

Holistic information + Smartphone = more sustainable travel practices? The MyWay approach.

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1. INTRODUCTION

The MyWay European Smart Mobility Resource Manager (MyWay) is being developed by a consortium of 14 partners across seven EU countries. The project is supported through the EU FP7 Smart Cities programme. The MyWay approach is to develop a meta-journey planner that aims to enable a better balance between public and private modes; stimulate service cooperation and market development; enhance personalisation and user adaptation of mobility services; and foster transformative technologies in smart mobility. The vision is that this approach will enable MyWay to contribute to reducing the issues of congestion, local air quality issues, and GHG emissions from transport by two means: firstly, by assisting road journeys to be more efficient; and secondly by encouraging users to take up sustainable travel options by making it easier to do so. Thus it is conceived as working on both the supply and demand side.

In support of the supply-side objectives, the MyWay platform will integrate existing journey planners using a meta-planner approach alongside facilitating low-cost entry to journey planning and e-booking for innovative mobility providers, presenting a seamless picture for users (the demand side). A user-focused vision based on personalisation sits alongside the vision of service integration. Personalisation is seen as key to enabling individual users to consider a wider range of transport options capable of satisfying their preferences. As part of this users will be able to opt-in to support mechanisms for voluntary travel behaviour change. MyWay will ultimately provide users with easy-to-access opportunities to feedback their views on transport services quality to stakeholders (such as transport authorities, city authorities and service operators). This new data stream direct from users, along with aggregated trip-logs, will provide new transport analysis opportunities to stakeholders, addressing the final objective of supporting smart mobility.

The long term vision for MyWay is that users will get personalised mobility recommendations based on preferences and user habits; real-time disruption notifications and solutions; personalised feedback on emissions, cost or calories (for example); single-point access to schedules, prices and booking services for all available modes; and ability to use their MyWay profile wherever MyWay is adopted across Europe. Authorities/operators will get improved data for fine-tuning operations and improving service quality, and insights for network development. During the 30-month project, the prototype is being tested 'in the wild' with real users in Catalonia (Spain), Berlin (Germany) and Trikala (Greece) – our 'Living Labs'. In this paper, we report findings from the pilot (Pre-Phase), describe the current Phase One trial and outline future work for the MyWay prototype.

2. BACKGROUND

Mobility is a key aspect of daily life for nearly all citizens, who must find daily solutions for reaching offices, schools, shops, healthcare or leisure destinations. Over the last half century, private cars have become the preferred transport mode for an increasing number of people (Dupuy, 2011). This effective dependence on private vehicles has contributed to a number of significant problems, particularly for urban environments (Garling and Steg, 2007). Recently, there has been considerable innovation that has resulted in an increasing availability of choice in the transport domain, particularly emphasising more sustainable mobility modes, such as vehicle sharing, ride-sharing or demand-responsive transport. Low carbon mobility solutions, such as electric vehicles (EVs) and hydrogen powered buses, are also emerging (Lanzendorf, 2014; Lanzendorf & Schönduwe, 2013). To that end, individual mobility behaviours should be supported to switch to a greener and more efficient way of moving. In this context, the MyWay project seeks to fill the gaps and provide end-users with a 'one-stop shop' to find all the mobility offers, tailored to her/his preferences and requirements.

During the project lifetime, a technology platform is being designed, developed, validated and evaluated. The main aim of this platform is to incentivize sustainable mobility by providing travellers with integrated personalized solutions that will take into account all the possible transport modes available in a region (public, private and collective ones). The platform will also consider the changing context which may affect a user's mobility (e.g. traffic conditions, service disruptions, weather events) and will provide alerts and possible alternatives to the original plan.

These progressive concepts in journey planning are being tested in three different Living Labs: Catalonia/Barcelona (Spain), Berlin (Germany) and Trikala (Greece) (see **Figure 1** below). The contrasts between these three cities/regions in terms of mobility offers, covered area and number of citizens enables the capabilities of the platform to be tested in very different conditions. Catalonia-Barcelona (population 7.75 million) demonstrates urban and regional mobility with highly personalised multi-modal travel services: bus/metro/train, bike sharing, EV scooter sharing (MOTIT), and flexible on demand services. Berlin (population 3.5 million) demonstrates mobility across a metropolitan area with intermodal travel services, a high-level availability of ITS services, intermodal info services (bus/metro/train), ride-sharing, and bike sharing. Trikala (population c. 76,000), is a mid-size town with a tourism industry, a network of healthcare centres for the elderly and a substantial university presence. It demonstrates regional seasonal peak mobility, provision of elderly services, student mobility, regular PT, private mobility, and spontaneous social mobility (car-pooling).

