported that they made some changes in their choice of modes of transport during the last 8 weeks, some said that they are more conscious or more aware of the impact of their choices. Others said that they could not make changes because there are obstacles that prevent them from doing so. I would like to collect now specific situations where you did change or did not change to a more eco-friendly mode of transport and the circumstances that surround each situation.

I will note down the situations on the board/flip chart. [Each situation mentioned by the participants will be noted down on the board/flip chart, input to a situation is added as it comes up during the discussion.]

1) **Collection of situations where a more eco-friendly mode of transport (MoT) was taken (walking, cycling, public transport) (10 min)**
    a. Situation/context (e.g., shopping, transport of things, children, commute, business trip, leisure, trip to country side, holiday, good/bad weather
    b. Switch from which to which MoT?
    c. Reason/cause for switch? Role of Peacox, which feature?

   d. How often do you do this? How often do you still use old MoT?

2) **Collection of situations/areas in life besides mobility where changes happened. (5 min)**
   a. E.g., energy use at home, appliances, food consumption, clothing/shopping, holidays, living
3) **Collection of situations where you did not change a more eco-friendly MoT (10 min)**
   a. Situation/context
   b. What MoT?
   c. Reason/obstacle?
   d. How often does it happen?
4) **Additions to obstacles (10 min)**
   a. How do pedestrians/cyclists/PT users deal with such situations? What strategies do you have to manage without a car?
   b. Is there someone that used to have a car and abandoned it before the PEACOX study? How did you deal with difficulties?
   c. To drivers: What would have to change in your life so that you can abandon your car? How would you have to arrange your daily life or your job differently to live without loss of comfort? Can non-drivers give tips?
   d. What tips do all participants have to overcome the obstacles? (What can the participants do themselves, besides infrastructural changes, such as expanding public transport network, better cycling paths?)
5) **Estimation, if changes in use of MoT will be maintained after the end of the study (5 min)**
   a. If yes: why? What happened that reminder from PEACOX is not necessary anymore?
   b. If no: why not? What circumstances prevent you from keeping the changes without PEACOX?

--- After 60 minutes: short break (5 min) ---

Part 2: Support for new mobility behaviour (65' – 105')

Introduction (5 min)

As the PEACOX study is now over, and you won't be able to use the apps for much longer, we would like you to be a bit creative and think of an alternative that could do the job:

- For those of you that changed some choices, or that increased awareness of their choices: What kind of tool/support for yourself can you think of that helps you to maintain your changes in the long term?
- For those of you, that did not make changes to more eco-friendly MoT: Think about the obstacles that we have discussed before the break, and the tips or possibilities to overcome them. What tool you wish to have that allows you to change or mobility habits?
- For those of you, that believe they are already very eco-friendly in terms of mobility, think about what kind of tool you wish you had that makes continuing this practice more comfortable or allows you to transfer this lifestyle into other areas of your life.

The tool you should think of can be anything that you can make yourself. It should not be an app (unless you are a programmer), and it should not be something that things like "better public transport" (unless you work for the public transport authority). It should be something that helps personally and can be built with the materials I have put on this table. Or, if this is not possible, it should at least be a model of what you want to have. Please get up and have a look what is available.

Single work (10 min)

First, everyone works alone for about 15 minutes.

Short intermediate feedback round (5 min)

Each participant briefly tells the group their idea to see what they are working on and to get inspirations from others.

Finishing of work (10 min)

Final presentation and discussion (10 min)

Participants present their results and explain why they believe that the tool is helpful for them. Afterwards participants keep their work to take it home.

De-briefing (105' – 120')

- Present results of challenges
- Q+A about study? Do participant have questions about background and motivation of study?

