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

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Stakeholder and Technological Requirements

[FLU]

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Executive Summary

The PEACOX project has the purpose to reduce CO_2 emissions by providing personalised multi-modal navigation tools for the travellers that allow, help and persuade them to travel and drive ecological friendlier. The PEACOX application will be piloted in the cities Vienna (AT) and Dublin (IRL).

The deliverable documents the work performed in Task 2.4 "Stakeholder Requirements" and Task 2.5 "Technological Requirements", representing a part of the PEACOX WP2 "Requirements for Eco-Travel Information Systems".

The main objective of the Task 2.4 was the analysis of the (potential) stakeholders as well as their aspirations and expectations towards the PEACOX application. Therefore, the following tasks have been performed:

- Assessment of the PEACOX value network, involved stakeholders and their roles.
- Assessment of stakeholder aspirations

In order to derive a valid picture of the PEACOX value network, typical roles of the involved stakeholders, their needs and expectations have been analysed mainly by means of literature research, partner meetings as well as the collection of questionnaires.

Stakeholders relevant for the provision of the PEACOX application are Local Authority and Association, Linked Transport System, Data / Content Provider, Service Provider and Application Provider. The stakeholders and their roles are described in more detail in Chapter 2.1 Stakeholder Groups and Roles.

Additionally, a questionnaire-based survey was carried out with the purpose of identifying stakeholder requirements in respect to the PEACOX application. In the first part of the questionnaire the current problems and challenges faced by potential stakeholder were identified. The stakeholder stated that barriers exist in respect to integration of CO_2 information into their travel information services. The most important barriers were the lack of user data (e.g. the type of car that is used) and the non-standardised formats of available environmental data. Secondly, the incompleteness of available environmental data as well as lack of environmental data represents an additional major barrier. In the second part, the

needs and expectations of the projects' stakeholders when it comes to the most important features, services and contents of the PEACOX application were identified.

In respect to relevant static content, the participants stated road information and public transport information as most important. Furthermore, parking information and event / POI (Point of Interest) information are also identified as important, whereas trip history and weather information are stated as least important and were identified as "nice to have" features. Additionally, most important dynamic services and contents are identified based on the online questionnaire. Public transport journey planning/routing and road journey planning were considered as very important followed by multi modal planning/routing and road journey routing. Participants stated additionally that public transport information is very important. Event/POI information, parking information, weather information and walking planning were considered as important. Furthermore, the participants were asked which additional contents and services they consider as important. In this context walking information was considered as a very important feature for the participants, followed by service personalisation. The possibility of providing individual trip alternatives and related ecological costs to the user was seen as important whereas providing the individual ecological footprint to the user was identified as a "nice to have" feature.

The first survey focused on what the stakeholder perceived as important for the user, i.e. what the stakeholder thinks the individual end users wants.

The goal of the second stakeholder questionnaire was to collect further requirements for the system that are not directly related to the end users and their expectations. The questionnaire was divided into two parts, identification of challenges and expectations for the following categories: system architecture, data/contents, service feature, service/interface design, legal, organizational, environmental impact and economic commercial as well as the identification of barriers and drivers from the technical, commercial and legal perspective.

In terms of technical topics the stakeholder stated that personalization, user tracking as well as the integration of the different modules represent a challenge within the project. Additionally, the user tracking is a critical aspect concerning data privacy and should be considered within the project. The key question is, who has access to the collected data, how transparent is the transfer of data, and how much influence has the user.

In respect to the stakeholder expectations regarding the environmental impacts it was mentioned that the expectations is that more people use more public transport instead of their private car, if necessary they will take a shared car, or at least chose CO2---friendly routes. It should also be notices that there exist the possibility, that the users increase their CO2 emissions, if the user gets the feeling he saved that much CO2 by following the recommendations every day, that he deserves using the plane once a month.

The stakeholder stated that the UI design should not only have the focus on "saving the earth" but also on the easy usage of the journey planner application. If using the service helps the user in daily life, the focus should be to get from A to B without trouble.

According to the stakeholder the business model for the PEACOX applications could be that the public transport operator pays for the cost for the application, since the possibility is small that the user is willing to pay for the application. The generation of revenues is an open question and from the perspective of the stakeholder it will be a challenge how to generate the revenues without selling user data.

Within the Task 2.5 the technological requirements for the PEACOX application are identified. The purpose of the task is to create a consolidated set of technological requirements for the overall project and therefore establish the basis for the development of the PEACOX application. By setting a common set of technical requirements, documenting the specific requirements for different functional components and assigning the responsibilities for each partner, this deliverable lays the foundation for the coordination of the architectural work, which is seen as an enabler for coherent and mutually consistent solutions to be proposed.

The functional components and the responsibilities for every component were identified as follows: Recommendation service (ICCS), User profile (ICCS), Evaluation – Behaviour model (TCD), Emission model (TCD), Exposure model (TCD), Travel and trip mode detection (ETHZ), Routing engine (ITS Vienna Region), Mobile applications (FLU, TMX).

The purpose of the Recommendation service will be to provide urban travellers with a personalised mobile travel recommender that will nudge them to plan trips while considering the environmentally friendliest travel modes. The recommendation service will focus on mobile technologies that encourage green transportation habits among travellers who have a pre-existing interest in taking action to lessen their impact on the environment.

The User Profile is the central repository of PEACOX where information required by various components for further processing is stored. It includes user specific information as well as information relevant to the usage of the PEACOX application (GPS traces, recommendation that are presented to the user, emission and exposure data, etc.). The next functional component, the Evaluation-Behaviour model, is closely linked to the previous mentioned component (User Profile). The aim of this component is to assess the impact that information associated with an individual's trip alternatives has had on his/her trip choice. User input comes from the functional component User Profile.

The next functional component is the Emission model. Within the model there are two distinct pieces required to meet the tasks for emission modelling in the project. The first model will give a prediction about emissions for routes recommended by the other partner. The second model will give real time emission taking account of vehicle trajectories from the Global Positioning System (GPS) data.

The counterpart to the Emission model is the Exposure model. The aim of this component is to predict the exposure of an individual to air pollution as a result of travelling a given route by a given mode or series of modes. The Exposure model will provide information about exposure to a particular pollutant for the recommended routes.

An additional functional component is the Travel and trip mode detection. This component uses the GPS and accelerometer measurements logged by the smart phones to detect when the participant performed a trip and when an activity, with which mode the trip was undertaken, what route or public transport connection was used and what the purpose of the activity was. In the first phase of the project, it does this using only the current GPS and accelerometer measurements. In the second phase, it will also take into account the person's personal travel history.

The routing engine is a functional component that is not direct involved within the PEACOX system and is placed outside. However, this component provides important input and functionalities that are relevant for other components. Therefore, the routing engine of the trial city Vienna, which is provided by ITS Vienna Region, will be described in more detail.

The functional component Mobile applications represent another important component of the PEACOX system since this component is the most visible output and will be available for the end users.

The technological requirements of the individual functional components are described in detail in the corresponding subchapter of Chapter 3.1 Functional components and their requirements. At the end of the deliverable, the resulting requirements for the system architecture itself will be discussed.

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1. Introduction

1.1 Background

The objective of the second work package is to analyse and specify the requirements for the PEACOX project from all relevant perspectives. Within the first two tasks – *Task 2.1 Identification and Characterization of User Groups* and *Task 2.2 Situational/Context Analysis* - the focus is on potentially PEACOX users as well as the situations in which they can use it. The *Task 2.3 User Requirements* focuses on the identification of user requirements for the PEACOX application. The result of the third task should be a detailed description of the user requirements and expectations for the PEACOX application. The goal of *Task 2.4 Stakeholder Requirements* is to identify stakeholder requirements for the PEACOX application, whereas *Task 2.5 Technological Requirements* has the purpose to collect all technological requirements that are relevant for the PEACOX application.

The outcome of the *Deliverable 2.2 Requirements Document* and *Deliverable 2.3 Stakeholder and Technological Requirement* will influence the further specification process of the PEACOX application, including the possible functions of the application as well as the interface design, including the persuasive presentation approach.

The purpose of the PEACOX application is to offer mobile applications enabling users to easily plan and organize their trip (by foot, bike, public transport, motorcycle, car, and by use of car-pooling). To convince and stimulate the users to behave more environmentally friendly when travelling, PEACOX will enrich trip planning and information system with innovative approaches and features, like personalised travel recommendations, automated trip purpose identification, individual emission modelling as well as exposure modelling, eco-friendly driving models, and persuasive presentation approaches.

1.2 Scope of the deliverable

Within this deliverable the stakeholder and technological requirements for the PEACOX application need to be identified and analysed.

Within the first part of the deliverable, the stakeholders as well as their needs and expectations were identified. A survey amongst potential PEACOX stakeholders has been conducted in order to identify current problems and challenges faced by potential stakeholders, and gather needs and expectations related to the PEACOX application. Furthermore, a second questionnaire was conducted in order to collect the further requirements for the system. These requirements that are not directly related to the end users of the system but other stakeholders interests.

The second part of the deliverable deals with the analysis of the technological requirements for the PEACOX application. The result of the technological requirements should be a consolidated set of technical requirements for the overall project. By setting a common set of technical requirements and documenting the specific requirements for different functional components, this deliverable lays the foundation for the coordination of the architectural work, which is seen as an enabler for coherent and mutually consistent solutions to be proposed.

1.3 Methodology

For the identification of the possible stakeholders for the PEACOX project, a value network was used as a method. A value network can be described as sequence of value-adding activities in the provision of a service. As such it consists of a comprehensive representation of the various stakeholders involved in the service provision. It has to be pointed out that in this context it is essential to provide not only a general listing of potential stakeholders but also a description of their interdependencies and the interplay among them (In-Time, 2010).

In order to derive a valid picture on the PEACOX value network, typical roles of the stakeholders involved as well as their needs and expectations are identified through literature research, partner meetings, as well as the collection of questionnaires and their analysis.

In April/May 2012 Fluidtime undertook a questionnaire-based survey with the purpose of identifying stakeholder requirements. The questionnaire was online based and was distributed using Google's web based survey application. 11 responses were received with a completion rate of 100%.

Major goal of the stakeholder questionnaire was to collect information related to the

- current situation with respect to personalised multimodal navigation tool
- shortcomings and challenges faced nowadays
- related expectations and interests with respect to PEACOX and
- desired contents and services as well as their quality indicators

2. PEACOX Stakeholder Requirements

Within this chapter, the (potential) PEACOX stakeholder groups and their main aspirations are identified and analysed. An in-depth review of roles, responsibilities and the respective situation of stakeholders is carried out. Problems/challenges faced nowadays are reviewed, providing results towards major stakeholder needs and expectations related to the PEACOX application. The first survey focused on what the stakeholder perceived as important for the user, i.e. what the stakeholder thinks the individual end users wants. The results of this survey will be used as an input for the development and later deployment of PEACOX. Additionally, the second questionnaire should provide further requirements for the system that, from the perspective of the stakeholder, but are not directly related to the end users. Results for the analysis and the questionnaires are based on methods already described in chapter 1.3 Methodology.

2.1 Stakeholder Groups and Roles

In a first step the main stakeholders in the context of PEACOX are identified, including stakeholders that are directly and indirectly connected to the project. Figure 2.1 shows an overall picture of the possible stakeholders related to the PEACOX system.

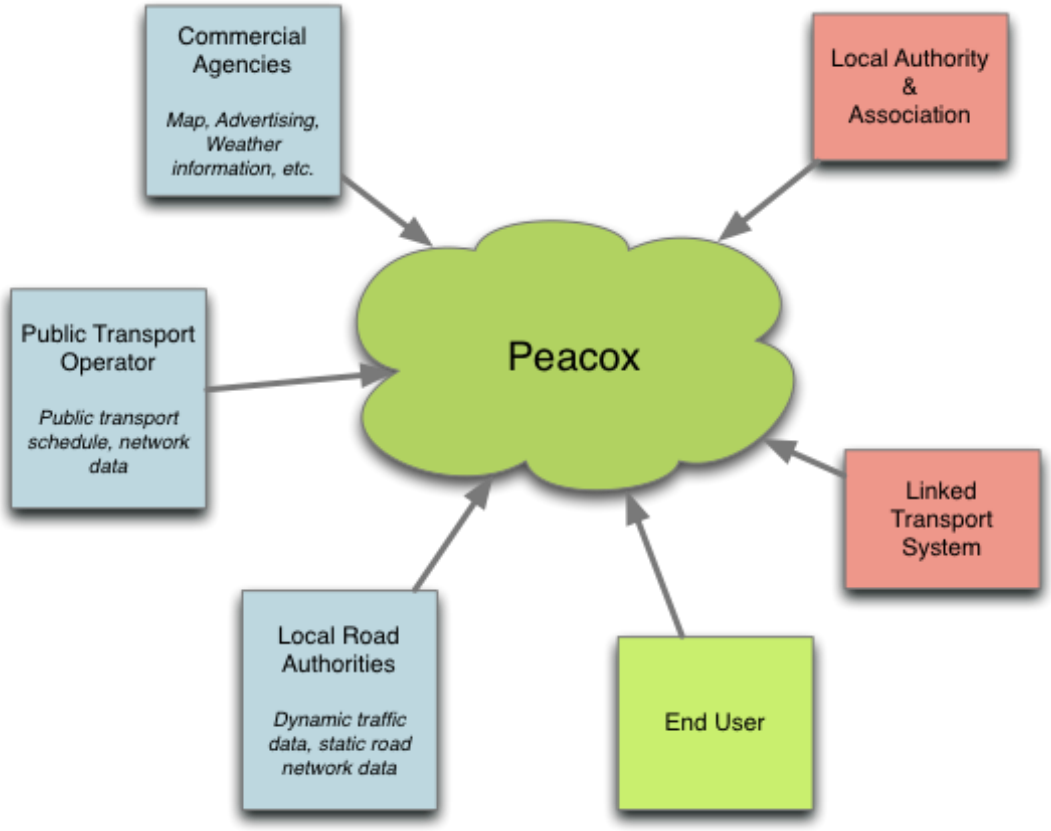


Figure 2.1: Overall stakeholder picture

The stakeholders are, as already mentioned, divided in two parts: directly involved stakeholders and indirectly involved stakeholders.