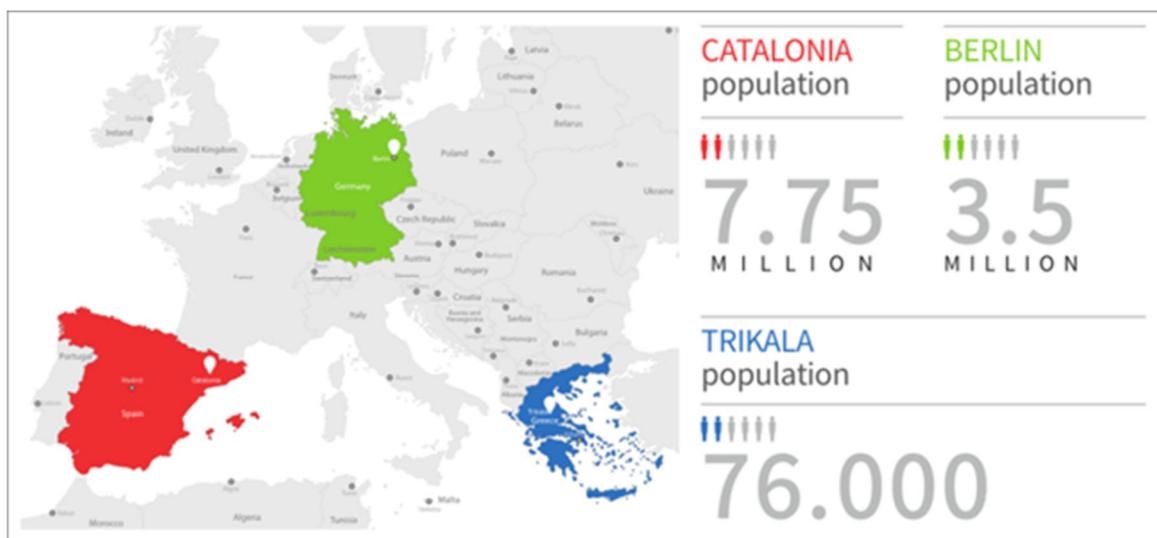


Figure 1 Map showing the locations and sizes of the MyWay project Living Labs

3. TECHNOLOGICAL APPROACH

The realization of the MyWay platform is making significant technical advances in several areas.

- *Expressive representation framework for flexible mobility services.* MyWay has developed data models and specifications that provide abstractions for representing properties and attributes specific to flexible transport services, including area and interval of operation, availability, pricing and reservation policies. A key challenge in designing the data model lies in balancing the expressivity of the model and the computational complexity of various query and filtering operations required in the service discovery and matchmaking process. The proposed data model reuses abstractions from existing specifications, both in the transport domain (NeTeX, GTFS, DATEX) and in the area of service-oriented computing; this facilitates interoperability and increases future potential for turning proposed languages into accepted standards.
- *Mobility resource discovery and allocation algorithms.* The MyWay platform requires efficient algorithms and protocols for matching mobility service requests to available mobility resources. Therefore, MyWay is developing resource allocation algorithms in the context of personal mobility that support a wide spectrum of allocation strategies with different levels of automation and centralization.

- *APIs and protocols for integrating resource allocation into journey planning.* In addition to acting as a mobility resource hub for end-users of mobility services, MyWay also provides resource management capabilities to existing multi-modal journey planners. MyWay is developing APIs and protocols to allow highly granular interactions between journey planners and the resource management platform. This enables the journey planner search to efficiently consider resource availability during the journey plan search process. The APIs and protocols are designed to support different levels of integration and to support gradual transition from standard, resource-unaware journey planning, to fully resource aware planning.