- Return of GPS devices + signed confirmation
- Confirm online questionnaires
- Hand out remuneration vouchers (150 euros) + let participants sign confirmation receipt
- Thank for participation. Ask if anyone needs help uninstalling apps

Appendix C. Interview Guidelines

C.1. First Interview

Technical questions

1. Are all apps installed and working?

2. What is your username on PEACOX?

Questions about the typical use of PEACOX

3. Can you describe a **typical situation** during the last weeks where you travelled from one place to another using the PEACOX app? Please describe from where to where, which mode of transport did you use and why.

4. What other conditions were in place (time of day, weather, were you travelling alone or not)?

Questions about the CO2 information and recommendations

5. **Did the CO2** information have any influence on your route choice?

6. Are environmental impacts more conscious?

7. Have you noticed **short recommendations** (e.g. "The destination is in walking distance") next to the route options?

8. What do you think about them?

9. Are recommendations you are getting realistic/relevant? How often are they unrealistic? When are they unrealistic?

10. Have they influenced your decisions? Have you ever changed your route choice based on the proposed options? How often, why / why not?

Questions about the tree

11. Do you pay attention to the tree?

12. How did it change since the start of the trial?

13. Have you done anything to help the tree to grow more leaves?

Questions about the statistics

14. What do you think about the statistics feature?

15. Do you use it? If yes, in which situations and why? If not, why not?

16. What features of the statistics have you used so far?

Questions about the trip diary app

17. How do you get along with the **trip diary**?

18. What is your impression about the quality of the data (missing routes, additional routes, wrong activities detected)?

Questions about the trip diary app

19. How is your impression of the **Dynavix app**?

20. How often do you use it?

21. Do you use it separately from the PEACOX app or do you start it with the “start navigation” button?

Questions about the challenges

22. Have you participated in any challenges so far?

23. If not, why not?

24. What is your impression so far?

Questions about the logging

25. Is **sensor logging** (the PEACOX icon in the status bar on the top) usually activated at your phone? Do you have GPS and WiFi on?

26. Have you already had to deactivate it? How often? Has the battery gone completely flat so far?

Final question

27. Is there anything else you would like to add, because it could be interesting for us?

Next steps

- Please fill in the 2nd online survey if not yet done
- Please contact us to make an appointment for the 2nd interview in the week from 29/9 to 3/10

C.2. Second Interview

Instructions

- Today I will go through the PEACOX functionalities with you and ask you about your opinion about them
- I will ask you a lot of times „Why“. Please answer these questions as best as you can, even if they seem a bit odd or strange to you
- Also, please tell me your honest opinion – you can be critical and say negative things

Interview questions

- Functionalities:
    - Trip planner, search results, choose a route
    - Navigation (Dynavix) app
    - Tree
    - In the statistics you can see your individual past mobility behaviour, e.g. average CO2 emission per day, week or month, these bars. On the other side you can compare yourself to the other PEACOX users, e.g. the leaderboard or comparing yourself with one other user
    - First I would like to talk about the individual functionality

- And now to the comparative statistics
- Challenges

- For each functionality
  - Have you/How did you/How far have you used this functionality?
  - [Useless answer: can you describe a concrete situation, where you used the functionality?]
  - Why did/didn't you use the functionality?
    - Why?
      - Why?
        - …

- Final questions:
  - Would you say that your attitude regarding mobility has changed because of the study or did it stay the same?
    - If yes: Could you highlight a specific functionality, which did especially support you in that? Why {have you changed your attitude}
    - If no: Why not?
  - Would you say that your mobility behaviour changed because of the study or did it stay the same?
    - If yes: Could you highlight a specific functionality, which did especially support you in that? Why {have you changed your attitude}
    - If no: Why not?