The identified **directly involved stakeholders** are commercial agencies, public transport operator and local road authorities. All of the stakeholders mentioned act as possible data or content provider. They act as sources for data and information used in the respective services and in most cases they are also content owner, i.e. the institution that collects the data and has all rights to use it and to hand it on. In the context of PEACOX, public content providers on the one hand and private/commercial content providers on the other hand can be distinguished with respect to underlying business models. Possible public and private data/content providers are:

- Traffic information centres (TIC) (dynamic traffic data)
- National, regional or local road authorities (dynamic traffic data, parking data, static road network data)
- Toll System Operators
- Parking Facilities Operators

- Public transport operators (static and dynamic public transport data)
- Automobile clubs (traffic messages)
- Private road operators (dynamic traffic data, static road network data)
- Private address and POI data provider (address data and POI data)
- Weather services (weather data)
- Event organiser
- Map agencies (map data for background map, address data)
- Commercial map enterprises (road network data, road maps)
- Municipal authorities (emission data)
- Advertising agencies (advertising on mobile)

Regarding the **indirectly involved stakeholders**, particularly in a local and regional context of multimodal navigation services, authorities and associations play an important role when it comes to setting the scene for service offerings due to their political influence. If the reduction of emissions is on the political agenda of local and regional authorities and associations, the PEACOX application could benefit from their support. Additionally, the linked transport system plays also an important role for the cities where this mobile application should be introduced. They could support merchandising the PEACOX application. For instance, in Vienna there is a linked transport system, called VOR (Verkehrsverbund Ost Region), including Vienna and its surroundings.

The last indirectly involved stakeholder is the end user. The user is typically the customer of the service provider and is interested in using a tool that should support him or her to travel eco-friendly. The success and acceptance of the PEACOX application is closely linked to end users. Therefore, user requirements represent an important factor and should be collected during the early phase of PEACOX application concept. The user perspective and the user requirements for the PEACOX application were already covered in Deliverable 2.2 User Requirements.

Finally, the stakeholders are mapped on the PEACOX value chain (see Figure 2.2).

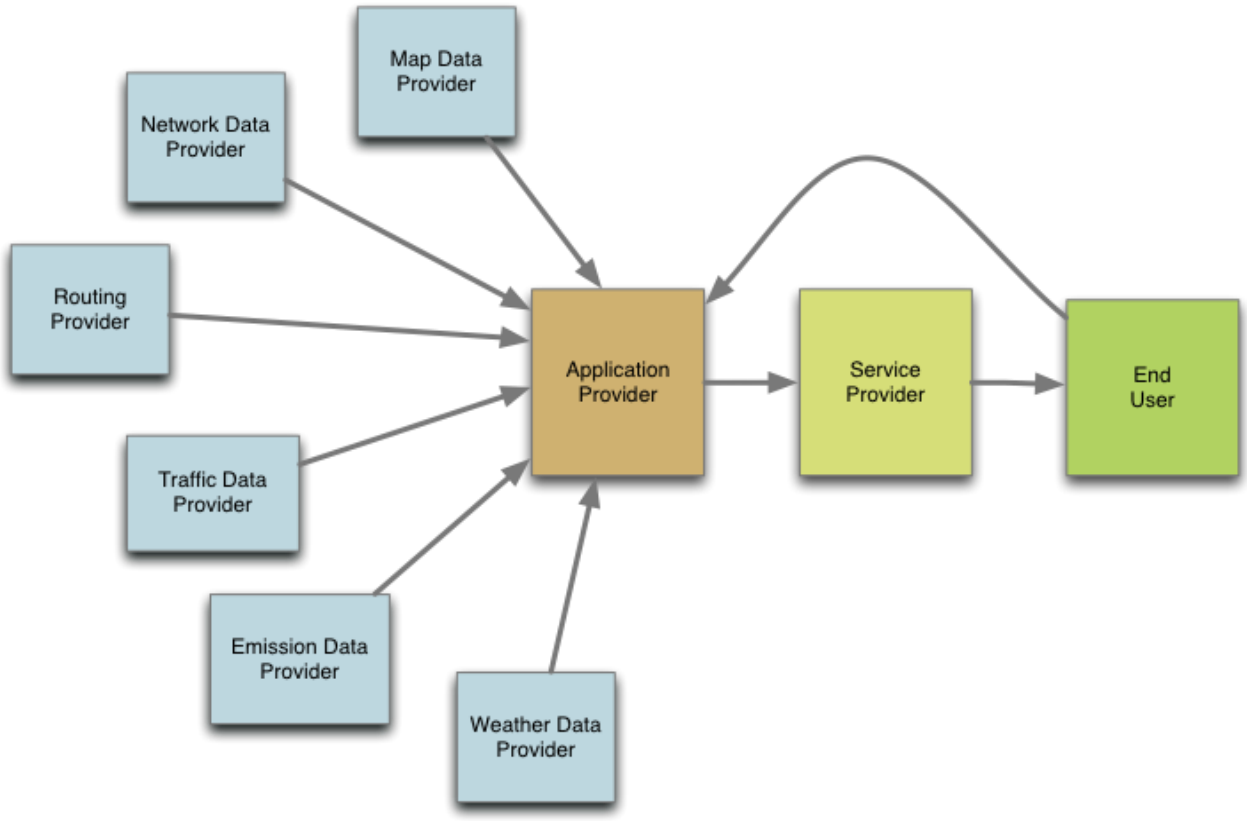


Figure 2.2: PEACOX value chain

Firstly, several data provider deliver their input to the application provider, including traffic data, emission data, weather data, network data, map data as well as routing results. Additionally, the user acts as an additionally data source, since the GPS data of the individual user is used for the personalisation of the service and is therefore forwarded to the application provider.

The application provider is responsible for data collection from different content/data providers as well as data integration. Additionally, the application provider is responsible for the integration of developed models.

The service provider uses data from application provider to refine them and to generate the respective information service for the end user's device.

The roles and responsibilities heavily depend on the local context. For instance, the individual stakeholder roles maybe be fulfilled by separate organisations or one organisation is responsible for different activity types.

2.2 Stakeholder Aspirations

In order to collect the stakeholder's current situation with respect to eco-friendly services, challenges faced nowadays and resulting requirements as well as to raise awareness, an online questionnaire was conducted. The structure of the questionnaire was based on the questions created by the project partners with the goal of finding the answers to the above mentioned purposes. 11 respondents were approached during the survey, with a completion rate of 100%.

The organisations which filled in the questionnaire have been asked to specify their role by choosing between stakeholder roles identified in chapter 2.1 (Local Authority and Association, Linked Transport System, Data / Content Provider, Service Provider, Application Provider, Other). Table 2.1 provides an overview about the (potential) stakeholder that took part at the online questionnaire.

Nr.	Company/Organisation	Role	Relevance for the city
1	National Transport Authority	Content Provider, Linked Transport System	Dublin
2	Railway Procurement Agency	Content Provider (PT Operator)	Dublin
3	Dublin City Council	Local Authority and Association	Dublin
4	Wiener Linien (Vienna's public transport operator)	Content Provider (PT Operator)	Vienna
5	ITS Vienna Region / Verkehrsverbund Ost Region (Linked Transport System around Vienna)	Content Provider, Linked Transport System, Service Provider	Vienna
6	IQ mobile	Content Provider (Advertising)	Vienna

7	TomTom	Content Provider (dynamic traffic data), Service Provider	Vienna/Dublin
8	TomTom	Content Provider (map data for background map), Service Provider	Vienna/Dublin
9	TomTom	Content Provider (road maps, road network data), Service Provider	Vienna/Dublin
10	TomTom	Service Provider (navigation tool for cars)	Vienna/Dublin
11	TomTom	Service Provider (navigation tool for cars)	Vienna/Dublin

Table 2.1: Stakeholder that took part at the online questionnaire

2.2.1 Problems and Challenges Faced

In the first part of the questionnaire the potential stakeholders were asked which services they offer, whether the focus within the service is related to the provision of ecological information and which problems and challenges in respect of the integration of environmental data into the services they face.

The stakeholders that took part in the online questionnaire offer the following services (ranked by their frequency):

- Journey planner for public transport (web and app) (5)
- Navigation tool for cars (3)
- Multimodal journey planner (web and app) (3)

The participants were asked if they include information about emissions in their travel information services in order to raise awareness by the user. A couple of the participants mentioned that they provide ecological information to the users (pre- and on trip) and after a travelling in a logbook. TomTom, providing navigation tools for cars, mainly uses the logbook functionality. The majority stated that are not providing such kind of information at all. The reasons for this are shown in Figure 2.4 and will be discussed later on.

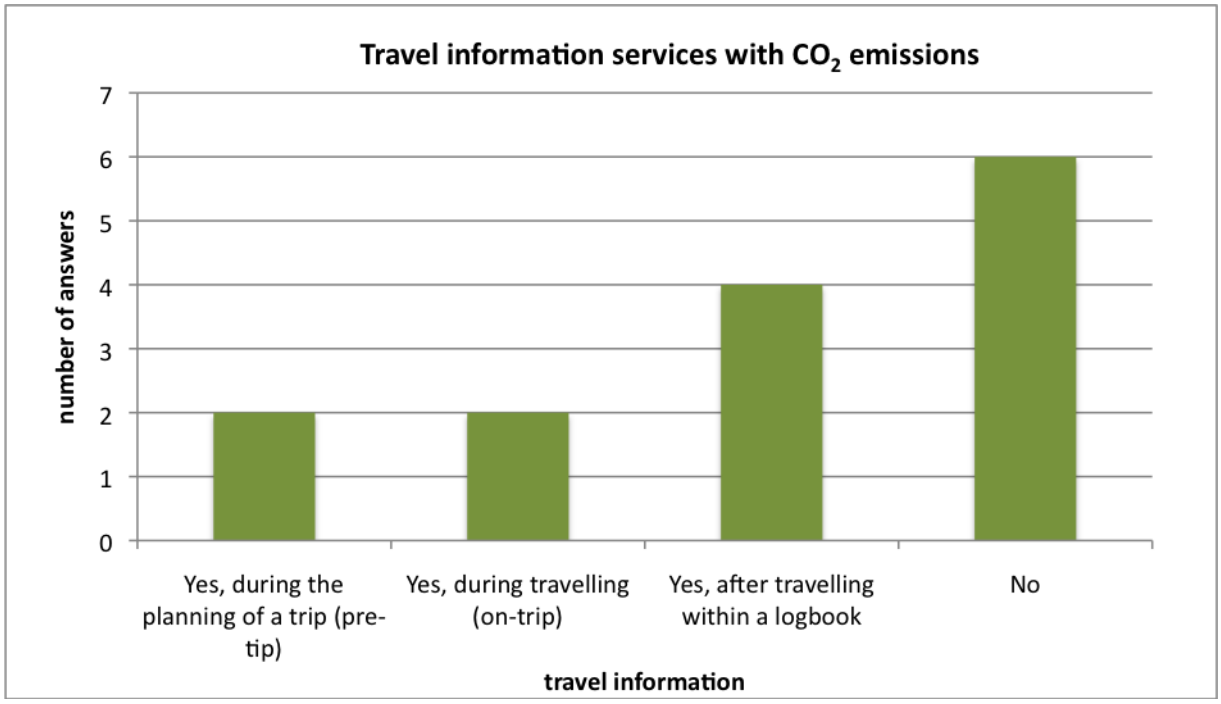


Figure 2.3: Travel information with emission information

Stakeholders providing such kind of information apply three different ways of doing so: The first option is to provide information about emissions generated by the specific travel mode, followed by visualisation of "green" travel choices (e.g. highlighting of non-emission routes) and comparison of emissions generated by different travel modes.