In order to achieve these technological objectives, the conceptual design of MyWay has followed some main principles:

- Open design of the system, flexible enough to integrate MyWay with other services and systems. This includes a MyWay Open API to interconnect all the main parts of the system representing its core (back-end part) with the MyWay front-end (web application and mobile applications), and with 3rd party systems.
- Scalable application with flexible deployment model, respecting the needs of individual Living Labs but allowing for possible further dissemination of the system.
- Loose-coupling of components allowing further extensions, adaptation and maintenance of the system.
- Meta-planner concept: MyWay acts as a meta-planner which integrates and combines the detailed routes from sub-planners to calculate trip plans that cannot be calculated by specialized sub-planners alone.
- Collaborative design: all the parts of the conceptual design are a consensus of all parties involved based on the discussion and feedback provided.
- Compliance with existing standards in the domains of software engineering, intelligent transport systems and relevant EU standards.

By employing these principles, our aim is to implement a solution which will be open, flexible and reusable. **Figure 2** below shows the high-level architecture/meta-planner concept.

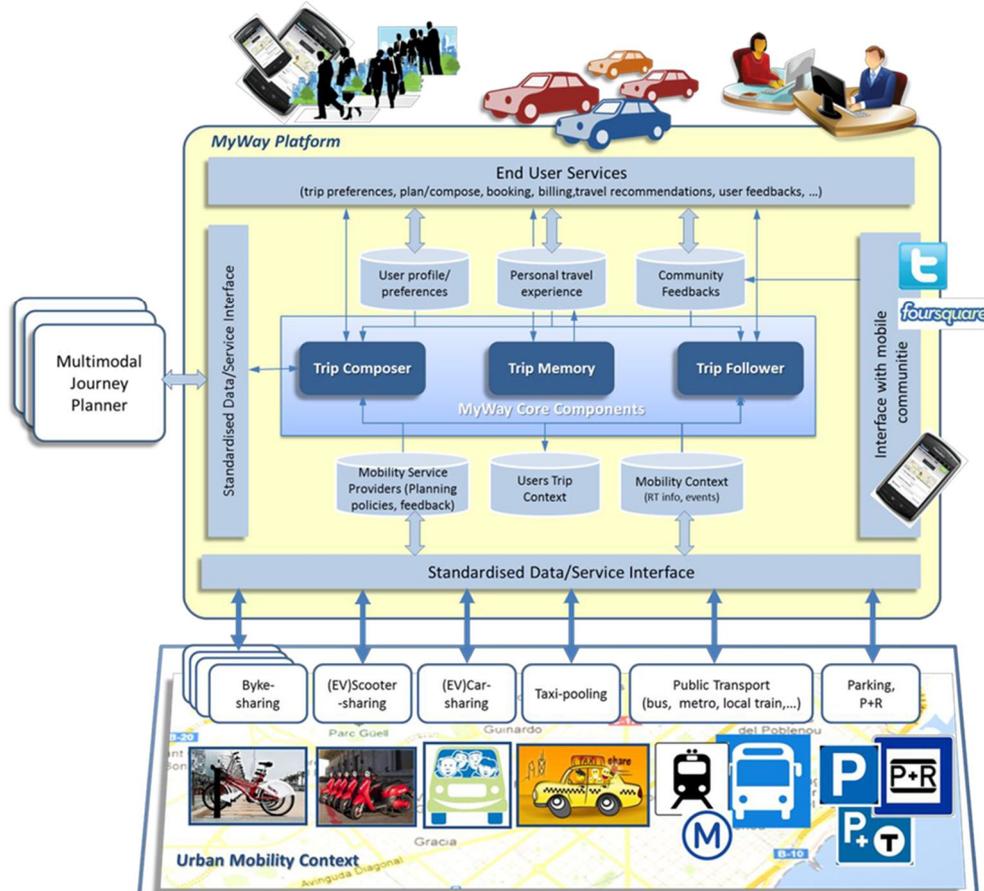


Figure 2 MyWay High Level Functional Architecture

4. METHODOLOGY

The centrepiece of the project is the MyWay app, the technical details of which are described in the previous section. In order to validate the approach and evaluate MyWay's effectiveness, a number of different techniques are being used. The Living Lab methodology for live testing and evaluation is the primary approach which all activities are designed to support (see Background section above and **Figure 1** above).