- Debriefing
  - Confirm date of final workshop

Appendix D. Online Surveys

D.1. Demographic data

How old are you?	_____ years
You are...	○ female ○ male
What is your highest completed level of education?	○ Secondary education – Junior cycle ○ Apprenticeship / professional training ○ Secondary education – Senior cycle (leaving certificate) ○ Third-level education
What is your current main occupation?	○ Student → filter 1 ○ Employed (full time) → filter 1 ○ Employed (part time) → filter 1 ○ Housekeeping → filter 2 ○ Parental leave → filter 2 ○ Unemployed → filter 2 ○ Retired → filter 2 ○ Permanently unfit for work → filter 2 ○ Other (please specify): _____ → filter 2
How many inhabitants does your place of living have?	○ Up to 1,000 ○ 1,001 – 10,000 ○ 10,001 – 50,000 ○ 50,001 – 100,000 ○ 100,001 – 500,000 ○ More than 500,000
You are...	○ single ○ married/in a relation ○ divorced/living apart ○ widowed ○ Prefer not to say
How many persons leave in your household, including yourself?	_____ persons
Do you have children?	○ Yes → filter 1 ○ No
How many children live in your household?	____ child(ren)
How old are the children, who are living with you in your household?	____ years [….]
How far is your home from your workplace?	○ _____km ○ I don't know

D.2. Technology Experience

Which statements describe your use of an in-car GPS navigation device?	□ I have never had one. □ I own one, but I never use it. □ I used to use one, but not anymore. □ I use it just for exceptional trips (e.g. holidays). □ I use it whenever I go to an address I don't know. □ I use it for most trips, including commuting. □ I use it for virtually every trip.
Do you use navigation or route planning apps on your smartphone?	○ Yes → filter 1 ○ No
Which of the following applications do you actively use on your smart phone?	□ Google Maps □ Apple Maps □ TomTom □ Garmin □ Journey Plan (Transport for Ireland) [Ireland only] □ Hit the Road [Ireland only] □ Dublin Bus [Ireland only] □ Irish Rail [Ireland only] □ Other (please specify): _____
For which reasons do you use the apps mentioned above?	_____

D.3. Interest in ICT (Weiss et al., 2012)

Technology has always fascinated me.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
It is interesting how single parts of technical devices cooperate in order to fulfill its purpose.	same as above
I never talk to speech dialog system (e.g., telephone banking, self service, route guidance system).	same as above
Unusual devices are interesting and exciting.	same as above
I always listen to music, audio books or radio shows on a mobile device.	same as above

D.4. ICT Competence

I did not receive sufficient instruction with computers.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
So far, I did not have the possibilities to learn using technical devices.	same as above
In situations I have to learn a new technical device, I could not easily understand the manual.	same as above
I never communicate in the Internet via chat, forum, blog or instant messenger.	same as above
I always use a mobile phone for calling somebody.	same as above
I do not understand people from technical customer service.	same as above
I never use so called organizers on mobile devices (calender, address book).	same as above

D.5. Mobility Behaviour Questions

Which modes of transport do you have regularly available?	□ Own car → filter 1 □ Car, borrowed from friends or family → filter 1 □ Car, using commerical or private car-sharing → filter 1 □ Motorcycle → filter 1 □ Moped → filter 1 □ Own bicycle, in working condition □ Own bicycle, not in working condition □ Bicycle, borrowed from friends or family □ Bicycle, using bike a bikesharing system (dublinbikes) □ Public transport □ Leap card for public transport □ Walking □ Other (please specify): _____
Which mode of transport do you use most of the time for your daily commuting trips?	○ Car / Motorcyle / Moped ○ Bicycle ○ Public Transport ○ Walking ○ Other (please specify): _____