As already mentioned, there exist important barriers in respect of the integration of environmental data into services, summarised in Figure 2.4.

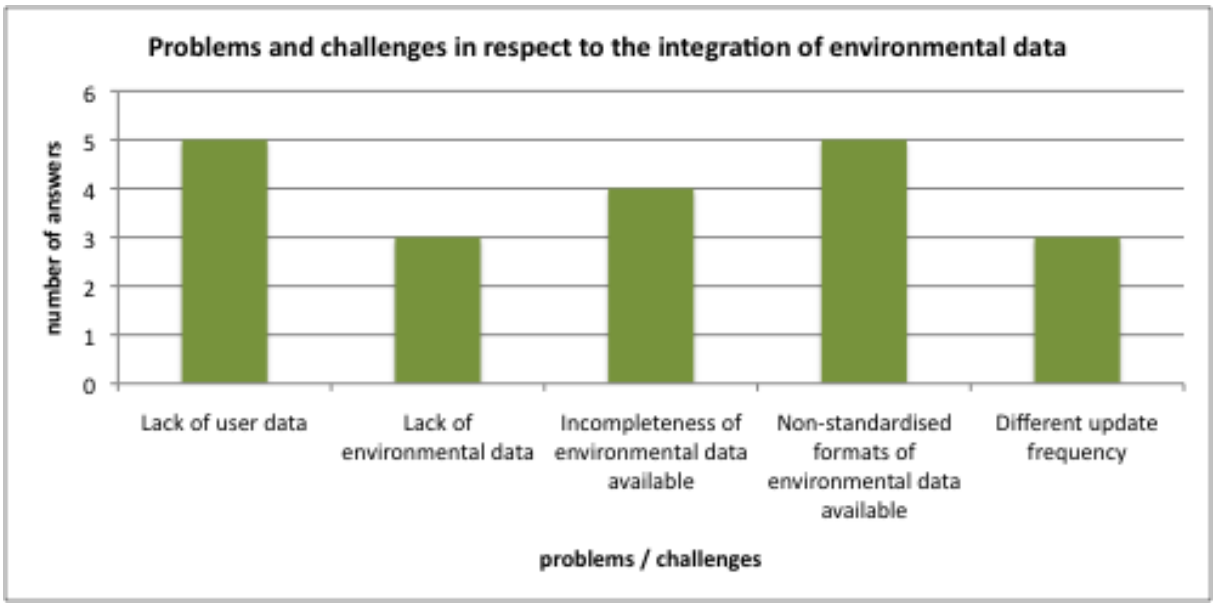


Figure 2.4: Challenges in respect of integration of environmental data

The most important barriers were the lack of user data (e.g. the type of car that is used) and the non-standardized formats of available environmental data. Secondly, the incompleteness of available environmental data as well as lack of environmental data represents an additional major barrier. A conclusion, which may be derived, based on these results is that some standardization must be done in respect to the availability of the environmental data and the format. This issue is seen as an important factor from the perspective of the stakeholder and is therefore also discussed in the next chapter needs and expectations.

2.2.2 Needs and Expectations

An additional part of the online questionnaire was the identification of needs and expectations of the projects' stakeholders when it comes to the most important features, services and contents of the PEACOX application.

To cover the viewpoints of the stakeholders, different questions related to static / dynamic information and journey planning / routing were posed. Furthermore, quality indicators related to the PEACOX application are analysed. In addition to that, the stakeholder's opinion towards the possible reduction of emissions and support of eco-friendly travel behaviour through the PEACOX application are outlined.

As shown in Figure 2.5, the majority of the participants stated road information and public transport information most relevant static content. Furthermore, parking information and event / POI (Point of Interest) information are also identified as important whereas trip history and weather information are stated as last important and were identified as "nice to have" feature.

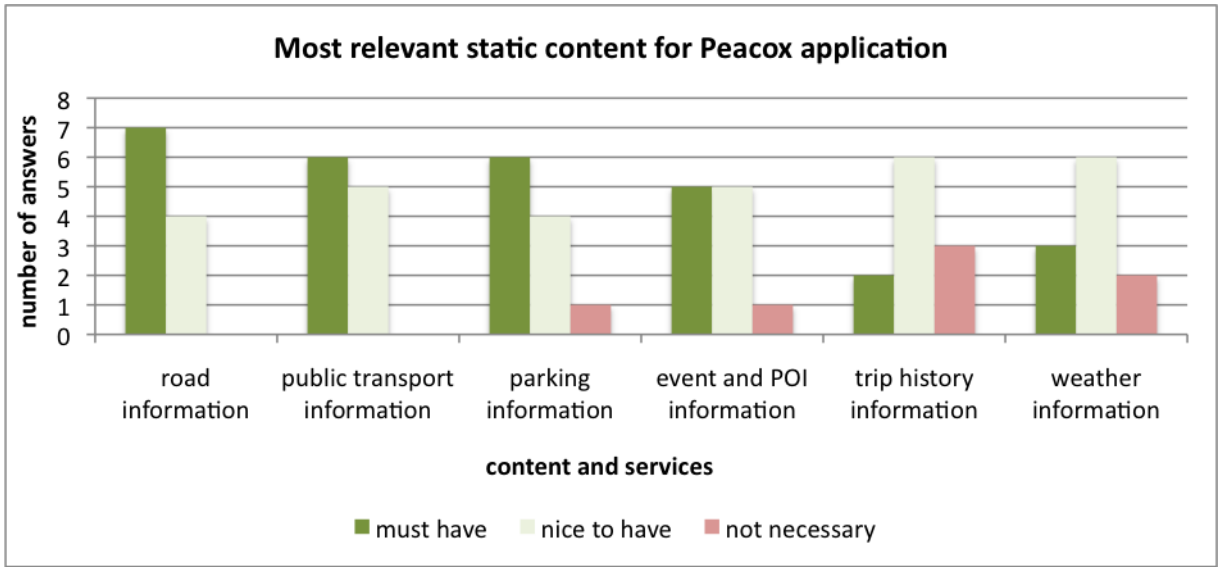


Figure 2.5: Static content for PEACOX application

Figure 2.6 and Figure 2.7 summarise the most relevant dynamic contents and services. Public transport journey planning/routing and road journey planning were considered as very important. Participants stated that the public transport information is additionally very important, followed by multi modal planning/routing and road journey routing.

Event and POI information, parking information, weather information and walking planning were considered as important.

Location information, walking routing as well as cycling planning/routing were considered as nice to have features.

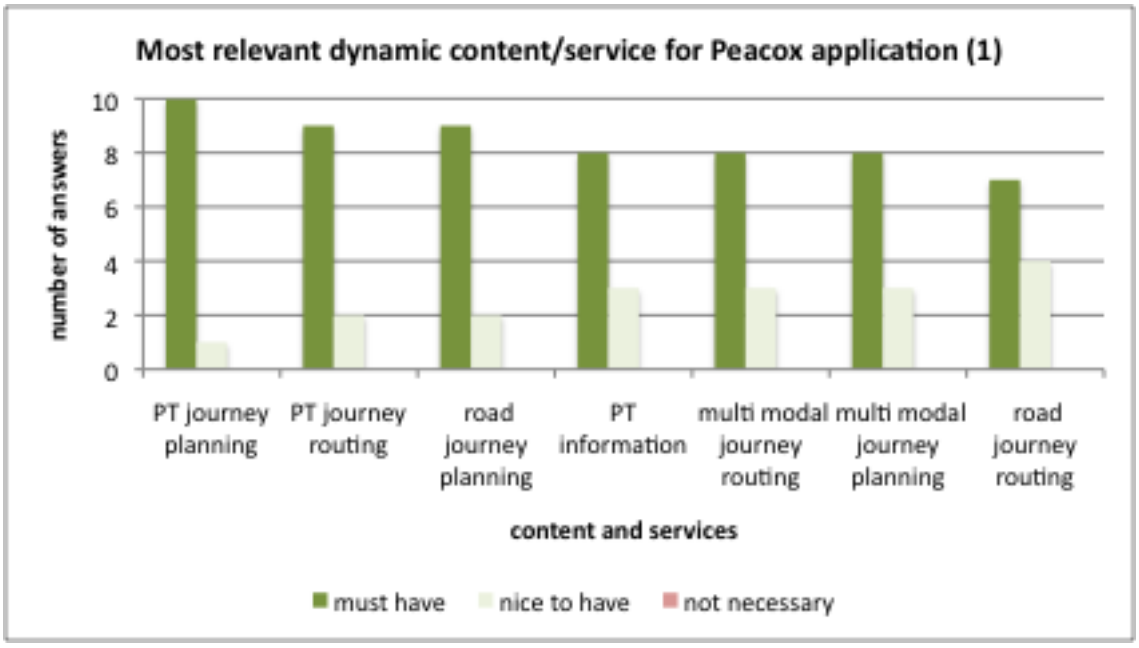


Figure 2.6: Dynamic content for PEACOX application (1)

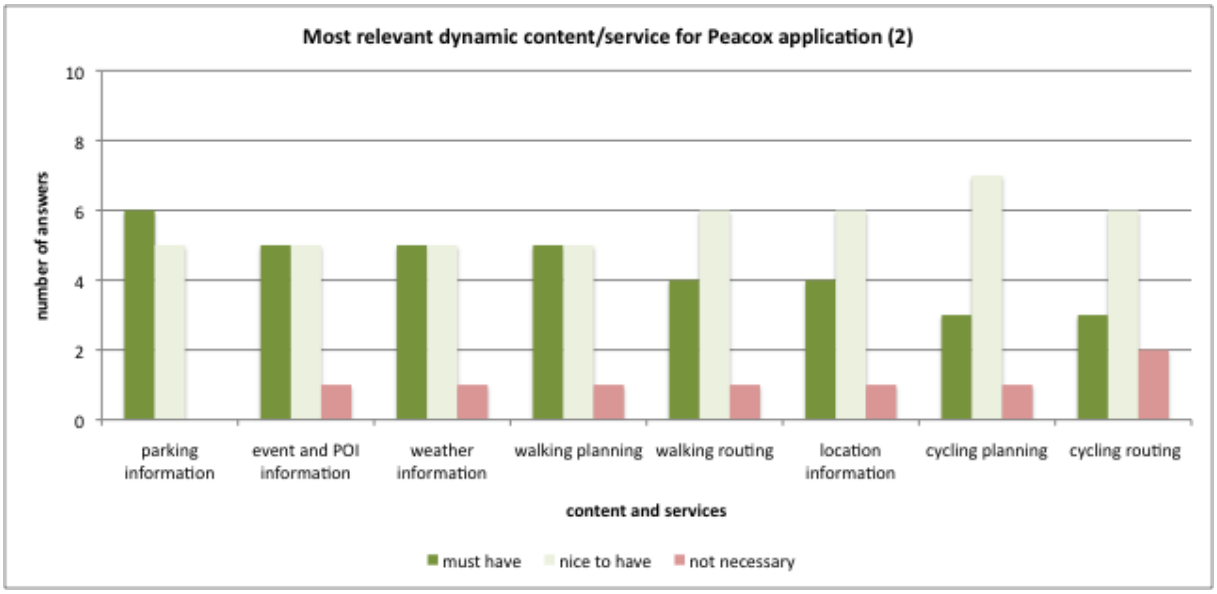


Figure 2.7: Dynamic content for PEACOX application (2)

The participants were also asked to rank other relevant content/services for the PEACOX application and the result is shown in Figure 2.8. In this context walking information was considered as a very important feature for the participants, followed by service personalisation. The possibility of providing individual trip alternatives and related ecological

costs to the user was seen as important whereas providing the individual ecological footprint to the user was identified as a “nice to have” feature.