4.1 Living Labs

The three cases are particularly complementary, allowing the evaluation in contrasting circumstances. Each Living Lab is subject to three phases of evaluation according to the development stage of MyWay. These phases consist of:

- A **Pre-Phase** which acts as a pilot with a very restricted number of real users, sufficient to guarantee a core of participants who will continue through the next phases. During this phase an initial beta version of the application will be used in real conditions. Pilot and real users' feedback on usability, functionality and execution errors is collected. This information will be fed back to the development team, so as to improve and develop the first version of MyWay application for the next phase.
- **Phase One** has more functionality than the Pre-phase and extends the number of real users. In this phase, MyWay will be available in its first stable version and it is the first phase oriented for the evaluation the MyWay objectives across the Key Performance Indicators selected. As in the Pre-Phase, pilot and real user feedback will be collected in order to improve the application on its second version.
- **Phase Two.** Building on Phase One, this continues with pilot users but extends the number of real users still further. In this phase the MyWay second version will have its full functionalities for evaluation. As in Phase One, the evaluation process will have two objectives:
 - To evaluate the MyWay objectives, at that point this can be considered as the evaluation of the project objectives; and
 - To detect further issues or considerations, so as to improve the application in its final version. It is expected that needs for changes in this phase should be minor.

There are two types of user:

- **Pilot users** are people connected to the project. They perform specific functionalities that need to be tested in the app in order to rapidly detect problems that could critically impact on functioning and usability. They also use MyWay in real conditions. These users report issues to the Living Lab Manager who sends them to the developer or evaluation teams as they are received. They will not be asked to give opinions or rate issues relevant to acceptance of MyWay.
- **Real users** have general information about the project but they are not directly connected to the project, and are testing the system in real conditions. In the Pre-Phase trial the main purpose for having this group of participants is to provide their perceptions of usability, appearance and reliability of the journey plan results.

4.2 User Focus Groups

Initially, focus groups with target user groups were applied in the early stages of the project to test the vision and user requirements by using 14 scenarios illustrating how MyWay could be used. The scenarios were developed collaboratively by the project partners. Using focus groups to discuss system usage scenarios is a standard method for reviewing (validating) proposed functionalities in human-machine interface (HMI) research and software development (Krueger and Casey, 2009). This is typically used early in system development to gather user requirements. We applied this approach in each Living Lab, presenting participants with locally relevant scenarios (i.e. customized to reflect local personal names, places and transport services).

The findings contributed to the development of MyWay's functional and non-functional requirements. Sample selection within each focus group was based on target group membership (students,

commuters, and retired over 60s) and is a convenience sample. Recruitment utilised advertisements on websites and email circulation. More than 140 participants took part in 16 focus groups across the three Living Labs. Selected results are described in Section 5.1 below.

4.3 User Evaluation

From the Pre-Phase onward, user feedback on the MyWay app is being collected in order to assess user perceptions of its effect on their travel behaviour and to evaluate the objective impact on user behaviour using log data. As the Living Labs are conducting live trials, the user evaluation activities within MyWay are in a naturalistic setting, meaning that the majority of involved users will be given the MyWay application to use as they wish in their daily travel (i.e. without specific instructions on using it in certain conditions). The evaluation is designed so that we achieve, as far as possible, comparable quantitative data from users' mobility behaviour while using MyWay and from a baseline condition.

There will be some small-scale user evaluation using scripted journeys based on a sub-set of the scenarios. This will enable some controlled use of MyWay as a comparator with the use of MyWay in 'the wild'. The subjective perceptions of MyWay users will be collected through the use of survey instruments, in a baseline questionnaire (level of expectations of MyWay and current travel), during the trial and at the end of the trial period. This is done so as to be able to assess the potential impact from a wide introduction of MyWay in the market. Structured stakeholder interviews are also being undertaken, to gather qualitative feedback on stakeholder requirements and their perceptions of the utility of MyWay in relation to their objectives.

4.4 Evaluating Usability

Evaluating usability is an important aspect of technology development. This is an HMI issue. Formal usability testing, which replicates the conditions in which real users might use software, does not form a part of the MyWay project. Formal usability testing of mobile applications poses a number of practical difficulties, including the context in which the mobile app is being used, connectivity issues, small screen size, different display resolutions, limitations of processing capability and power, and restrictive data entry methods (Zhang and Adipat, 2005). Complex interactions between these factors are a particular issue. The Living Lab trial methodology provides *de facto* usability tests, and the user evaluation surveys deployed in the trials incorporate questions about usability (see above). However, we are also making use of Expert Usability Evaluation (EUE) at key design stages. There are three EUE, one associated with the Pre-Phase pilot version, one with Phase One trial, and a second one prior to the start of the final, Phase Two trial.