Which mode of transport do you use most of the time for your daily private trips?	○ Car / Motorcyle / Moped ○ Bicycle ○ Public Transport ○ Walking ○ Other (please specify): _____
Which mode of transport do you use most of the time for your daily trips?	○ Car / Motorcyle / Moped ○ Bicycle ○ Public Transport ○ Walking ○ Other (please specify): _____
How large is the share of each mode of transport in your daily trips in total: (in percent of number of trips)? Please state a percentage for each of the listed mode of transport. The percentages for all modes of transport should sum up to 100 percent.	Warm season/summer: ___ % car / motorcycle / moped ___ % cycling ___ % public transport ___ % walking ___ % other (please specify): _____ Cold season/winter: ___ % car / motorcycle / moped ___ % cycling ___ % public transport ___ % walking ___ % other (please specify): _____
How satisfied are you with this distribution of your use of modes of transport?	During the warm season/ in summer: ○ 1 = very unsatisfied ○ 2 = rather unsatisfied ○ 3 = neutral ○ 4 = rather satisfied ○ 5 = very satisfied During the cold season/ in winter: ○ 1 = very unsatisfied ○ 2 = rather unsatisfied ○ 3 = neutral ○ 4 = rather satisfied ○ 5 = very satisfied
Is there something you would like to change about your use of modes of transport?	○ yes → filter 1 ○ no
What would you like to change about your use of modes of transport?	_____
Did you ever **consider** to drive less often by car / motorcycle / moped?	○ yes → filter 1 ○ no
Why did you consider to drive less often by car / motorcycle / moped?	_____

Would you be **able** to drive less often by car / motorcycle / moped?	○ yes → filter 1 ○ no → filter 2
Please specify, for which trips or in which situations you could drive less often.	_____
Please give reasons, why you cannot drive less often.	_____
Would you be **willing** to drive less often by car / motorcycle / moped?	○ yes → filter 1 ○ no → filter 2
Please specify, for which trips or in which situations you would be willing to drive less often.	_____
Please give reasons, why you are not willing to drive less often.	_____

D.6. Attitudes towards the Environment > Locus of control (Fielding & Head, 2011)

My individual actions can make a difference to the environment.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
I can make decisions now, that will help protect the environment in the future.	same as above
I am only one person, I can´t make a difference to the environment.	same as above

D.7. Attitudes to the environment > Environmental awareness, environmentally friendly traffic (Schahn et al., 2000)

When buying a motor vehicle you should primarily pay attention to a low fuel consumption and low exhaust emissions, as well as environment-friendly production and disposal.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree

I'm disappointed in how little money is spent on the development of public transport and cycle paths in comparison to the road construction.	same as above
I am in favor of limiting car traffic in inner cities and recreational areas, when good public transport lines and bike path networks are created.	same as above
I welcome a car-free Sunday.	same as above
When I have the chance, I take public transportation instead of driving.	same as above
When driving, I drive in such a way that I consume as little fuel as possible.	same as above
For shorter distances (up to 2 km) I leave the motor vehicle at home and ride the bike or walk.	same as above
Even if the public transport system would be better and cheaper than driving a motor vehicle, I would prefer the motor vehicle.	same as above
When I know that I have to wait a long time at a red light, crossing barrier, or construction site, I turn off the engine.	same as above
When I'm driving a motorised vehicle, in the future I will (continue to) turn off the engine during long stops at traffic lights and in traffic jams.	same as above
In the future, I will (continue to) leave the motor vehicle at home, if I can use buses, trains or the bicycle.	same as above
Please think of the travel mode you most frequently use for going to work or education, shopping, visits, etc. Which of the transport mode listed below do you use predominantly?	○ A truck or a van ○ A car ○ A motorcycle or a scooter ○ I participate in a carpool ○ Public transport (i.e. Bus, trains) ○ A bicycle ○ I walk

D.8. Attitudes towards transport modes (questionnaire of Steg adapted)

Driving… ... makes my life more easy.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
... is enjoyable.	same as above
... is comfortable.	same as above
... is sporty and adventurous.	same as above
… saves me a lot of time.	same as above
The car / motorcycle / moped… ... suits me.	same as above
... is always available.	same as above
... brings me wherever I want.	same as above
... gives me prestige.	same as above
I am safe in the car / motorcycle / moped.	same as above
Using Public Transport… ... makes my life more easy.	same as above
... is enjoyable.	same as above
... is comfortable.	same as above
... is sporty and adventurous.	same as above
… saves me a lot of time.	same as above
Public Transport… ... suits me.	same as above
... is always available.	same as above
... brings me wherever I want.	same as above
... gives me prestige.	same as above
I am safe in public transport.	same as above
Cycling… ... makes my life more easy.	same as above
... is enjoyable.	same as above
... is comfortable.	same as above
... is sporty and adventurous.	same as above
… saves me a lot of time.	same as above
The bicycle… ... suits me.	same as above
... is always available.	same as above
... brings me wherever I want.	same as above
... gives me prestige.	same as above
I am safe on the bicycle.	same as above
Walking… ... makes my life more easy.	same as above
... is enjoyable.	same as above
... is comfortable.	same as above
... is sporty and adventurous.	same as above