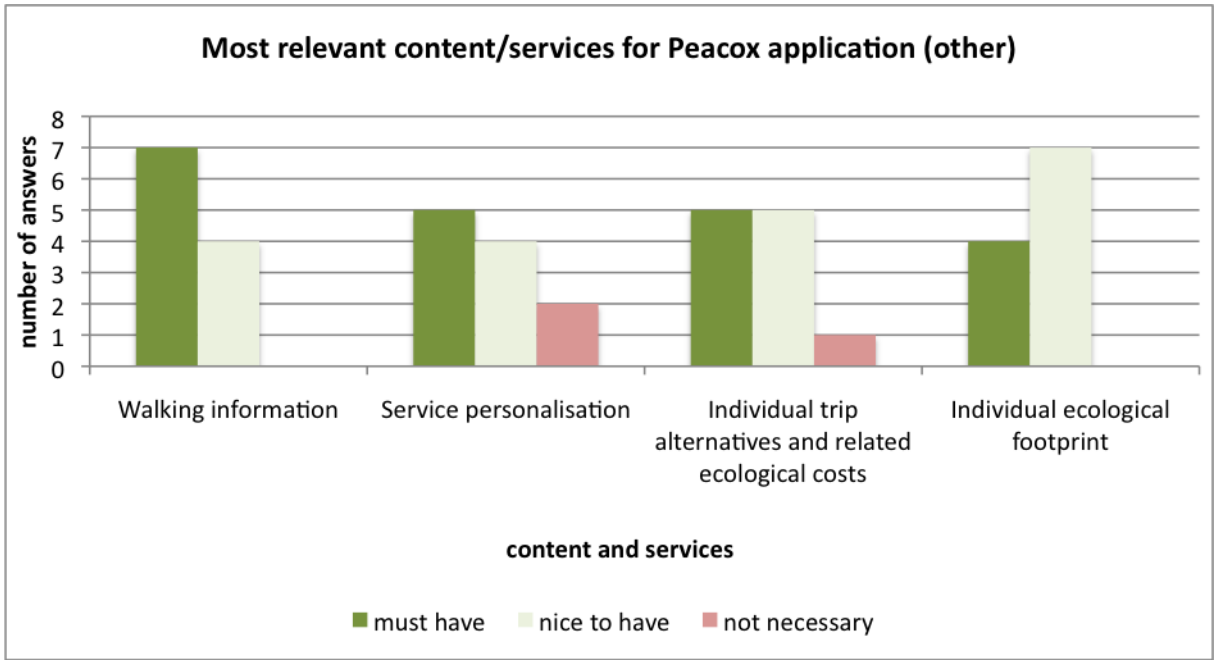


Figure 2.8: Most relevant content/services for PEACOX application (other)

Furthermore, quality indicators related to the service are analysed. The quality indicators mentioned most are: Data completeness and update of dynamic data as well as time accuracy. Data geo-reference quality, including the map matching quality and coordinate precision were stated as important indicators.

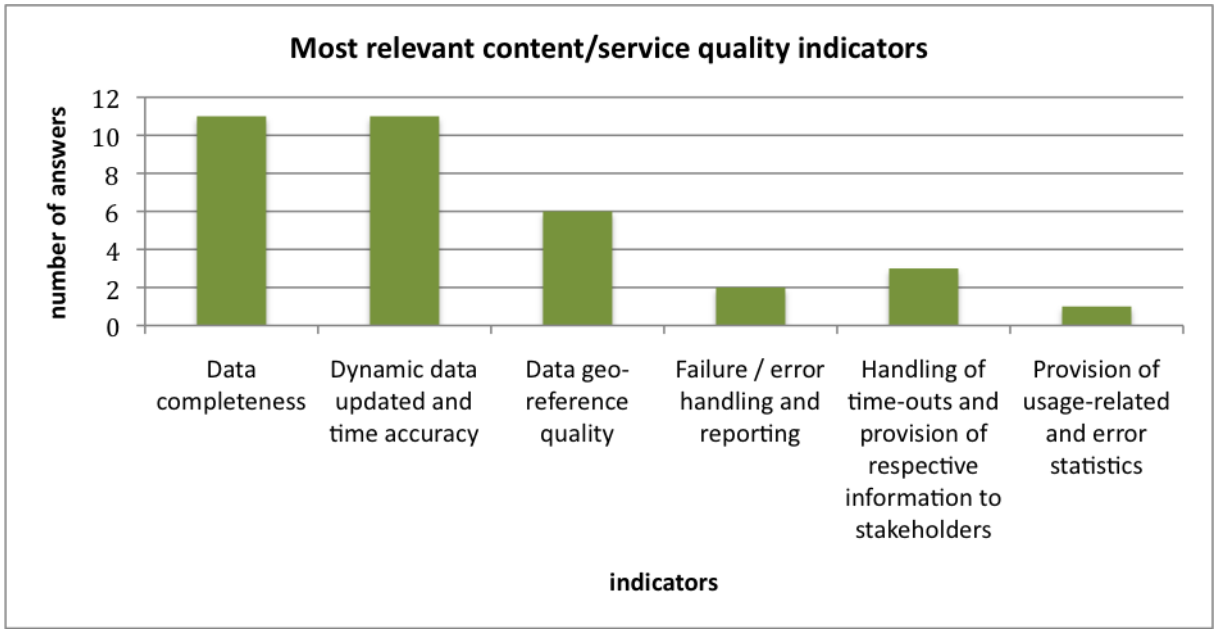


Figure 2.9: Most relevant content/services quality indicators

Participants of the online questionnaire were also asked whether they think the PEACOX application can help to reach the goal of CO_2 emission reduction and furthermore contribute to motivate the people to move towards eco-friendly travel behaviour. The answers are summarised in Figure 2.10. and explained in detail below.

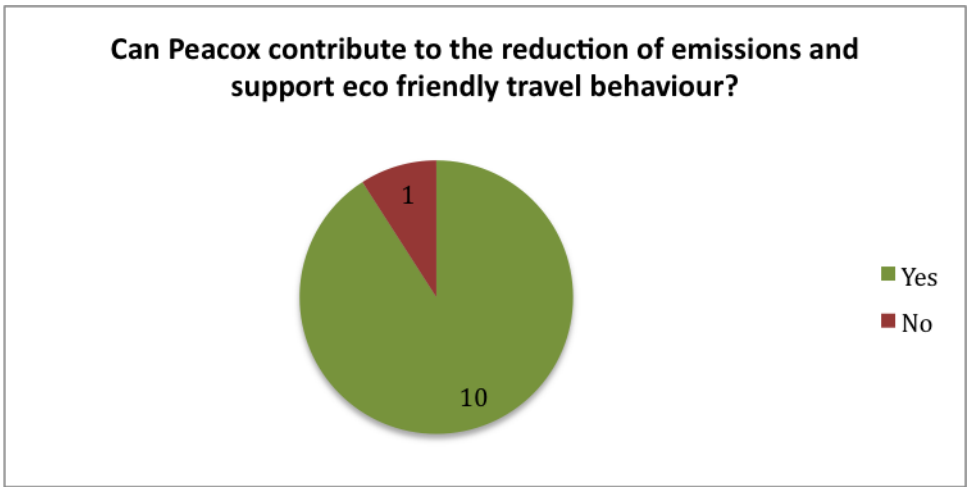


Figure 2.10: Most relevant content/services quality indicators

Thus, almost all participants are convinced that the PEACOX application can make a contribution to the goal of emission reduction. Additionally, the usage of the PEACOX application can result in awareness building of end-user towards a more eco-friendly travel behaviour. In this context the participants stated that based on the provided information, users can make better informed decision. Furthermore, it was mentioned that it is an important issue to provide information to the user about the (ecological) impact of the travel modes. This additional (ecological) information and the resulting motivation facts about environmentally friendly mobility options, as well as alternative routes, will help the user to change his or her behaviour to more sustainable travelling. It was argued that habits have a strong influence on a user's travel behaviour and on a user's perceptions about efficient travelling. Providing the right information can help users to change their perceptions and to build new, more divers habits - maybe even more environmental. On the other hand, one participant mentioned that the use of the PEACOX application- alone would be insufficient as a measure for environmentally friendly travelling. Additionally, he raised the question if extra incentive for going eco would be necessary (or subsidies or other benefits have to be offered.) He perceives the eco option as less optimal for individuals, arguing that reducing emission may not be an important goal for car drivers.

At the end of the questionnaire, participants were asked to assess which kind of information and services contribute mostly to the proposed goal of PEACOX project.

They stated the following issues as most important:

- Web or mobile services that visualize the comparison of the emissions generated by different travel mode (8)
- Detailed information about the individual travel mode emission (web or mobile) (8)
- Alternative route suggestions ordered by the most sustainable travel mode (6)

2.3 Stakeholder Requirements

The first survey focused on what the stakeholder perceived as important for the user, i.e. what the stakeholder thinks the individual end users wants.

The goal of the second questionnaire was to collect further requirements for the system that are not directly related to the end users.

The structure of the questionnaire was based on the questions created by FLU. The participants filled out the questionnaire. The questionnaire was mainly based on open questions.

The organisations which filled in the questionnaire have been asked to specify their role by choosing between stakeholder roles identified in chapter 2.1 (Local Authority and Association, Linked Transport System, Data / Content Provider, Service Provider, Application Provider, Other). Table 2.2 provides an overview about the (potential) stakeholder that took part at the online questionnaire.

Nr.	Company/Organisation	Role	Relevance for the city
1	ÖBB – Austrian Federal Railways – Passenger services	Content Provider, Transport Operator	Vienna
2	NTT Data	Content Provider	Vienna

Table 2.2. Stakeholder participant list – second questionnaire

2.3.1 Challenges and Expectations

The goal of this chapter is to find challenges and expectations in respect to several categories that are relevant for the PEACX project. The next table provides a summary of the categories and the answers provided by the participants.

	Challenges	Expectations
System architecture	System and data integration, scalability, cloud infrastructure	Device independency
Data/Contents	Data standards and quality, data synchronization, personalization, crowd---based data	Pushed real time travel data

Service Features	Personalization	Real time travel data
Service / Interaction Design	User has to get the impression, that he gets a benefit, so the enforcement has to be very subtle.	If using the service helps the user in daily life, the focus would not only be 'saving the earth' but getting from A to B without trouble.
Legal	Twenty---four---seven tracking is a critical aspect concerning data privacy. The key question is, who has access to the collected data, how transparent is the transfer of data, and how much influence has the user.	If the operator is a trusted organisation (e.g. EU), transparency could be the competitive advantage versus the potential rival Google.
Environmental impacts	It would be possible, that users increase their CO_2 emissions, and if the user gets the feeling he saved that much CO_2 by following the recommendations every day, that he deserves using the plane once a month. It would be counterproductive if only those people use the system, who did already act outstandingly CO_2--- friendly beforehand.	People using more public transport instead of their private car, if necessary they will take a shared car, or at least chose CO_2---friendly routes.
Economic / Commercial	***Q:* How could the business model look like?** The end---user is not willing to pay for such a service. It would be possible to charge companies using the system in their devices (car, navigation system). Also public transportation providers could pay for providing the service to their customers (via smartphone---app). App advertising would not be useful to implement because users would not trust a system (apparently) selling their private data (even if this is not the case).	

Table 2.3Challenges & Expectations

2.3.2 Drivers and Barriers

The goal of this chapter is to find drivers and barriers in respect to three important perspectives – technical, commercial and legal. The next table provides a summary of the categories and the answers provided by the participants.

	Drivers	Barriers
Technical perspective	System and data integration, improvement of all components developed by all partners.	If the app were only available for one platform, the critical mass would not be reached.
Commercial perspective	Partners providing the system to their customers (business model). Possibility to provide add-on services.	Earning enough money without selling personal data. How to get revenues is not clear.
Legal perspective		Tracking and enforcement are critical.

Table 2.4 Drivers & Barriers

3. PEACOX Technological Requirements

In order to pave a common ground for further work regarding the system specification, this chapter has the goal to collect the technical requirements for different functional components within the project.

Within the first part of this chapter the functional components as well as their dependencies will be described. Based on this overview picture of involved functional components, the correlation between the individual components and the necessary data input will be shown. Based on this overview picture, the technological requirements for each of these system components can be derived.

Afterwards, the requirements regarding the system architecture will be analysed and defined. These requirements will build the basis for further specification processes regarding the system architecture as well as the system design.

3.1 Functional components and their requirements

Figure 3.1 shows an overall picture of the involved components within the PEACOX system and how they correlate with each other. The overview picture is divided into three parts: client and server components, third party data and services.

Figure 2.1 shows the identified functional components of the PEACOX system. ETH Zurich is responsible for the travel mode and trip purpose detection model whereas ITS Vienna Region is in charge of the routing engine model of Vienna. ICCS (Institute of Communication and Computer Systems) is responsible for the user profile model as well as recommendation model. TCD (Trinity College of Dublin) is in charge of the emission and exposure model as well as behaviour model. Finally, TMX (Telematix) is responsible for the description of the navigation component and the resulting requirements for the integration of navigation tools with the journey planner.

Figure 3.1 gives an overview about the individual functional components and their dependencies. In the next step, the functional components will be described in detail as well as their requirements, including the software and hardware requirements, as well as their dependencies to other functional components.