The EUE process provides project partners and Advisory Board members with an opportunity to provide structured high-level feedback on their professional impressions of interface usability to the partners responsible for the design and development of the MyWay app (iOS and Android). The expert evaluators are not closely involved in building the interface, but have relevant expertise. Project partners and Advisory Board members are deemed to be 'experts' in the sense that they have knowledge of the project objectives and skillsets which are relevant to the development of a journey-planning app (for example, IT skills, HMI skills or detailed knowledge of the transport domain).

The EUE follows the Heuristic Evaluation usability inspection method (Nielsen 1994), which structures feedback on potential user interface usability problems in ways that are useful for developers. The method requires evaluators to examine the interface and make judgements about how far it complies with commonly recognised usability principles (known as 'heuristics'). The responses of multiple evaluators are then combined to produce a list of usability issues. For MyWay, a template for evaluators has been produced, based on the ten heuristics developed by Nielsen with an eleventh added on privacy (see **Table 1** below).

Table 1 Expert Usability Evaluation Heuristics (based on Nielsen, 1994)

1.	Visibility of System Status	6.	Recognition rather than recall
2.	Match between system and the real world	7.	Flexibility and efficiency of use
3.	User control and freedom	8.	Aesthetic, minimalist and safe design
4.	Consistency and standards	9.	Help users recognise, diagnose and recover from errors
5.	Error prevention	10.	Help and documentation
		11.	Privacy

5. RESULTS

5.1 Findings from User Focus Groups

The focus group data is discussed in full in Masthoff and Pangbourne (2014), but we report selected details here. On the whole, the scenarios were seen as realistic and engaging, though the most receptive target group is office workers, as the primary features of MyWay are most salient to their mobility needs (for example, on-trip re-planning of journeys affected by disruption). In line with other travel information research, participants tend to have quite a limited awareness of transport services available to them, particularly innovative modes (Kenyon and Lyons, 2003). This suggests that MyWay can act as a useful promotional tool, as Kenyon and Lyons identified that better information about alternative modes is highly likely to help individuals consider alternatives to habitual choices (though whilst necessary it is not sufficient to ensure change). For our focus group participants support for information and booking of parking was particularly important. Across all focus groups, it was clear that multi-modal journeys require more sophisticated support because of stress points: finding a parking place at an interchange; reducing waiting times; providing 'real time' waiting times; and having reliable information during disruption.

Other popular features include:

- Map-based interfaces;
- Weather information;
- Integration of wider variety of modes;
- Cost/prices and ability to book (though trust in paying via Smartphone split participants); and
- Points of Interest functionality was valued by some participants.

As we obtained demographic and attitudinal information from our focus group participants we were able to add depth to the analysis of focus group results. The attitudinal data about travel was collected using a segmentation approach (Anable, 2013, Anable and Wright, 2013) (see **Figure 3**). This allowed us to assess the balance of attitudes held by participants within and between focus groups (i.e. whether a focus group was dominated by Car Aspirers and Devoted Drivers or had higher numbers of Active Aspirers or PT Dependents, for example).

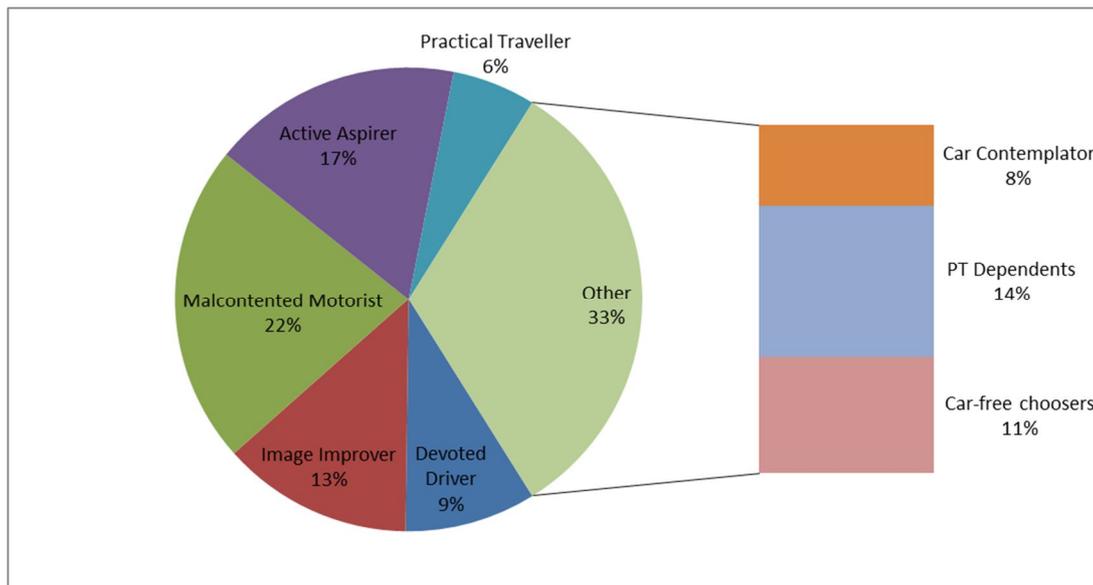


Figure 3 Attitude Segments of Focus Group Participants (%)

On the technology side, we found that variability in attitude towards technology, trust and privacy was slightly related to age group, affecting views on MyWay functionalities showcased in the scenarios and the likelihood of adoption by different groups. Older age groups were *generally* less receptive to new technology and more concerned about trust and privacy. In relation to differences between the Living Labs, we found that internet access and smartphone ownership was very low in the Trikala sample and below the EU average in the Catalonia-Barcelona sample. In Catalonia-Barcelona we noticed that older people were less likely to want to pay via smartphone, and the youngest age group (mostly students) was more open to ride-sharing.

5.2 Pilot: The Pre-phase Trial

The Pre-Phase Living Lab has been completed in the three sites in order to prepare and test the platform and procedures from the Living Labs before commencing the official Phase One and Phase Two trials as described above. As a result of the Pre-Phase, we have been able to successfully:

- release an early version of the MyWay platform for testing with the Living Lab participants;
- verify that the planned procedures for the local systems setup are good enough to prepare a first deployment for all the necessary components in each Living Labs;
- prepare and validate the procedures for the participant recruitment strategy and the registration process to be executed in the next phases; and
- receive feedback from users, stakeholders and Living Lab Managers. Analysis of the feedback has been used to iteratively improve the platform and procedures for the next phases.

To achieve these objectives, the Pre-Phase trial operated with a reduced number of MyWay functionalities and was tested by a limited and controlled number of both pilot and real users (as described in the methodology section above). There were 36 pilot users and 13 real users.

6. NEXT STEPS

The Phase One trial runs from early March to end April 2015, and had just commenced at the time of writing. It takes advantage of the experience and outputs obtained in the Pre-Phase in order to improve the procedures for recruiting, registration and participant follow-up. Additionally, further issues detected by the experts during the previous execution as well as the user feedback collected contributed to the release of a more stable version of the platform. The user evaluation commences from the Phase One as the set of functionalities is larger than that released for the Pre-Phase.

6.1 Functions Included in Phase One

For the trials both Android and iOS versions have been released in order to offer users the functionalities implemented in the MyWay back-end and provided with the Open API interface. The apps have been developed taking care about the graphical design and usability in order to increase user acceptance. In Phase One the apps provide capabilities of City information, Journey Planning, User profiling, Trip Follower, Context Awareness and Feedback. A complete list of functionalities for these categories is detailed in **Table 2** below:

Table 2 List of functionalities included in MyWay Phase One Trial

<i>City Information</i>
<ul style="list-style-type: none"> • Explore the city/region map showing different city information such as points of interest, public transport stops, parking and bicycle sharing areas. • Search for an address with the autocomplete control.
<i>Journey planning</i>
<ul style="list-style-type: none"> • Select an address as origin or destination using either autocomplete control or clicking on the map. • Quick journey planning for immediate trips (setting only origin and destination). • Custom journey planning that in addition to defining the origin and destination, allows: <ul style="list-style-type: none"> ○ Selecting a departure time; ○ Viewing recommended routes classified by the: fastest, most ecological and most comfortable; and ○ Viewing the full list of calculated routes. • Explore the selected plans graphically with the itinerary, journey segments and modes presented the map. • Detailed information for the steps of the selected route showing: departure time, distance, time, travel mode, origin and destination.
<i>User profiling</i>
<ul style="list-style-type: none"> • User registration, login and user profile. • Custom journey plans taking into account trip history and previous choices.
<i>Trip Follower</i>
<ul style="list-style-type: none"> • The user can indicate when to start and stop his/her trips being monitoring by the system in order to improve personalized results.
<i>Context Awareness</i>
<ul style="list-style-type: none"> • Real time information about traffic and weather (not at all Living Labs).
<i>User Feedback</i>
<ul style="list-style-type: none"> • Users can report problems or issues, send feedback about MyWay and about the trip plans.

6.2 Phase Two Trials

The final stages of the project focus on developing the prototype for the Phase Two trials. This new version will be more ambitious regarding the number and complexity of the functionalities and will have new capabilities for booking, integrate new flexible mobility services and provide real-time information for mobility services will be included. Some existing characteristics in Phase One will have their functionality extended or improved. For example, the Trip Follower will push messages to users about service disruptions or changing context conditions. It is also intended to include some functionality to support voluntary behaviour change.

The new prototype will be tested again in the three Living Labs taking into account the previous experiences of the Pre-Phase and Phase One. As the final trial within the project lifetime, the Phase Two Living Labs are also more ambitious in terms of the number of users (c. 200-600) and types of mobility services included (subject to data availability).

7. IMPACT

Smart mobility is a concept that is increasingly promoted as a critical pillar in achieving the Smart City paradigm. A city can be defined as 'smart' when social capital, traditional (transport) and modern (ICT) communication infrastructure work together to fuel sustainable economic development and a high quality of life (Caragliu et al. 2009). Smart mobility can be defined as a blend of tools and policies which work together to manage mobility by facilitating the inclusion of aspects which have traditionally been on the periphery of transport management: enabling seamless travel by integrating different modes, controlling and lowering emissions, improving accessibility and managing parking, alongside the traditional transport concerns of operations, infrastructure and congestion management.

The development of sophisticated ICT has been the critical factor that has enabled city and transport authorities and operators to analyse, plan, monitor and manage transport and transport related actions, as well as to implement more nuanced policies. As a smart application the MyWay journey planner is aimed at consumers of mobility services, helping them to negotiate their lives where they intersect with the increasingly intelligent transport-related infrastructures and enabling journeys to be increasingly flexible, utilising a wider range of modes and facilitating multi-modal journeys rather than mono-modal and habituated travel behaviours, without loss of convenience. Our premise is two-fold:

1. providing users with a more integrated overview of the transport means available in any place gives users the tools to evolve their mobility habits to include innovative modes; and
2. showing individuals the best route by criteria which are personally important to them supports sustainable change.

Seamlessness can be supported by MyWay as it reduces user uncertainty at the 'seams' of journeys: the first and last mile (km), interchanges and parking are all elements in journeys which create objective and subjective difficulties for people as highlighted in the focus groups. Reducing uncertainty is directly beneficial to users, but also for public stakeholders, as it is supporting behaviour change towards sustainable mobility.

For public stakeholders, a key benefit of MyWay lies in the data that it generates, as in the past detailed data on travel behaviour has proved difficult to gather. MyWay will also enable user feedback on mobility services to be collected. This same data on actual behaviour and perceptions of service quality will also be of critical utility to both public and private stakeholders responsible for operating mobility services.

The meta-planner approach of MyWay, and its use of personalisation also provides a platform for targeted travel behaviour change campaigns – policies which seek to deliver modal shift or an increase in active travel can be actively promoted through the feedback model, which is being integrated into the Phase Two trial of the project.

These advantages, along with the integration of more modes, both public and private, tradition or innovative in various ways, into a single information point for users, suggest that MyWay, as a smart mobility tool, has the potential for considerable impact where its use is adopted.

CONCLUSIONS

This paper has described the on-going MyWay project to create a holistic mobility manager application, funded under the EU Seventh Framework.

The paper reports on the technological approach, describing the key innovations and the design principles that have been adopted. The methodology combines user research, collaborative design and expert usability evaluation amongst the project partners and a Living Lab approach to field testing. A detailed evaluation methodology has been devised.

The project has successfully completed a pilot test of the basic functionality of MyWay and at the time of writing the Phase One trial in the three Living Labs is underway. The functionalities included in the Phase One trial have been described and the projected functionalities for the final Phase Two trial have been outlined. We have discussed our preliminary assessment of the potential impacts of

MyWay as a significant advance in the field of smart mobility that fills some significant gaps in the provision of holistic information to users and in generating useful data for public stakeholders and transport providers.

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