… saves me a lot of time.	same as above
... suits me.	same as above
... is always available.	same as above
... brings me wherever I want.	same as above
... gives me prestige.	same as above
I am safe walking.	same as above

D.9. Persuadability (adapted from Busch et al., 2013)

Rewards	Rewards motivate me.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
	I put more ambition into something, if I know I am going to be rewarded for it.	same as above
	I do more work, when I know that I will get something for it (something materialistic).	same as above
Self Comparision	I like to compare myself to other people.	same as above
	It is important to me to know what other people are doing.	same as above
	It is important to me, what other people think of me.	same as above
Suggestions	I usually follow the advices that I get from interactive systems.	same as above
	I appreciate suggestions from interactive systems for more desirable behaviour (e.g. to eat more healthy).	same as above
	I like to get recommendations from interactive systems for a variety of activities.	same as above
Self Monitoring	I appreciate interactive systems that provide means for tracking certain aspects in my life (e.g. daily step counts for sports activities).	same as above
	I like to get information about my activities and status in certain areas (e.g. health).	same as above
	I find it valuable to see (quantified) information about my behaviour (e.g. shopping behaviour).	same as above
Cooperation	I believe the best results in a project can be achieved if all involved people work together.	same as above
	I appreciate to cooperate with other people.	same as above

	I prefer working together instead of working alone.	same as above
Competition	It is important to me to be better in something than other people.	same as above
	I like competitive sports.	same as above
	I push myself hard, when I am in competition with others.	same as above
Simulation	I often imagine how the earth will look like in the future.	same as above
	I change my behavior more, when the results of that change are well illustrated.	same as above
	I like it when things are well illustrated, so I can get a better picture of things.	same as above
Reciprocity	When a family member does me a favor, I am very inclined to return this favor.	same as above
	I always pay back a favor.	same as above
Authority	I always follow advice from my general practitioner.	same as above
	When a professor tells me something, I tend to believe it is true.	same as above
Liking	I accept advice from my social network.	same as above
	When I like someone, I am more inclined to believe him or her.	same as above
Commitment/Consistency	When I say I will do something, I am committed in doing it.	same as above
	I like to be consistent with my previous behaviour.	same as above

D.10. PERCEIVE-ECO Questionnaire

Primary Task Support	The system encourages me to be more aware of environmentally friendly mobility.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
	The system encourages me to change my attitudes regarding environmentally friendly mobility in a positive way.	same as above
	The system encourages me to change my behaviour regarding environmentally friendly mobility in a positive way.	same as above
Dialogue Support	The system provides me with appropriate feedback.	same as above
	The system provides me with appropriate advice.	same as above

Credibility	The system provides me with personally relevant feedback.	same as above
	The system is trustworthy.	same as above
	The system is reliable.	same as above
Persuasiveness	The system inspires confidence.	same as above
	The system has an influence on me.	same as above
	The system is personally relevant for me.	same as above
Unobtrusiveness	The system makes me reconsider my mobility habits.	same as above
	Using the system fits into my daily life.	same as above
	Using the system disrupts my daily life.	same as above
Intention to Adopt	Using the system is convenient for me.	same as above
	I would consider using the system regularly.	same as above
	I would be willing to engage with the system (from now on).	same as above
	I can imagine to use the system during the next few weeks.	same as above
Perceived Enjoyment	The system is enjoyable.	same as above
	The actual process of using the system is pleasant.	same as above
	The system is fun.	same as above
Perceived Usefulness	The system is useful.	same as above
Perceived Ease of Use	The system is easy to use.	same as above