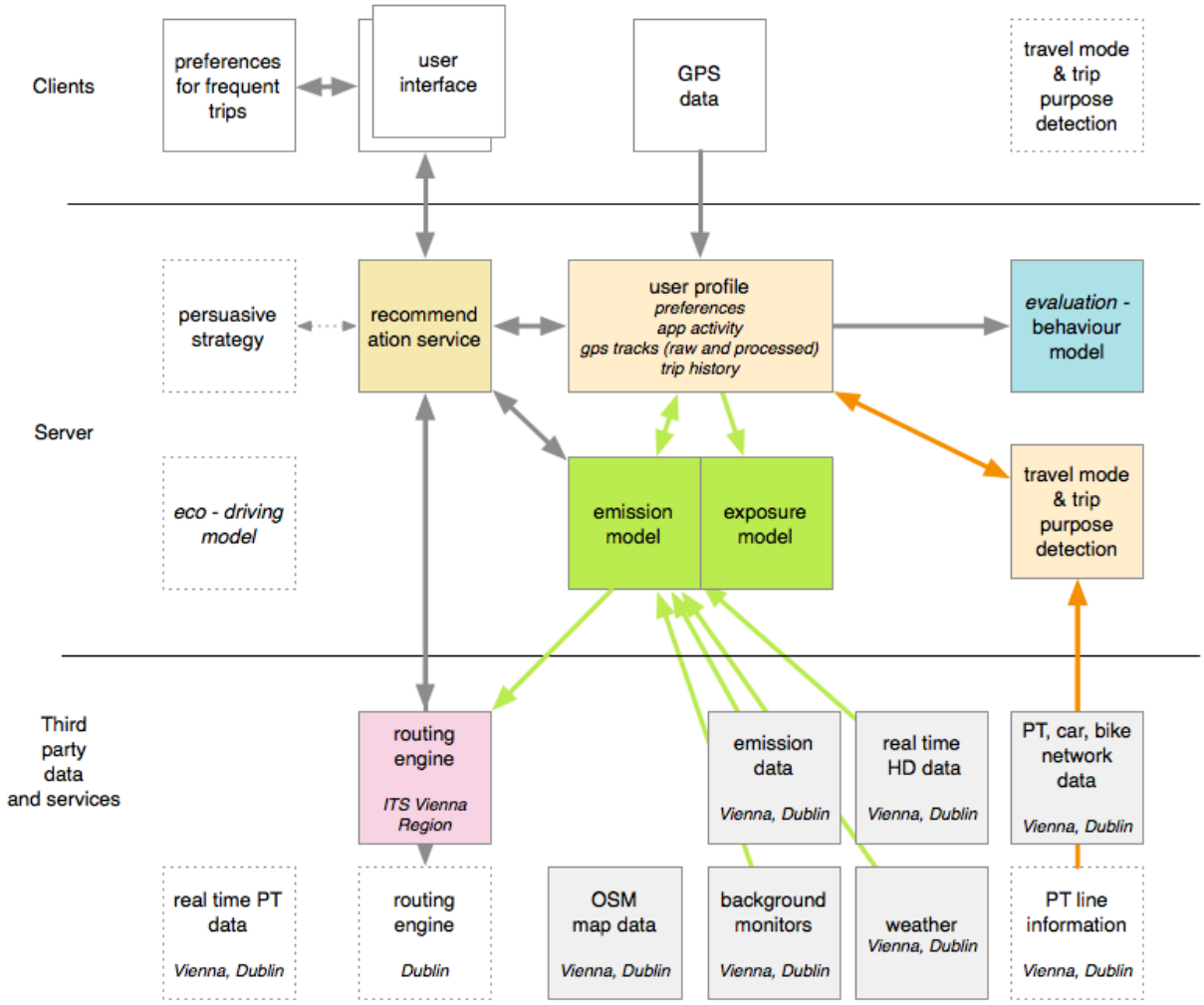


Figure 3.1: Functional components and their dependencies

3.1.1 Recommendation service

3.1.1.1 Aim of the component

The aim of the recommendation service is to incorporate small features or 'nudges' in the route selection process, which will assist individuals to overcome cognitive biases by highlighting the better choices for them, without restricting their freedom of choice.

The recommendation service will focus on mobile technologies that encourage green transportation habits among travellers who have a pre-existing interest in taking action to lessen their impact on the environment. Its purpose will be to provide urban travellers with a personalized mobile travel recommender that will nudge them to plan trips while considering the environmentally friendliest travel modes.

The core of the recommendation service comprises four functions while it interacts with various PEACOX components, including the front-end user interface, the routing engine and the 'recommendation information elements' consisting of the user profile and components that offer contextual information that depends on route characteristics and the time of day. Contextual elements are High Definition (HD) traffic (provided by TomTom), Weather, Emissions model and Exposure model (air pollution exposure).

The functions of the recommendation service are responsible for personalising and contextualising the alternative itineraries to be presented to the user. The first two, query personalisation and contextualisation, transform the user routing query and context signals into the appropriate routing engine API parameters.

Query personalisation is dependent on certain user characteristics, stored in the user profile. Examples include the availability of transportation means the user has at her disposal e.g. car/ motorcycle and bicycle and any disabilities the user may have. Indicative rules for these cases are:

- If the user owns a vehicle then routing results involving car/ motorcycle should be considered, similarly if the user owns a bicycle, routing results involving a bicycle should be considered.
- If the user has disabilities then bicycle and public means of transportation that do not provide amenities for persons with disabilities should be avoided.

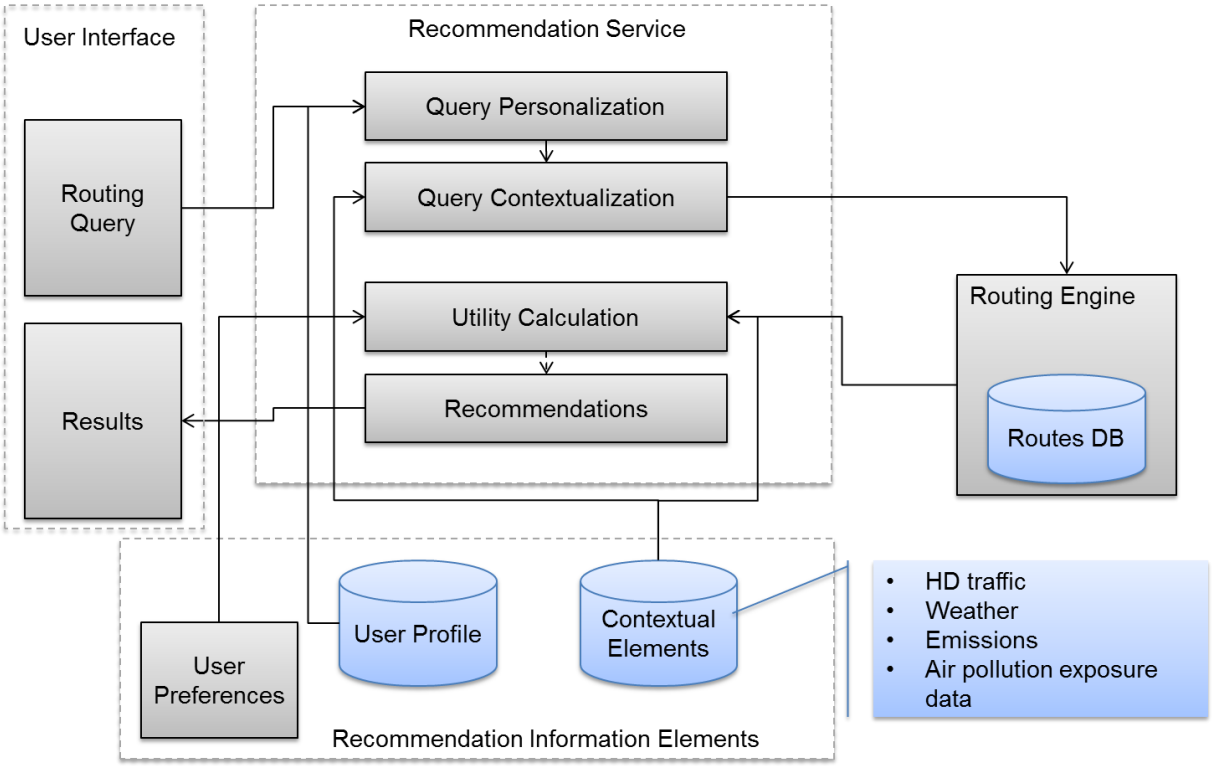


Figure 3.2: Conceptual Architecture of the recommendation service and interactions with the PEACOX components.

Query contextualization shall consider a number of static rules to further filter the initial set of results. Indicative rules are:

- Weather data: if the day is rainy, then bike and walking time should be kept to a minimum
- Traffic data: if there is indication of high traffic density, car time should be kept to a minimum
- Trip purpose affects the possible delays with respect to the time of arrival. Expected delays should be minimized for business trips, can be moderately tolerable for leisure trips, and tolerable for tourism trips

Once the results from the routing engine are available, two more functions are triggered in order to calculate the utility of each result which will determine the actual recommendations. The utility calculation function maps the recommendation information elements and the characteristics of the route to a preference value per user and itinerary.

The final step refers to the generation of recommendations. The purpose of this function is to select a set of *M* results to present to the user. The results must provide a proper balance between the estimated utility and eco-friendliness of the routes to be presented.

3.1.1.2 Technical requirements

The software requirements are:

- The recommendation service will be implemented in the Java programming language and will be compiled with the Java Development Kit (JDK) 1.6. For the runtime the Virtual Machine (VM) of Java 6 will be required
- The recommendation service will implement CRUD (Create, Retrieve, Update, Delete) operations against the database server hosting the 'User Profile'. A Java Database Connectivity (JDBC) driver for the selected database server will be required in order for the recommendation service to communicate with the server and perform the CRUD operations
- Where needed, the recommendation service will use third party JAVA libraries. Libraries that will be considered include:
    - JAMA (Java Matrix Package provided by the National Institute of Standards and Technology (NIST)): http://math.nist.gov/javanumerics/jama/
    - COLT (Open Source Libraries for High Performance Scientific and Technical Computing in Java provided by the European Organization for Nuclear Research (CERN)): http://acs.lbl.gov/~hoschek/colt/
    - Apache commons math (provided by the Apache Software Foundation): http://commons.apache.org/math/
    - Mallet (A Machine Learning for Language Toolkit provided by the University of Massachusetts Amherst): http://mallet.cs.umass.edu/
    - Weka (a collection of machine learning algorithms for data mining tasks provided by the University of Waikato): http://www.cs.waikato.ac.nz/

The hardware requirements are:

- A server with a clock speed of at least 3GHz and 4 GB of memory will be required
- In terms of hard disk non-volatile storage, at least 2 GB will be required for log files and other recommendation service internal static data

3.1.1.3 Input requirements

The recommendation service will implement a set of RESTFul web-services over the HTTP protocol in order to allow other components to execute requests for route suggestions. The web service shall require as input the following parameters:

- Starting / Destination points
- Common Navigation Preferences (e.g. preferred time of arrival, avoidance of tolls etc.)
- User preferences for route utility calculation

The response shall contain a set of ordered routes to be presented to the user.

3.1.1.4 Dependencies to other components

The recommendation service will combine information from a number of PEACOX components. It is expected that the other components will expose the required information as RESTFul web-services over the HTTP protocol. Dependencies with the following components are foreseen:

- Routing Engine: The recommendation service shall execute routing queries in order to retrieve alternative routes. In order to limit the amount of results to be retrieved, the following parameters will be supported in the query:
    - Starting / Destination points
    - Preferred time of arrival
    - Transportation Modes
    - Common Navigation Preferences (e.g. preferred time of arrival, avoidance of tolls etc.)
- Emission model: The recommendation service shall provide a list of routes to the emissions model and get as result annotated routes with estimated emissions
- Exposure model: The recommendation service shall provide a list of routes to the emissions model and get as result annotated routes with estimated exposure to air pollution
- Weather data: The recommendation service shall retrieve weather data from external information sources

- HD traffic data: The recommendation service shall retrieve traffic data from external information sources

3.1.2 User profile

3.1.2.1 Aim of the component

The user profile is the central repository of PEACOX where information required by the various components for further processing is stored. It includes user specific information as well as information relevant to the usage of the PEACOX application, including GPS traces from the real routes the user follows, emissions and exposure statistics, the recommendations the user receives and tracking of all actions the user performs within the application.

3.1.2.2 Technical requirements

The software requirements are:

- The user profile shall be a relational database management system (RDBMS) based on the proven and open source PostgreSQL (http://www.postgresql.org)
- JDBC drivers will be used by the individual PEACOX components to access the user profile (if required other native drivers will be made available to meet the components requirements e.g. PDO (PHP Data Objects) driver for php)

The hardware requirements are:

- A server with a clock speed of at least 3GHz and 4 GB of memory will be required
- In terms of hard disk non-volatile storage, at least 2 GB will be required for log files and other recommendation service internal static data

3.1.2.3 Input requirements

An initial data model of the User Profile is depicted in Figure 3.3. It consists of 6 entities as follows:

- User: Here we place user specific information. A unique ID is used to identify the user within the PEACOX application whereas the ‘First Name’ and ‘Last Name’ attributes are optional. In addition the ‘Birth Date’ shall be optional. Nonetheless, if provided, these attributes will be used for more fine grained personalization. The ‘Eco Attitude’

reveals how receptive the user is for more eco-friendly route suggestions. The 'Avatar Name' as well as the 'Eco Score' are attributes which will be used by the 'persuasive strategy' component

- Stage: All GPS traces (trips) recorded in the users' mobile device are stored in this entity
- Preferences: This entity will store explicit user preferences to be incorporated in route personalization and recommendation
- Recommendations: All recommendations presented to the user are stored in this entity. Combining these recommendations with the actual GPS data, the behavioural model will evaluate the impact of the PEACOX application on the users' behaviour.
- Emissions statistics: The emissions of every trip are stored in this entity
- Exposures statistics: Air pollution exposures of every trip are stored in this entity
- Application activity: This entity holds a log of every action the user makes within the PEACOX application. The 'Module ID' refers to the specific model/ service/ component where an action takes place whereas 'Action ID' to the identifier of the action within the model/service/component
- Frequently visited places: This is a list of places the user visits very often like his home and his work. The favourites will be used for quick calculation of routes
- Owned vehicles: This is a list of the vehicles the user owns including their characteristics. The vehicles characteristics shall be used for the emissions calculation

In Figure 3.3 we present with a blue colour the information that is completed by the user using the PEACOX graphical user interface.

The presented user profile data model (see Figure 3.3) will be revised during the further development of the system architecture, especially in WP6 System Design and Implementation, Task 6.3 System Design.

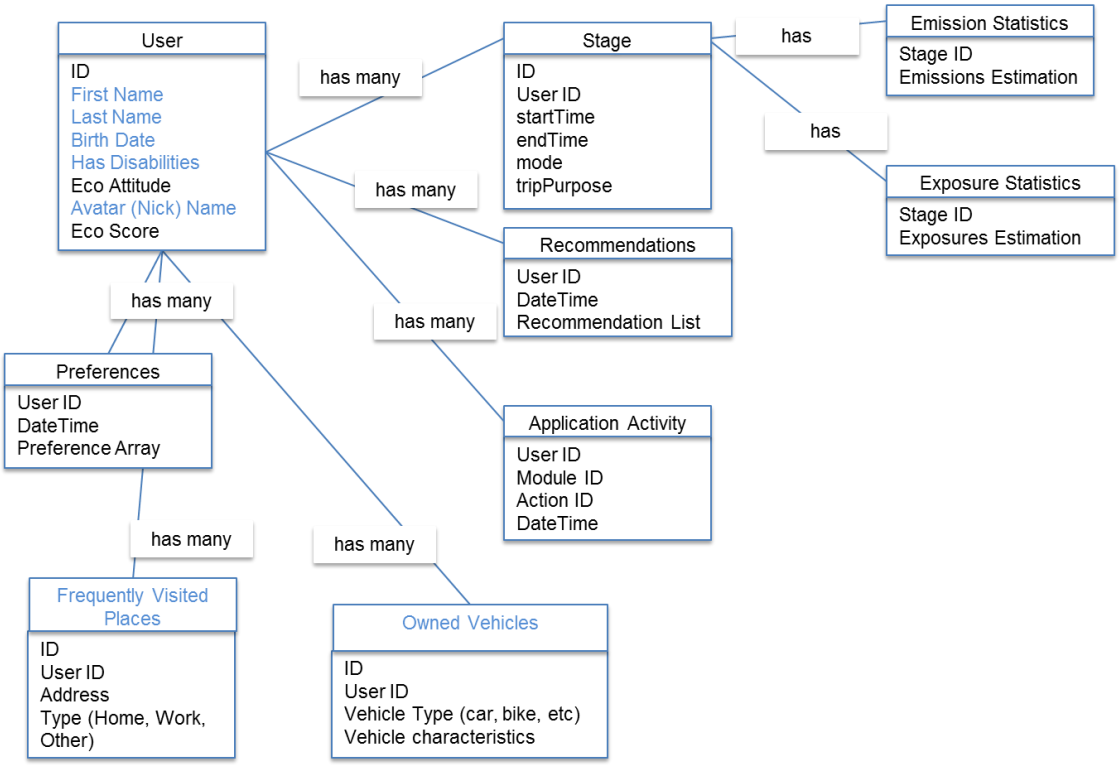


Figure 3.3: PEACOX User Profile data model.

3.1.2.4 Dependencies to other components

This is not relevant for the user profile, as all other components will be communicating with native database drivers to the technologies used for implementing the PEACOX components.

3.1.3 Evaluation - Behaviour model

3.1.3.1 Aim of the component

The aim of this component is to assess the impact that information associated with an individual's trip alternatives has had on his/her trip choice.

3.1.3.2 Technical requirements

The behavioural model will receive input from the user profile. The exact technical format this input has not yet been finalised however it is essential that it is possible to identify the ID of the user, the trip alternatives (and associated information) that they received, and the

mode/route they took. This data will also need to be historical containing information on all trips taken.

3.1.3.3 Input requirements

The behavioural model requires the following inputs from the user profile

- Socio-demographic information about the users such as gender, age, occupation, level of education, family status (with/without children) which can be collected pre-trial. The exact nature of this information will be specified closer to the beginning of the field trial
- The cluster into which the user falls, e.g. reluctant rider etc.
- The choices that the user was presented with for each trip by the application interface (bike/car/public transport etc.) and the information related to these choices i.e. the costs, travel times, route lengths, emissions produced and emissions exposed to for each mode
- The mode(s) that the user took for each trip

3.1.3.4 Dependencies to other components

As the construction and evaluation of the behavioural model occurs post-trial, there exists no real-time dependency with any other component. The behavioural model will access all historic information stored within the user profile.

3.1.4 Emission model

3.1.4.1 Aim of the component

The aim of the project component under TCD is also to build an emission model. Two distinct pieces of models are required to meet the tasks for emission modelling in the project. The first model will give a prediction about the emission for the routes recommended by the other partner. The second model will give real time emission taking account of vehicle trajectories from the Global Positioning System (GPS) data. Thus, the aim can be sub-divided into following two objectives:

To i) predict the CO_2 emissions associated with travelling a given route by a given mode or series of modes in future, and ii) to estimate the CO_2 emissions associated with travelling a given route by a given mode or series of modes in real time.

The most convenient way has been considered to build these models in terms of adaptability of the partners' data, simplicity of analysis and suitability of the model in context. Here, context refers to the mobile application as well as trip-by-trip scenario. It has been taken into account that a trip can be a multi-modal trip or in other words, modes can be used for a trip are Car(C), Bus (B), Tram (T) and Walk (W) successively. The modal characteristics like route ID, speed and length for each mode or segment of the trip are important for emission modelling. Thus, both real-time emission and prediction models are dependent upon different sources of data, both external sources (like Real time speed information, temporal data from an inbuilt clock etc.) and inter-partner data (e.g. GPS component, user profile and recommended services/routing engine, etc.).The prediction model will take input for modes (e.g. car, walk, bus, and tram) and corresponding route IDs, length from the recommended routes and use those data against emission factors/equations and other variables in the model for predicting emission. Similarly, for real time emission modelling the other model will take instantaneous trajectories and corresponding modes from GPS information.

3.1.4.2 Technical requirements

The program will be written and delivered on the MATLAB® platform. MATLAB Builder™ JA will be required for the system developer to create Java™ classes from MATLAB® programs to integrate into Java programs, developed by other partners.

For field testing and validation, a portable emissions monitoring system device (PEMS) and mobile GPS device is required. A PEMS device will be required for measuring emission in field tests for validation. Whereas, the GPS device will provide speed and acceleration input for cross checking the data while counting emission by PEMS device.

3.1.4.3 Input requirements

To predict/estimate emission per person according to different modes for a given route during different times of the day, a large set of data is required. The data will be used for

both building assumptions and input factors in the model. The emissions models will require the following data input:

- Route segment IDs according to mode (using the same link IDs as real time traffic data) and segment wise length
- Travel mode per segment for an entire trip
- Real time traffic data (for real time in trip emissions estimation; speed and travel time per segment) from TomTom or, Floating car data as a source for Historic travel time data (Need to be specified)
- User Profile information (Private vehicle type-Euro category, vehicle weight and engine size, fuel technology and catalyst converter, Temperature etc.)
- Temporal Private vehicle occupancy (Data required for assumption)
- Public transport occupancy & vehicle fleet information (Data required for assumption)
- Database of Emission Equations
- Database of Emission rates and fuel per vehicle category (Public transport including electronic vehicle)
- GPS travel time data (for validation purposes only)
- Time and Date as an input for the Model
- Real time Temperature
- Available modes of travel in Vienna
- Traffic information: Peak and off-peak period in Vienna

3.1.4.4 Dependencies to other components

The emissions model will be dependent on:

- The route recommender for route segment IDs and corresponding length of the recommended route(s)
- Travel mode detection component and GPS Data

- Users Profiles (First User Setting: Private vehicle type-Euro category, vehicle weight and engine size, fuel technology and catalyst converter etc. and for each time model application Temperature)
- Input for current temperature
- User Interface (Occupancy of private vehicles used)

Please see the questions and coding in the table 3.1 which should be obtained from user setting. Arrows in the Figure 3.1 and 3.2 show the input values for the models for each time application. The numbers in the bold downward arrow show the access sources for such inputs from the corresponding partner components. The input file format has been shown in the figure 3.3.

What is the Vehicle Emission Standard?

User Will be asked to indicate	Feedback for Emission Modelling
Pre-Euro	100
Euro I	1
Euro II	2
Euro III	3
Euro IV	4
Euro VI	5
Euro VI	6

Please Select Your Vehicle Fuel Technology

User Will be asked to indicate	Feedback for Emission Modelling
Petrol	11
Diesel	12

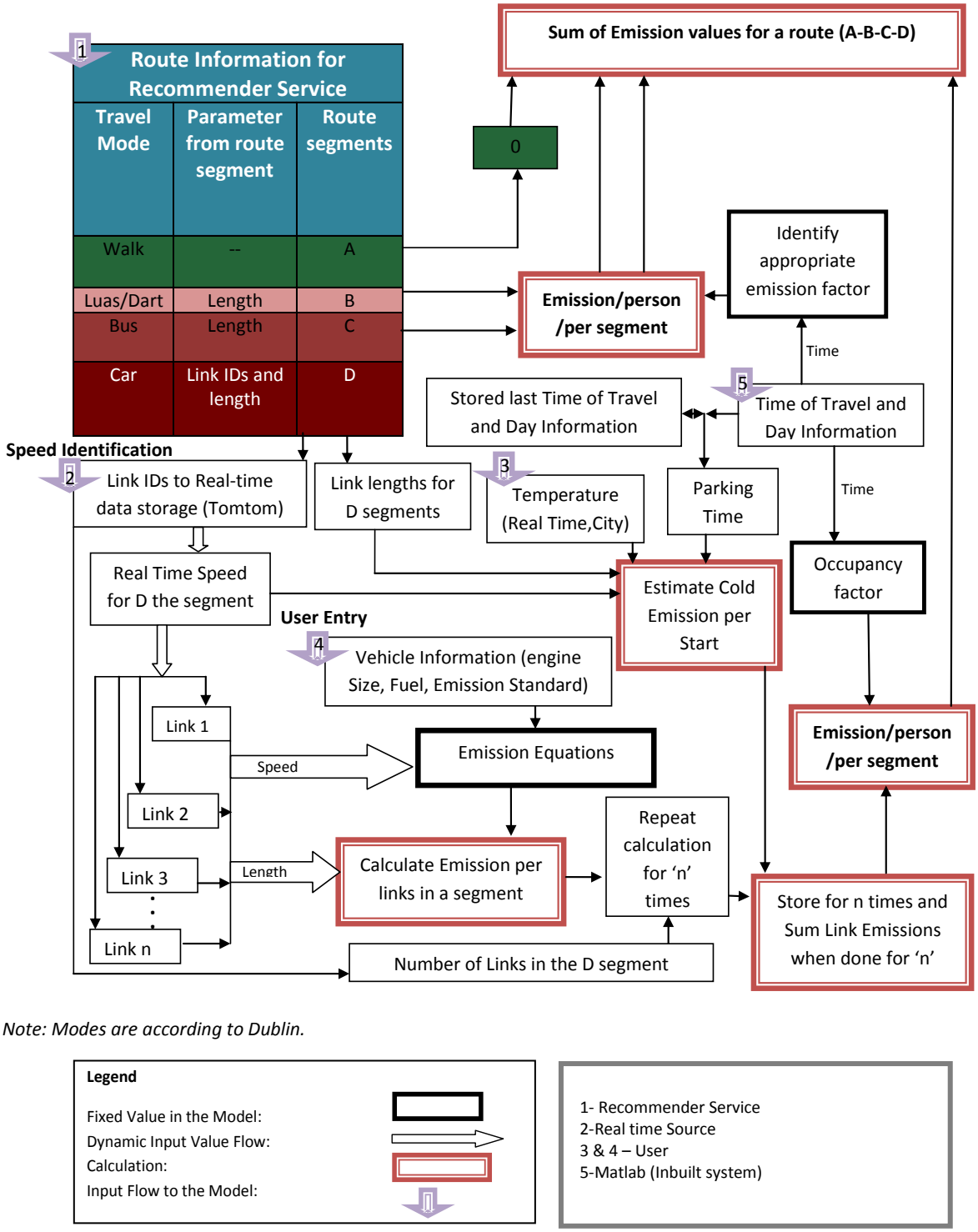
Please Select Vehicle weight and Engine Size

User Will be asked to indicate	Feedback for Emission Modelling
<2.5 tonnes (1400cc)	21
<2.5 tonnes (1400-2000cc)	22
<2.5 tonnes (>2000cc)	23
2.5-3.5tonnes (any)	24

Do You have Catalyst Converter?