D.11. Social network use

Do you use social networking sites like Facebook or LinkedIn?	○ yes → filter 1 ○ no → filter 2
Which social networking sites do you use?	_____
How often do you use Facebook? (Choose the most appropriate answer)	○ never ○ once a month ○ once a week ○ every day ○ several times a day
Why don't you use social networking sites?	_____

D.12. Questions related to specific PEACOX system aspects

What do you like about the PEACOX trip planner app?	_____
What do you dislike about the PEACOX trip planner app?	_____
What would you change about the PEACOX trip planner app?	_____
What do you like about the PEACOX navigation app (Dynavix)?	_____
What do you dislike about the PEACOX navigation app (Dynavix)?	_____
What would you change about the PEACOX navigation app (Dynavix)?	_____

D.13. App Usage Questionnaire

The route search is handy for searching routes.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
Please give reason for your answer.	_____
The route suggestions are personally relevant for me.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
Please give reasons for your answer.	_____
The order of the suggested routes is satisfactory.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
Please give reasons for your answer.	_____
The suggested routes adapt according to my habits.	○ totally disagree ○ rather disagree ○ neutral ○ rather agree ○ totally agree
Please give reasons for your answer.	_____

The CO2 emission data presented along the route information is very useful.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The CO2 emission data had an impact on my trip decisions.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The short recommendations next to a route option were interesting.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The short recommendations were simple to understand and provided specific suggestions.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The repetition of the short recommendations was superfluous.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The short reccommendations had an impact on my trip decisions.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

The short recommendations persuade me to follow a specific route.

○ yes → filter 1
○ no → filter 2

Can you recall which type of transportation means you followed? _____

Why did the short recommendations not persuade you? _____

I would like to see these sort of short recommendations in mobile applications like PEACOX.

○ totally disagree
○ rather disagree
○ neutral
○ rather agree
○ totally agree

Please give reasons for your answer. _____

How often did you look at the tree and check your CO2 balance?

- ○ never
- ○ once, so far
- ○ once a week
- ○ several times a week
- ○ every day

How often did you look at the tree and check your CO2 balance?

- ○ never
- ○ once, so far
- ○ once a month
- ○ once every other week
- ○ once a week
- ○ several times a week
- ○ every day

Please give reasons for your answer. _____

How often did you adjust your travel modes in order to help your tree to grow some more leaves?

- ○ never
- ○ once, so far
- ○ once a week
- ○ several times a week
- ○ every day

How often did you adjust your travel modes in order to help your tree to grow some more leaves?

- ○ never
- ○ once, so far
- ○ once a month
- ○ once every other week
- ○ once a week
- ○ several times a week
- ○ every day

Please give reasons for your answer. _____

How often did you access the statistics?

- ○ never
- ○ once, so far
- ○ once a week
- ○ several times a week
- ○ every day

How often did you access the statistics?

- ○ never
- ○ once, so far
- ○ once a month
- ○ once every other week
- ○ once a week
- ○ several times a week
- ○ every day

Please give reasons for your answer. _____

In how many challenges did you participate?

- ○ 0
- ○ 1
- ○ 2

In how many challenges did you participate?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6

Please give reasons for your answer.	_____
On the right side you find a list of different smartphone apps for routing and navigation. Please select those apps you are using frequently. You can also add apps you use that are not listed already.	Google Maps Apple Maps TomTom Gramin Journey Plan (Transport for Ireland) [Ireland only] Hit the Road Dublin Bus Irish Rail _____ _____ _____ I don't use any routing or navigation apps (except PEACOX trip planner and PEACOX navigation app / Dynavix)
Please sort the apps by dragging them to the left, putting the app you like most on the top and the app you like least to the bottom.	PEACOX trip planner app PEACOX navigation app / Dynavix [chosen app from last question]