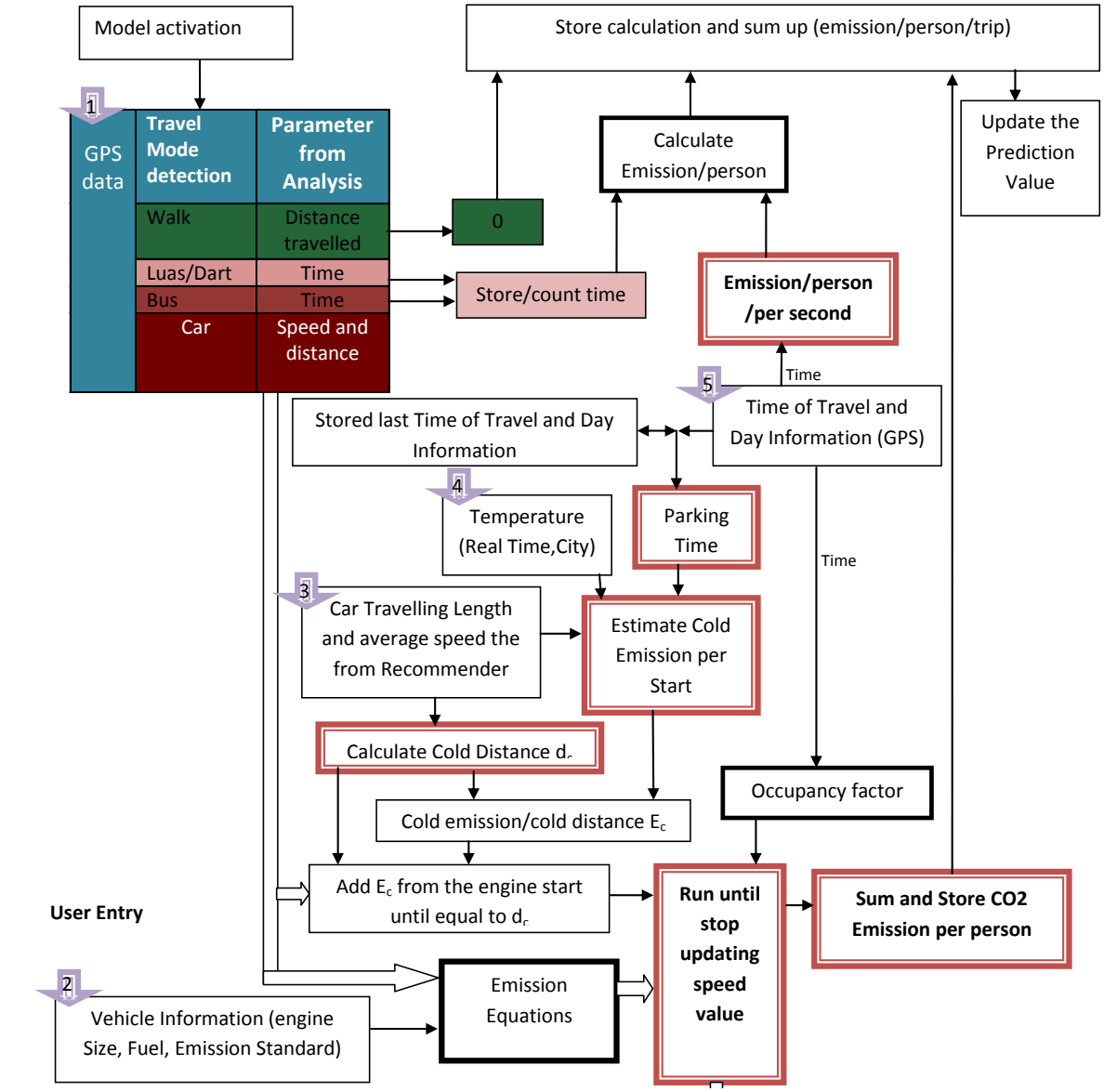
User Will be asked to indicate	Feedback for Emission Modelling
Yes	31
No	32

Table 3.1 Sample Questions for the Users



Note: Modes are according to Dublin.

Figure 3.4: Emission Prediction Model Architecture



Note: Modes are according to Dublin.

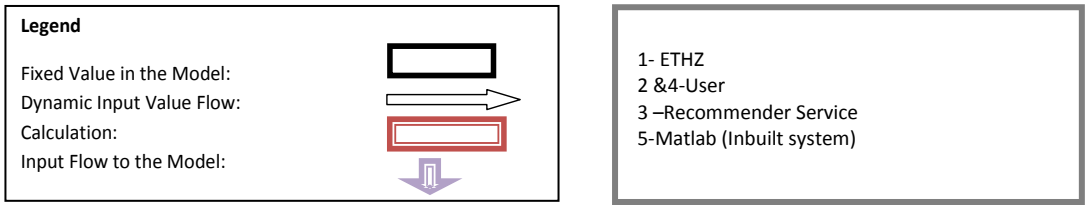


Figure 3.5: Real Time Emission Model Architecture

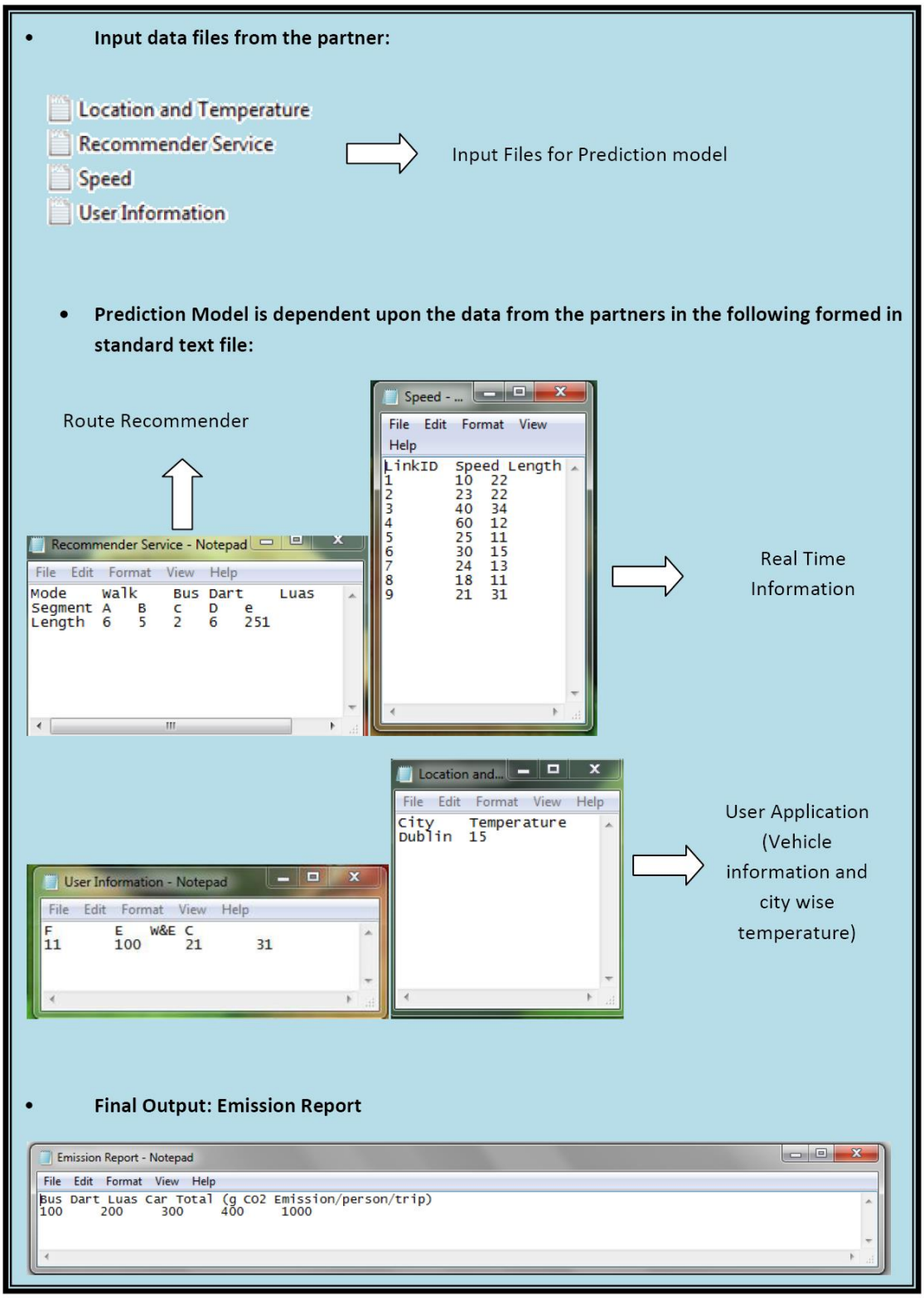


Figure 3.6: Input-Output file format

3.1.5 Exposure model

3.1.5.1 Aim of the component

The aim of the component is to predict the exposure of an individual to air pollution as a result of travelling a given route by a given mode or series of modes. The Exposure model will provide information about exposure to a particular pollutant for the recommended routes which will also be subject to mode use.

To take account of real time exposure analysis for different types of mode user, two different exposure models will be developed in two different levels. For the first level of analysis, it is necessary to estimate the background concentration of the emission for a particular link. A case study in Dublin will be used for the basic model. However, there will be an option to select the city background concentration level to the users to make the model useful to the context. Secondly, direct linear regression for personal exposure analysis will be done. The output for the model will be a rating on a five-point scale.

The inputs to the models are dependent on recommended routes and trip segment, user profile for selecting background concentration, etc. For external sources, the model will be dependent upon real time traffic volume, weather data, etc. Internal database of TCD will be adapted with primary data collection (as per requirement, if needed) for building the personal exposure equations talking Dublin as a case study.

3.1.5.2 Technical requirements

The model will be written and delivered in the MATLAB® platform and thus, also subject to MATLAB Builder™ JA compiler for later integration.

Portable exposure monitoring system device and portable weather monitoring device will be required for the development of exposure regression equations and model validation later.

3.1.5.3 Input requirements

The exposure model will require the following data input:

- Weather forecast (wind speed, wind direction, temperature, precipitation, stability class) - Needed to identify the reliable Source, access to data and system for integration with the developed model
- Background air quality (Historic database of 24hr average background air quality data) –access to data is required
- Traffic volume composition (i.e. emissions rate) per segment (at least city, if not detail data available) - for building assumption
- Real time traffic volume data from Tom-tom or other sources - Needed to identify the source format, ways to access to data and system for integration with the developed model
- Route segments according to mode and IDs

3.1.5.4 Dependencies to other components

The exposure model will be dependent on:

- The route recommender for route segment IDs according to mode for the recommended route(s)
- Travel mode detection component (variations in exposure by mode of transport)
- City selection option in initial setting in User Profile: (to Select Background Concentration for the city)

A preliminary methodology for exposure model has been attached in the figure 3.4.

3.1.6 Travel mode & and trip purpose detection

3.1.6.1 Aim of the component

This component uses the GPS and accelerometer measurements logged by the smart phones to detect when the participant performed a trip and when an activity, with which mode the trip was undertaken, what route or public transport connection was used and what the purpose of the activity was. In the first phase of the project, it does this using only the

current GPS and accelerometer measurements. In the second phase, it will also take into account the person's personal travel history.

For the logging of GPS data a mobile phone client will be developed by Telematix (TMX). This functionality will be later on integrated into the PEACOX client.

3.1.6.2 Technical requirements

The software requirements are:

- The travel mode and trip purpose detection package will be implemented in the Java programming language (Java Development Kit (JDK) 1.6). For the runtime the Virtual Machine (VM) of Java 6 will be required
- Where needed third party open-source JAVA libraries will be used and bundled in an executable jar file
- Data stored in files or in a database (MySQL) can be handled by this package

The hardware requirements are:

- Servers to store the huge amount of collected data.
- The devices running the PEACOX application need
    - GPS sensor
    - accelerometer sensors (3 dimensions)
    - enough memory to log one day of data (~10MB) before sending it to the servers
    - internet connectivity to communicate with servers
    - multitasking ability

Within the testing phase of GPS data it was recognised that the battery life is seemingly important and should be considered within the choice of the testing mobile device. The result of the testing phase was that iPhone battery life was shorter compared with Samsung battery life. Based on this result, the consortium decided to use SAMSUNG devices (Android platform) as testing devices within the first trial. In the later stage of the project, it will be decided if the mobile application should also be available for the iPhone.

3.1.6.3 Input requirements

The following input is required for mode identification and trip purpose detection:

- Live GPS and accelerometer measurements
- Historic GPS and accelerometer measurements and processed trip diaries of a person
- Corrections made by the participant to the processed diary – if provided by the participant, since this will not be mandatory – for the learning routines
- User preferences / profile (e.g. car availability, preferred mode, age)
- High-resolution network information (i.e. navigation networks) for each mode, either in separate networks or in a multi-modal network (network attributes including: node coordinates, node altitudes, link lengths and free-flow speeds per mode)
- Public transport stop and line route information

3.1.6.4 Dependencies to other components

From an input perspective, this component only depends on the GPS and accelerometer logger and some data stored in the user profile. All other connections relate to the output that is required by other components: the recommendation model, the behavioural model, the emmisions model and the exposure model. The different outputs required by these components will be agreed upon during the development process. All outputs will be stored in the user profile so that the other modules can access them from there.

3.1.7 Routing engine

3.1.7.1 Aim of the component

The routing engine is a functional component that is not direct involved within the PEACOX system and is placed outside. However, this component provides important input and functionalities that are relevant for other components. Therefore, the routing engine of the trial city Vienna, which is provided by ITS Vienna Region, will be described in more detail and instantly updated in the case of an interface is changed.

However, the National Transport Authority of the Republic of Ireland (NTA), operator of the national journey planner in Dublin, will provide the routing engine for Dublin. The routing engine in Dublin uses the intermodal journey planner from the company Mentz (EFA) and this product is currently in use in Vienna. Consequently, the description of the Mentz (EFA) routing engine from Vienna could be used as a basis for the description of the Dublin routing

engine. The detailed technological requirement of the routing engine will be specified in the WP6 System Design and Implementation, Task 6.3 System Design.

The routing engine of ITS Vienna Region calculates trips for individual traffic (IT) as well as for public transport (PT) journeys. Technically two routing engines will be used, one for IT and one for PT. The PT routing engine controls the IT routing engine. This behaviour is also applied for the calculation of intermodal journeys.

Generally, the routing engine takes one start point, one destination point and many routing options. Afterwards, the routing engine calculates one or more journeys for each mode of transport and for all predefined intermodal journeys (e.g. Park&Ride, Take bike along, …). The user interface gets all the details of a trip from the routing engine. Additionally, a turn-by-turn instruction is presented to the user.

3.1.7.2 Technical requirements

The software requirements are:

- PT Routing software
- IT Routing software
- IIS or Apache

The hardware requirements are:

- A 64-bit Intel quad core processor

3.1.7.3 Input requirements

The following input is required for the routing engine:

- GIS Network
- Timetable information
- Incident information
- Real Time Information (if necessary)

3.1.7.4 Dependencies to other components

The routing software accepts http:// requests from the user interface and posts the calculated routes via an XLM-format. The Utility Calculation will take these posted journeys and use it to generate recommendations.

3.1.8 PEACOX journey planner client

This component represents the first of the two user interfaces that is directly handled by the PEACOX user.

3.1.8.1 Aim of the component

The journey planner client component should provide necessary functionalities and relevant information so that the user can make ecologically sound travel decisions while on the move.

3.1.8.2 Technical requirements

For the development of the PEACOX journey planner FLU will build on its „brivel“ development framework. The framework will be further developed based on the PEACOX specific needs and requirements. Key focus will be a seamless user experience that integrates various map and routing data with all aspects of the PEACOX solution like environmental impact, personalisation and persuasive strategies.

The PEACOX application will be developed for the Android platform.

3.1.8.3 Dependencies to other components

The PEACOX journey planner needs to connect to all PEACOX system components in order to create the defined user experience.

3.1.9 PEACOX navigation client

This component represents the second of the two user interfaces that is directly handled by the PEACOX user.

3.1.9.1 Aim of the component

This component provides the user with navigation functionality, drawing on all aspects of the PEACOX system like intermodal routing, environmental impact and personalisation. The PEACOX navigation client should support the user for a more ecologically friendly driving and travel behaviour.

3.1.9.2 Technical requirements

TMX will use the navigation system Dynavix and provide interface to PEACOX system to reach turn by turn navigation enriched with PEACOX functionality. The PEACOX navigation

client will have maps stored on the smartphone. In respect to that, several technical requirements need to be addressed:

1. geo-referencing: matching map data on the routing server with the client off-line maps
2. public transport navigation: allowing navigation covering individual transport as well as public transport
3. data exchange between the PEACOX server system and the navigation tool

The PEACOX application will be developed for the Android platform and additional implementation platforms will be evaluated.

3.1.9.3 Dependencies to other components

There is link to all modules of PEACOX system.

3.2 Requirements for the specification of the system architecture

The previous chapter made clear that many different project parts as well as the different functional components are closely linked with each other. Therefore, it is of crucial importance to create a common platform where all project partners can share data with each other and where the interfaces between content and user service are standardized. This would require that a server middleware should exist between the PEACOX mobile application and the different server components.

Concept requirements for the PEACOX system can be derived as follows:

- Coordinated and parallel development without dependencies
- Consistent integrated service
- Maximum flexibility
- Simple integration in the overall system

Service interface requirements for the PEACOX system are:

- Coherent data communication between content and end user application
- Flexible integration of additional content elements
- Maximum flexibility
- Simple integration in the overall system

4. Summary and outlook

The deliverable documents the work performed in Task 2.4 “Stakeholder Requirements” and Task 2.5 “Technological Requirements”, representing a part of the PEACOX WP2 “Requirements for Eco-Travel Information Systems”.

The main objective of the Task 2.4 was the analysis of the (potential) stakeholder as well as their aspirations and expectations towards the PEACOX application. Therefore, the following tasks have been performed:

- Assessment of the PEACOX value network, involved stakeholders and their roles
- Assessment of stakeholder aspirations

In order to derive a valid picture of the PEACOX value network, typical roles of the involved stakeholders, their needs and expectations have been analysed mainly by means of literature research, partner meetings as well as the collection of questionnaires.

Stakeholders relevant for the provision of the PEACOX application are Local Authority and Association, Linked Transport System, Data / Content Provider, Service Provider and Application Provider. The stakeholders and their roles are described in more detail in the Chapter 2.1 Stakeholder Groups and Roles.

Additionally, a questionnaire-based survey was carried out with the purpose of identifying stakeholder requirements in respect to the PEACOX application. In the first part of the questionnaire the current problems and challenges faced by potential stakeholder were identified. The stakeholder stated that barriers exist in respect to integration of CO_2 information into their travel information services. The most important barriers were the lack of user data (e.g. the type of car that is used) and the non-standardised formats of available environmental data. Secondly, the incompleteness of available environmental data as well as lack of environmental data represents an additional major barrier. In the second part, the needs and expectations of the projects’ stakeholders when it comes to the most important features, services and contents of the PEACOX application were identified.

In respect to relevant static content, the participants stated road information and public transport information as most important. Furthermore, parking information and event / POI (Point of Interest) information are also identified as important, whereas trip history and weather information are stated as least important and were identified as “nice to have“

features. Additionally, most important dynamic services and contents are identified based on the online questionnaire. Public transport journey planning/routing and road journey planning were considered as very important followed by multi modal planning/routing and road journey routing. Participants stated additionally that public transport information is very important. Event/POI information, parking information, weather information and walking planning were considered as important. Furthermore, the participants were asked which additional contents and services they consider as important. In this context walking information was considered as a very important feature for the participants, followed by service personalisation. The possibility of providing individual trip alternatives and related ecological costs to the user was seen as important whereas providing the individual ecological footprint to the user was identified as a “nice to have” feature.

Within the Task 2.5 the technological requirements for the PEACOX application are identified. The purpose of the task is to create a consolidated set of technological requirements for the overall project and therefore establish the basis for the development of the PEACOX application. By setting a common set of technical requirements, documenting the specific requirements for different functional components and assigning the responsibilities for each partner, this deliverable lays the foundation for the coordination of the architectural work, which is seen as an enabler for coherent and mutually consistent solutions to be proposed.

The functional components and the responsibilities for every component were identified as follows: Recommendation service (ICCS), User profile (ICCS), Evaluation – Behaviour model (TCD), Emission model (TCD), Exposure model (TCD), Travel and trip mode detection (ETHZ), Routing engine (ITS Vienna Region), Mobile applications (FLU, TMX).

The technological requirements of the individual functional components are described in detail in the corresponding subchapter of the chapter 3.1 Functional components and their requirements.

The identified stakeholder requirements for the PEACOX application and the technological requirements coming from the project partner will be used and further adapted in the system specification phase, principally within the WP6 – System Design and Implementation. Especially the technological requirements will be used for the finalisation of the Use Cases (Task 6.1 Use Case Specification) where the technological requirements will be mapped with the PEACOX use cases.

5. List of figures

6. List of tables

Annex A – Stakeholder questionnaire I

Situation, shortcoming and challenges faced today

1. What kind of information and services in the context of travel planning or navigation do you offer today? *

- ☐ Journey planner for public transport (web)
- ☐ Journey planner for public transport (app)
- ☐ Multimodal journey planner (web)
- ☐ Multimodal journey planner (app)
- ☐ Multimodal navigation tool (web)
- ☐ Multimodal navigation tool (app)
- ☐ Navigation tool for cars
- ☐ Mobility journal/log book
- ☐ Other:

2. Which of these strategies do you currently use to reduce emissions? *

- ☐ Campaigns in press and other media to raise awareness
- ☐ Expansion of the PT network or bicycle lines in order to make sustainable modes of transport more attractive
- ☐ Provision of environmental information in web or mobile services
- ☐ Statistic about users driving behaviour and saved emissions (day, week, month)
- ☐ Other:

3. Do you combine your travel information services with CO2 emissions information in order to raise awareness? *

- ☐ Yes, during the planning of a trip (pre-tip)
- ☐ Yes, during travelling (on-trip)
- ☐ Yes, after travelling within a logbook
- ☐ No (continue with question 7)

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Annex B – Stakeholder questionnaire II

Service / Interaction Design

Challenges / Risks:

Example: Acceptance

_____
_____

Expectations:
Example: Acceptance, Usability

_____
_____

Organisational/Legal

Challenges/Risks:
Example: Branding/Profiling (tracking)

_____
_____

Expectations:
Example: Branding (wide label solution) / Profiling (tracking) data protection)

_____
_____

Environmental Impacts

Challenges/Risks:
Example: Reduction of environmental impacts

_____
_____

Expectations:
Example: Reduction of environmental impacts

_____
_____

Economic / Commercial

Q: How could the business model look like?

_____
_____

Please select the contents and services that you consider most relevant for a personalized multi-modal navigation tool *

	must have	nice to have	not necessary
Static road information	○	○	○
Static public transport information	○	○	○
Static parking information	○	○	○
Static event and POI information	○	○	○
Static trip history information	○	○	○
Static weather information	○	○	○
Walking information	○	○	○
Dynamic public transport information	○	○	○
Dynamic parking information	○	○	○
Dynamic event and POI information	○	○	○
Dynamic location information	○	○	○
Dynamic weather information	○	○	○
Dynamic road journey planning	○	○	○
Dynamic public transport journey planning	○	○	○
Dynamic multi modal journey planning	○	○	○
Dynamic walking planning	○	○	○
Dynamic cycling planning	○	○	○
Dynamic road journey routing	○	○	○
Dynamic public transport trip routing	○	○	○
Dynamic multi modal journey routing	○	○	○
Dynamic walking routing	○	○	○
Dynamic cycling routing	○	○	○
Service personalisation	○	○	○

13. Please select the content and service quality indicators that you consider most relevant for personalized multi modal navigation tool *

- [ ] Data completeness
- [ ] Dynamic data updated and time accuracy
- [ ] Data geo-reference quality (coordinate precision, map matching quality, etc.)
- [ ] Failure / error handling and reporting
- [ ] Handling of time-outs and provision of respective information to stakeholders
- [ ] Provision of usage-related and error statistics
- [ ] Other: