



**ERA-NET TRANSPORT III Flagship Call 2013 “Future Travelling”**

**Deliverable D 2.2 Seamless travel: Customer requirements**

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Deliverable information

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**WP** WP 2: Evaluation of sociological, legal and technical background  
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## INTRODUCTION

Wearable devices (WD) might be a key for a cheaper, faster and more comfortable travel experience while using public transport. However, due to the limited spread of current WD based mobility solutions throughout Europe the real impact is barely known – some of these early solutions will be analysed in the third work package of Guide2Wear. An impression on their relevance for future travelling can more easily be gained by expert workshops with professional stakeholders active in the field of WD. These workshops were held to collect a comprehensive set of viewpoints from experts from different countries.

Whether the use of WD will really spread depends on the fact if they really address the needs of their potential users. To identify the point of view of groups who are the addressees of these new solutions, focus group discussions were held. They covered a wide variety of topics including current mobility behaviour, attitudes and general preconditions in regards to existing transport systems.

A broad set of potential barriers, expected functions and benefits and future potential could be collected by taking the expertise of professionals in the fields of implementation, technology, planning and policy, as well as the view of potential users of WDs into account.

## 1. Expert workshops

### 1.1 Objective

The Guide2Wear-Delphi-survey aimed at identifying assessments of the current use and potential meaning of Wearable Devices from an overall point of view. They should be supplemented by a series of expert workshops with the aim to gain expertise and feedback from local/national experts detecting the role of wearable devices and their impact on mobility behaviour. Additionally, the expert workshops served as dissemination channel towards national stakeholders.

The following aspects were addressed in the expert workshops:

- **Current problems and weaknesses of wearable devices**  
Wearable devices have certainly the potential to facilitate mobility behaviour. However, current WDs have weak points and cannot fulfil all requirements to the desired extent. The workshop in Berlin started with an analysis of shortcomings of current WDs as a sound foundation for the development of a vision for their future use.
- **General potentials of WDs to solve local/national mobility related problems**  
The main purpose of WDs is to provide information or other services to their users. As a first step in developing ideas for the future use of WDs, the principle opportunities of WDs to influence mobility behaviour were discussed. The collection of ideas should be made without regarding practical barriers such as the availability of certain WD or technical limitations.
- **Initiatives taken and planned in the context of wearable devices**  
Based on the discussion of general potentials, the experts explained the initiatives in the context of wearable devices conducted or planned by their institutions, companies or by other actors in their countries.
- **Expected relevance of specific wearable devices in the medium-term perspective**  
Finally, more visionary ideas for WB-based applications facilitating PT use and intermodal mobility behaviour were discussed by the participants and an assessment of the relevance of WDs in the medium-term future was given.

### 1.2 Methodology and organisational aspects

Expert workshops were held in Austria, Belgium, Germany and Sweden between February and April 2015 using general guidelines developed by the project team. Additionally, there was the opportunity to use specific questions to cover all relevant topics while highlighting the national or local characteristics with regard to wearable devices and the transport system.

The guideline was developed in order to guarantee a shared structure and a unique level of quality of all workshops. The guideline described the procedure, contents of interest and the modus of reporting the results.

Each workshop was led by a moderator representing the responsible national project partner; in case of two project partners from the same country, one researcher each attended. One of the attendants took the minutes. All workshops started with a round of introduction of the participants and a short presentation on the project, its objectives, the method applied and preliminary results. Afterwards, discussions started either guided by questions asked by the moderator or facilitated by presentation tools.

Place (Country)	Date	Number of external participants; Affiliations of participants
Vienna, AT	06.02.2015	12; Private companies (Software provider of mobility information systems), local PT operator, semi-public institutions, federal transport ministry, associations (car users, ÖAMTC, visual impaired).
Berlin, GE	05.03.2015	11; Software provider of information services, PT operators, research institute
Linköping, SE	31.03.2015	11; County and district councils, PT operators, research institute, government body.
Leuven, BE	24.04.2015	5; Provider of intermodal travel, provider of information services, PT operator, government body, research institute

Table 1: Expert Workshop participants

The workshop in **Vienna** addressed the future use of Wearable Devices in the Austrian context. It was separated into presentations and an open discussion. First the project Guide2Wear was introduced to the participants, then presentations were given on the WienMobil-Card – an intermodal mobility card which was introduced in March 2015 and is subject of the analysis of mobility behaviour in the Guide2Wear project – and on the Smile-project which is a prototype of an intermodal navigation app developed by Wiener Linien (local PT operator) and ÖBB (largest national railway undertaking for passenger transport). Discussions followed after the presentations.

Topic of the workshop in **Berlin** was the opportunities provided by Wearable Devices to facilitate public transport. The workshop was separated into two phases. The first one served to highlight problems regarding intermodal mobility and answer the question why current mobile services cannot really solve them. This was also basis for developing a catalogue of demands for new mobility services. The second “visionary” phase aimed at developing ideas for the use of WDs tool for facilitating PT use of specific groups.

The workshop in **Linköping** was conducted in a similar way as the one in Vienna in so far as it started with formal presentations before the main discussion started. The first presentation provided a short description of the project Guide2Wear. This was then followed by the regional bus company presenting what they could offer today and how their information in the mobile device looked like. They also presented what was in the pipeline and the difficulties in keeping up with developments because of procurement and long-term contracts. After that two short film clips were shown produced by a mobile device developer describing what kind of information their app can provide. Discussions followed after the presentations.

The Workshop in **Leuven** tried to answer questions related to the future use of Wearable Devices in a broader sense. It started with a presentation of the project followed by an open discussion on different aspects related to the use of WDs for sustainable mobility.

## 1.3 Results

### *Current problems and weaknesses of wearable devices*

While the other workshops only focused on the expected development of WDs and their future meaning, the workshop in **Berlin** started with an analysis of weak points of current WDs. These can be distinguished in backend- and frontend-related problems. Frontend related problems include:

- Data quality in terms of real-timeliness and accuracy including missing inclusion of valid real-time information (congestions, vehicles being late); accurate data for bicycle navigation including road surface, traffic lights...; accurate navigation to and within transfer stations including

- indoor-navigation or the street side of a bus stop; on-trip guidance; seamless navigation (indoor, outdoor, different transport modes)
- Usability related aspects such as lack of clarity for many transport options; missing integration of many transport options; one-stop-applications integrating different offers from all providers; missing willingness to cooperate of different providers; usability in terms of reliability, registration and booking expenses; comfortable user interfaces; geofencing.
  - Ticketing schemes: no best-price offers available; various different ticketing schemes; specific problems since each car sharing provider will have exclusive contracts with the local PT provider.

Backend related problems refer to:

- Battery power of devices
- Missing or inaccurate GPS network
- Data flat rate preferred but often not available
- Data related aspects including data availability in rural areas, abroad, underground; combination of actual and target data; manipulation of data in case of short-term changes; internal interfaces between different data types.

### *General potential of WDs to solve mobility related problems*

In order to develop an idea how WDs could be used in the future, general potentials of WDs regardless their practical implementation were analysed.

The participants from **Germany** followed that WDs facilitate PT use. This will most likely be the case, if tailor-made offers are provided to specific user groups:

- Occasional PT users and commuters: real-time navigation including disruption management suggesting alternative routes; information could also be provided by other travellers; internet access; gamification such as collecting points in case of PT use
- Tourists and business travellers: gamification; multifunctional devices for tourists with voice control including information on tours, restaurants, events...; sightseeing-tips; augmented reality as promising option; offline applications for points of interests
- Youths: Gamification and encouragement systems; social networks; chats
- People with limited mobility could be supported in their mobility behaviour in several ways.
- For all: Gamification; wearables allow to establish a private area in public space by adapting light, noise,

Main result of the workshop in **Vienna** was that WDs have the potential to make mobility behaviour faster, safer, easier, cheaper and more comfortable. "New" WDs will not offer other information than smartphones, but will provide them in another way since there are new opportunities to provide information such as augmented reality or voice control.

WD might be a contribution to the objective of guaranteeing equal mobility for mobility impaired people. This mainly refers to blind people if the wearable device works in combination with voice control and also gives advices via a voice output.

WDs are a prerequisite for flexible intermodality. Since intermodality seems to be a promising trend, it is not really questionable if WDs will be more important in the future, but who will offer the best applications. It seems to be desirable that this will be public authorities instead of private companies, since these institutions/companies will have access to the data.

Infrastructure-WD and WD-WD-communication might provide potentials for new mobility solutions. This can refer to visual impaired people, if the WD can communicate with tactile ground surface indicators or with traffic lights. WDs also might increase transport safety by WD-car-communication allowing decreasing reaction time in dangerous situations.

The experts from **Belgium** highlighted that better information services are always desirable and improvement of traveller information can only support PT use. However, while WDs will gain in importance in the future, the potential of already available information devices such as information signs, smartphones and websites has not been reached yet. It could rather be of benefit to develop better information services and applications than to modify the devices themselves. Additionally, PT providers have to make choices in the type of applications they develop due to limited resources and cuts in budgetary allocations.

Autonomously driving cars might most likely be connected with WDs. The rise of these cars and the likely market deployment in the coming years/decades will be a significant challenge for public transport. On the other hand, the same technology can also help the provision of (cheap) public transport options, for instance for a call-a-bus service towards persons living in remote areas.

All the participants in the **Swedish** workshop agreed that WDs will be relevant for all people if future devices will be customer friendly, simple to use and easy to understand. This is of great importance to all potential groups of people, but particularly for people with special mobility needs.

Useful WDs should provide tailor made information considering the personal circumstances of the users. For example, the device could give information about where to find the bus stops but also where to go off when they travel in an area less known to them. The WD could also help to choose the smartest way to travel in case of disturbances.

WD based services have to cover all mobility options during the entire journey. Meaningful devices have to provide information during the whole trip and the services provided at the different stops. This includes different aspects such as if free charging stations for electric vehicles or if taxis or sharing systems are available at the end station. In any case, the system in the devices must be updated all the time and reflect/show reality at all times. This is of great importance in order to be able to trust the device and its information.

WDs can make the use of public transport more comfortable by providing new services such as the possibility to book a seat on the bus, in the same way as for trains. This would be especially important for the disabled persons since it certainly would make the journey more convenient. Another value could be to offer different service pick-up when arriving at the destination. An example is to pick up a pre-ordered dinner at the grocery. A carpooling app was also something the group would find useful. This device would show if someone else is driving to the same destination.

One of the major barriers for PT use in Sweden is that all the different bus companies have their own cards and ticketing schemes. This makes it very complicated to travel between different regions and for tourists without a regional commuting card. One single card for the whole of Sweden or Europe would simplify travelling. This could be offered on a WD or be introduced when advanced WD solutions are available.

### *Initiatives taken and planned in the context of wearable devices*

Afterwards the experts reported and discussed current or planned initiatives for facilitating PT use or intermodal mobility behaviour in their countries.

In **Vienna**, Smartphones play a major role when travelling intermodal or using public transport. They are a relevant source of information on routing. Mobile, real-time navigations systems from local or national PT operators (Qando, Scotty...) are widely spread. Certain local mobility services – namely

certain car sharing-systems – can only be used in combination with Smartphones (access control). Smartphone/mobile PT ticketing is offered since a couple of years.

In the future, wearable devices will most likely be used for information provision and the promotion of intermodality. Access control is – in particular for public transport – not relevant; ticketing is also less important. Instead, wearables could be used to support mobility impaired persons and those, who are not familiar with the local PT system (e.g. tourists).

In **Leuven**, operators of public transport companies are mainly concerned with the provision of accurate information towards their travellers such as a door-to-door intermodal route planner integrating multiple public transport modes (train, bus, tram, subway). Current mobile applications of most PT operators include real-time travel information and also the possibility to purchase tickets. Additionally, a proof-of-concept ‘stop announcement application’ to announce stops to travellers on a personalized basis as well as a park and ride application and information campaign was launched. The MoBIB card is an electronic chip card which can be used as a ticket for certain PT services and bicycle sharing. PT providers in Belgium also are looking at options to include social media into the information provision; this will most likely take the form of updates sent from a certain twitter account. Linking this with community based information from other travellers is a promising option.

A lot of research is being done on improving information services towards travellers. Developments of applications for wearable devices are currently mostly restricted to apps for Smartphones. The main goal is the provision of basic trip information, as accurately as possible. Optional, add-on features such as gamification, tailoring of applications towards different user groups, etc. are not actively pursued today due to shortages in budgets. The MoBIB should be further developed and integrate payment services of other public transport operators.

Within the TraPIST project additional ‘layered’ information should be provided to train users by integrating multiple information sources. Examples are ‘community-based’ information from other travellers, integration of social media or weather predictions. Data of multiple sources are collected and classified. The information is selected and provided to travellers by both, public information channels such as screens in train stations, but also based on a personalised traveller profile on the personal device of the users. The service also includes a ticketing option.

### *Expected relevance of specific wearable devices in the medium-term perspective*

In the end, the experts were asked for an assessment about the medium-term relevance of specific WDs and about visions for the future development.

A major part of the expert workshop in **Vienna** was the discussion of specific wearables:

- Certain WDs offer specific advantages and are suitable for specific functions. A SmartRing might be used for accessing vehicles or stations, a SmartGlass will be a perfect tool for navigation. This could imply that a person will use several WDs. However, the participants consider this as too expensive and too complicated. Instead, they expect one device to include most functions.
- Thus, Smartphones are expected to remain the most important WD in a medium-term perspective since other devices are still missing or at least, unique functions of other devices (= a function that offers a major benefit and can only be used on a certain device) are not yet available. This additional benefit will be crucial for the success of a WD.
- SmartWatches and SmartGlasses have advantages compared to Smartphones since they presumably offer a more comfortable handling. This particularly refers to certain situations such as bad weather conditions, during sports activities or when accompanying children.
- Mobility cards will only be an in-between-step on the way towards completely app-based solutions. Mobility cars might be used by people without WD and by tourists.

- Data security concerns of users might limit the use of WDs, in particular SmartGlasses working with cameras.
- SmartContactlenses might offer advantages compared with SmartGlasses.

The experts in **Berlin** discussed about SmartClothes allowing reacting on the temperature in vehicles. SmartRings and SmartWatches could control access to vehicles or buildings and offer a ticketing function by Bluetooth. SmartWatches allow intermodal navigation and ticketing. People with limited mobility could be supported by Smart Glasses through accurate guidance based on camera based recognition of the surrounding area and voice control for blind people.

According to experts from **Belgium**, the indoor-navigation application iBeacons in combination with mobile applications can be a helpful navigation device for blind people, for instance in subway stations or inside of buildings.

The experts from **Sweden** discussed a number of new technologies and devices, such as SmartClothes, SmartWatches and SmartGlasses. The Smartphone is expected to remain the main device in the foreseeable future and hence the connecting point to other wearable devices. Especially web-access is a central aspect that will be covered by the Smartphone. It will be the most widely used device in the near future. Amongst the other WDs SmartWatches seem to be most useful since they make the journey easier. That is, if the watch is connected to the Smartphone and provides updated information regarding the trip such as timetable changes, where to change when travelling, being able to check in/pay with the watch instead of paying with the phone/credit card.

## 1.4 Conclusion

The rapid development of WDs must not distract from the fact that WDs are a comparably new technology. Current WDs still have several weak points such as data quality, limited usability or concerning the hardware. Nevertheless, all workshops highlighted the potentials of WDs of providing information and services and, by that, facilitating public transport and intermodal mobility behaviour. This is expected to become more important in the future and affect the mobility behaviour of travellers.

Overall the expert workshop presented a wide variety of essential information on the question where the development of wearable devices in an intermodal mobility context is standing, where it is expected to be heading and which aspects still need further discussion and research. Providing accurate information pre-trip and on-trip is a concern which is shared by all public transport providers and stakeholders active in intermodal transport. Today, limited resources and integration of data from multiple IT systems and data sources are still challenges for PT providers. These challenges entail that the focus is mainly on the provision of basic information to travellers, preferably real-time information on the vehicles which are driving in the public transport network. The integration of social media and improvement of e-payment possibilities are additional elements in view. However, further gamification options or device-specific applications (e.g. NFC-based access control on SmartRings or others) are currently not in the focus of most experts.

There was a consensus that the application that runs on the device is more important than the device itself. Most experts expect Smartphones to remain the most important WD in the next years. SmartWatches might also gain in importance since they might offer a more comfortable handling than Smartphones. Applications running on future WD will most likely be easily understandable, real-time services integrating offers of many mobility providers.

## 2. Focus group discussions

### 2.1 Objective

Focus group discussions were held to collect information concerning a broad range of relevant aspects related to WDs by contacting the most affected ones: the (potential) users themselves. Thus, the focus groups aimed at identifying their attitudes, activities and perceptions towards wearable devices, mobility behaviour and intermodality in particular as well as the use of information when planning trips or when travelling. Research questions included:

- General mobility behaviour: How can the mobility behaviour of the participants be described? How and why do they decide to use a certain mode? What barriers to their mobility behaviour do they experience?
- Intermodality: Do the participants combine different modes on a given trip? What are barriers to combine different modes?
- Information use and demands: What information is currently used? How is information currently gathered? What information demand participants when planning a trip or travelling? How do they like to receive them?
- Wearable devices and mobile services: What WDs do participants know and use? What are attitudes and expectations concerning Wearable Devices? What are barriers to the use of WDs? What are potentials of the technology?

The focus group discussion in Leuven was held after the selection of wearable device for the prototype development in Guide2Wear.

### 2.2 Methodology and organisation aspects

Focus group discussions were organised in Austria, Belgium, Spain and Sweden. A guideline was written in order to prepare the focus group discussions.

According to a theoretical approach a standardised guideline for focus groups was developed (Krueger and Casey, 2000; Newman, 2002). The guideline followed a well-established pattern: (1) The process started with a typical opening question that stimulated the participants to discuss. (2) Each research topic was introduced with a transition question (3) followed by key questions in order to gain more detailed information. (4) The particular discussion topics were closed by an ending question. Of major relevance was to develop a common understanding of the term "Wearable Device".

In most cases, two researchers experienced in moderating and documenting group discussions (see Kitzinger 1994, 1995) managed the focus groups. One moderated the discussion; the other one was responsible for documenting the discussion. The moderator was trained and instructed to keep a neutral position, to show no emotional-, supporting- or critical reactions. The discussion was also recorded electronically.

Contrary to the procedure described above, three Guide2Wear-researches were involved in the German focus group, since a researcher of each of the two German project partners attended the focus group.

The participants were selected according to their everyday mobility behaviour and level of use of technologies in order to cover persons with different mobility behaviour, information needs and affinity to (information) technology. The Focus group discussions took place between February and April 2015.

Place (Country)	Date	Number of participants	Age of participants (years)	Duration (minutes)
Vienna (AT)	05.02.2015	11 (5♂, 6♀)	18-75	120
Donostia (ES)	03.03.2015	5 (5♂, 6♀)	32-51	120
Linköping (SE)	18.03.2015	9 (5♂, 4♀)	18-75	120
Leuven (BE)	14.04.2015	9 (6♂, 3♀)	26-61	120

Table 2: Participants of focus group discussions

## 2.3 Results

### General mobility behaviour

*“I like to drive the car because it gives me a feeling of independence and freedom.”*

*“Even if I wanted to take public transport, accessibility is limited and I am often still faster by car.”*

*“I consciously chose to work very near to where I live, stimulating the local economy and avoiding all the hassle of daily commuting, being stuck in traffic jams, having to wait for late trains, etc.”*

All focus groups included persons with fixed mobility habits in favour of private car or public transport as well as persons selecting the mode depending on the trip.

Some participants from **Leuven** try to avoid car use as much as possible; they also select their places for work and living in order to limit car use. They aim at avoiding congestion, gaining time by not being in the car and/or a have the desire to be active in the local community. In their leisure trips, these participants use the car more often. They consider this more practical. Also, travelling with children makes car use sometimes the most suitable option.

Others have a more mixed profile including PT and car use. The choice between public and private transport for a trip is mainly determined by the trip destination. The most important argument in favour of car use is the accessibility of the destination, the shorter total time spent on the trip and the practical aspect that car use has fewer constraints (not dependent on time schedules of public transport etc.). Arguments for PT use are that it is sometimes cheaper, the direct connection with a city centre without the need to look for parking, the much more limited congestion in comparison to road transport and sometimes the possibility to work or relax on the train. In general, public transport thus becomes a more attractive option during busy peak-hour transport trips. These participants also tend to use the train or bus in their leisure trips. Price is then the main decision criterion.

Some participants are intensive users of private transport in their daily transport, with most of their trips being done by car; some of them live in rural areas with limited PT accessibility and awareness of PT. Others live in urban areas but prefer the stick to car use for reasons of higher accessibility of various destinations, low availability of public transport connections (even in some urban areas), the availability of a company car (related to fiscal incentives) and the freedom and independence related to car use. For leisure trips, these people also tend to put a stronger focus on car use.

Focus group members in **Donostia** can be distinguished by their mobility behaviour. Some participants have fixed mobility habits and prefer certain modes, e.g. walking or PT. For others, the selection

of a mode depends mainly on the trip purpose. Hard facts (travel time, costs) are relevant for commuting trips, while there is a more relaxed attitude for leisure trips.

Safety aspects are also relevant in selecting a mode. The perceived safety is higher in subways than, e.g. in busses. Barriers for PT use mentioned are the low periodicity, overcrowding of certain public transports and mismanagement of the air conditioning when they are oversaturated. The lack of easily understandable information is often crucial when deciding which means of transport to choose. A best-practice example is subway maps which are easily understandable.

Participants of the focus group in **Vienna** discussed general reasons to select a certain mode or another.

- Comfort and costs are the most important aspects for mode selection.
- Transport costs are used as an argument for and against car use.
- Reasons not to use the car can be divided in those preventing from car use (push factors) and those in advantage of other or combined modes (pull factors). Push factors are the high costs for cars and inconvenient car use in the city (too slow, too much traffic jams, searching for a parking place). Pull factors are the unbeatable price of annual PT ticket in Vienna, easy access to transport modes, that time can be used for other purposes (reading, working, etc.) while being transported as well as health and fitness benefits from active mobility. Environmental reasons belong to both categories.
- Arguments in favour of car use are based in aspects of the car use (pull) or those preventing people from using other modes (push). Pull factors are arguments like cheap transport costs, shorter trip duration, a guarantee to reach your destination also in rural areas, and the fun aspect. Push factors are based on inconvenient PT modes due to temperature [for example no AC in summer], dirty or old as well as overcrowded vehicles. Further push factors are data protection issues or the problem of dealing with weather conditions that change unexpectedly.

### *Intermodality*

Some focus groups dealt with the topic of intermodality. It was discussed if and why different modes are combined **on** a trip and what prevents persons from doing this.

Result of the **Donostia** focus group was that the willingness to travel intermodal mainly depends on trip purpose. It was concluded that the main barrier for intermodality in Spain is a cultural habit. This cultural barrier determines the policies and prevents initiatives that could promote it. In Spain there is a culture closely associated with the use of private vehicles, while cycling or public transport in commuting is not encouraged. In practical terms, combining PT and bikes is difficult since transporting a bike in a bus is often prohibited.

Participants of the **Austrian** focus group argued that the good PT system in Vienna supports multi- and intermodality. A specific barrier to intermodality including car-sharing are the costs, data protection issues as well as confusing information about costs and handling prevent people from multi- and intermodality. In order to improve the situation for multi- and intermodality, car sharing systems like Car2Go and DriveNow should be combined with electro-mobility systems. In any case, real and clear information about costs and handling should be offered and would make intermodality much more attractive.

Participants from Sweden described the mode they usually used, but several pointed out that they used more than one mode of transport. One participant, for example, usually goes by bus to and from school, but sometimes she takes the car if she only has a few lessons, because the buses are less frequent during off-peak. Another participant, who often bikes to and from work, takes the bus if the weather is bad. The participants consider intermodality to be quite complicated especially with regard

to ticketing and payment systems for different modes and in different regions. This creates frustrations, which can result in not using the public transport system.

### *Information use and demands*

Information is crucial for intermodal persons but also for those with fixed mobility habits in terms of mode selection but with different destinations and travel patterns.

In **Donostia**, there is a lack of reliable real-time information on the exact time schedules and trip durations. Information based on official timetables is needed for planning journeys, but have to be supplemented by real-time information. With regard to intermodality, all transport service providers should share, combine and publish their information on a common platform in order to provide all available and needed information. In this context, collective intelligence shared passively through Smartphone-Smartphone-communication could provide useful information on delays and service quality. Some participants are willing to pay for accurate information and even a specific device for intermodal journeys that provides reliable information.

Participants living in **Vienna** expressed needs for information before and during the trip, post-trip information is of no importance. Information demands exist particularly when planning unknown trips, particularly abroad – however, roaming fees and unknown costs for using information services prevent travellers from using information.

Focus group participants from **Leuven** who use private cars rely on applications such as google maps or yahoo maps for routing and local navigation; they share their location and real-time traffic information with other users through Waze. They rely more heavily on pre-trip information than on-trip information. There was a consensus that pre-trip and on-trip information for private transport is relatively broadly available today.

Public transport users generally have a higher level of dissatisfaction with information availability through mobile applications. The information content provided by mobile applications is sometimes not able to cope with the information flow in case of most exceptional circumstances, which is when information is most valuable. Also, there is a feeling that applications integrating information from different transport modes are not available. One often needs to know all the separate applications and access each of them separately. In addition, one often needs to know the name of the different stops. All this information is quite specific and may be available to people who use this route daily but not for occasional trips. Also, there is a feeling that a good intermodal routing application could stimulate the use of train or bus as it could demonstrate that it is often the best option in terms of time use. There was a consensus that information needs for public transport users and on intermodal trips are not always covered.

The need for information is highest when travelling abroad to an unknown location. In this situation, one of the main barriers to the use of wearable devices for information related to mobility is the roaming charges. The willingness to pay for roaming is very low. A solution can be applications which offer information without the need for an online connection such as City Mapper in London or an application in Los Angeles allowing tracking your position in a previously saved public transport route based uniquely on a GPS-signal, without any mobile internet connection.

**Swedish** participants pointed out that a main barrier preventing them from using public transport is their unreliability. The participants reported on buses that do not arrive in time and the related frustration. In order to avoid these problems they prefer to use car or bike instead. Whether one sees public transport as reliable was largely about access to information. For instance, a negative effect on the reputation of the PT system is if travellers get no information about delays. Immediately provided information evokes a feeling of control.

### Wearable devices and mobile services

*'If you have a Smartphone, you just have to take care to have this one device and this should be charged and no further device is needed.'*

*'The Smartphone is all in one'*

*'The Smartphone serves as control centre between wearable devices you own. These connect with the phone then.'*

*"I used a lot of applications on my Smartphone in the past (navigation, tracking, location-sharing, music, etc.) until it nearly exploded... My batteries could not cope with it. Now I just use my music app."*

*"I am all in favour of the e-wallet. I can really imagine walking around, cycling, running, swimming, without the need of carrying a wallet with all my belongings."*

*"Before I came here, I thought that all these new wearable devices were of limited use. But after this discussion, I became much more convinced of the usefulness and potential applications of a Smart-Watch."*

The opportunity of wearable devices to make mobility behaviour faster, more comfortable or cheaper, as well as barriers to their use and their shortcomings was the main part of all focus groups.

In **Donostia**, there was a consensus that the most important aspect is not the WD itself, but that it provides real and reliable information in real time:

- All participants use Smartphones when planning trips. The experiences made during the last years are positive.
- Most important aspects of wearables are reliable information, followed by intuitive usability.
- Barriers to the use of WDs are data consumption and roaming fees. A solution can be of apps that include offline maps to avoid data consumption.
- Future wearables should provide customized information; Hearing guidance will be an option for the output channel of a WD as head-up displays, for example in helmets, are. Children and their parents are a main target group for WDs. The children could use the device and parents could track and support them if needed.
- It is not obvious if the Smartphone is to be considered a wearable device or not since it is not a wearing complement. However, some participants consider it wearable as the Smartphone has a fashion component.

Participants from **Vienna** highlighted the following aspects:

- People without practical experience with WDs and information systems tend to be more sceptical.
- Helpful WDs should be fast, simple and uncomplicated; easily understandable and should provide precise information including salient points (such as shop-names, or buildings) in order to support orientation.
- Barriers to the use of WDs are data privacy issues. Roaming fees also prevent people from using information services when being abroad. Also concerns were expressed that persons have no need to 'think' any longer and to orientate without those techniques.
- WDs are not helpful if they offer too much features and different functions in one app that are perceived as not needed (too many features makes it confusing), if they take too long, include 3d-maps, if 'they do things that are not controllable for the user' and if roaming fees are too expensive.

- WDs should offer
  - o Navigation apps combined with information about public transport
  - o Precise information about the location and orientation points
  - o Information about the most optimal transport modes
  - o Opportunity to switch data logging/saving off
  - o Additionally to the routing information, health-relevant information (e.g. names of medication abroad; next pharmacy, etc.)
  - o Lower roaming fees
  - o Individually tailored additional information (e.g. health-relevant, restaurants, sights, hospitals, etc.)
  - o a 'construction kit' where everybody can create its app with the features that are individually perceived as relevant
  - o An app that provides intermodal transport information not only from one city or one country but comprehensively, transnationally
  - o Fitting connection times between different modes
- The Smartphone is considered to be the main mobile device since almost everybody has one and it is able to include all functions that are perceived as relevant. In case of using several WDs, the Smartphone still remains the central element communicating with the other devices. When everything is connected there is a higher chance of errors and that all data get lost (by viruses for instance)
- Additional devices to the Smartphone would be too much and are perceived as limitation
- SmartWatches will include all needed functions in the future

Leuven (BE):

- Smartphones are used broadly.
- Applications supporting public transport should be kept simple and intuitive, and focus on delivering the most necessary information such as routing and time scheduling. Since the screen and the interactive elements are often limited, the focus should be on simple, directly accessible and useful information. For more complex actions, participants prefer to use a laptop at home and access this information pre-trip or post-trip.
- The main barrier for the use of WDs are privacy concerns which are relevant for the majority, but not for or all workshop participants. They prefer to turn off the location services, even though this would increase the ability of the applications in providing useful information for them. People thus face a trade-off between effectiveness of the app information and protection of their privacy. A more practical barrier is a relatively small screen of the wearable devices which makes visible information a problem, sometimes combined with the difficult to use user interface. Voice output can be helpful, but is considered as insufficient in case of navigation, for example.
- Interesting services for the near future are
  - o An interesting application seems to be guidance for persons with a view limitation or blind people. Voice output from a wearable device can be useful in support of visual

- information, but most participants consider voice output only as probably too limited; they also require some visual support from a wearable device.
- Crowdsourcing and collective intelligence could be used for providing better real-time information.
  - The integration of information sources in one navigation device is definitely very interesting. For example, integrating parking information, availability of bicycles and subsequent public transport possibilities into a GPS or navigation device is considered as very useful. This could be integrated in existing devices or in a Smartwatch.
  - E-ticketing and electronic payments using Smartphone or other wearable devices are an avenue for future developments.
  - Tracking of customers by travel companies, tourist service providers, etc. to enable them to better plan their activities or run operations more smoothly when customers arrive late. This location sharing request could be integrated with the booking or ticketing process, rather than through a standalone application like Waze or Hangouts.
  - A SmartGlass could integrate augmented reality together with increased services for people with viewing disabilities. The watch could translate visual information into voice output to help them in their local navigation.
  - A SmartBracelet could help in locating disabled people or people with cognitive impairments.
  - A Smartwatch could integrate e-ticketing, access/identification, payment services and also an electronic agenda and buzz some time before an important appointment.
  - E-ticketing in combination with an electronic wallet integrating ID, payment devices and other information could be important. However, there were some answers indicating that off-line payment systems will remain important.
  - A water proof watch can be a very useful 'wallet' when swimming, running or cycling for example. No need to carry many add-ons; your wallet, keys, money, etc. would all be integrated into a smart watch.
  - A watch could be used for local navigation by tourists. A 'light beam' could indicate the direction in which they have to walk. Tickets for the subway can be paid by swiping your smart watch against a payment terminal.
- Participants share the view that an integration of devices would be most useful. They do not want to have a separate interaction with Smartphone, Smartwatch and smart glass; this would become quite cumbersome. On the other hand, they would find it useful if devices were automatically synchronized and updated with each other. For instance, if they can figure out a route using laptop or Smartphone, which would then directly be uploaded to their Smartwatch.
  - The Smartwatch is seen as the most useful 'new device' that participants do not use today. The direct accessibility of information is considered a very useful feature and an added value in comparison to Smartphones particularly for private transport (car – bike), but also for public transport and intermodal trips. Another advantage is that it is more difficult to steal or less likely to be lost in comparison to a Smartphone. The small screen is a challenge, however.
  - The smart glass is questioned much more than the smart watch. The use in traffic is considered dangerous. The applicability is considered higher in industry than for mobility applications. They argue that augmented reality applications for smart glass are nice, but could be integrated with a Smartphone or other device as well.

- Smart rings and smart bracelets are considered a useful add-on for specific situations, but applicability is limited due to small interaction possibilities and small screen. These devices should definitely be automatically synchronized with larger applications, as standalone devices they are probably useless.
- Smart clothes can have useful applications in health area, for safety assistants, or fire fighters. Sensors can indicate high temperature or gas concentrations or CO<sub>2</sub>, or send out signals to skiers or rescuers in avalanche-prone areas.

The **Swedish** participants discussed desirable functionalities of WDs. All of them have the potential to make intermodal mobility or PT use more convenient, cheaper or faster.

- The Swedish participants highlighted that they prefer one single app on one device which offers all needed functionalities. Payment, tickets and information of all transport modes and providers should be included.
- One important aspect was being able to have a nationwide ticketing and payment system. This would create a much smoother and more attractive public transport system. Such a ticket and payment system could be designed as an app. Another participant instead suggested a nationwide card that could be read using the owner's fingerprints. That would be even more convenient than having to hold the phone against a reader. Initially this kind of ticketing and payment system should be valid for Sweden; it could also be extended to Europe.
- There is a generation gap in the use of internet and apps. Older people may prefer to have a printed timetable. However, they also pointed out that not all young people are accustomed to this type of technology and therefore the payment system must be simple.
- WDs are helpful to provide information to persons with disabilities. This allows supporting their mobility behaviour. Auditory information and voice control for the visually impaired would thus be helpful.
- A useful app should be able to provide information about services available at stations in order to promote intermodality.
- Tourists could benefit from WDs since information can easily be given in their national language.
- A reminder function could support mobility behaviour. Examples are a signal when it is time to leave the bus, or when you usually go to the bus stop and signal that it is time to go to the bus.
- The app could show a map on which the location of the bus is shown. In this map it should be possible to follow the movements of the bus in real time.
- A more advanced app for long-distance travel could cover the entire journey. After entering origin and destination of the trip a number of options would appear to select from. The entire trip would be paid at the same time. The app could provide not only information dealing with modes of transport but also further aspects such as hotels or the weather.
- Information on facilities at interchanges or stops is often not easily to retrieve. An app could provide information such as toilets, shops or restaurants and by this make the travel more convenient. Since this information is not needed for all trips, there should be the opportunity to opt this option out.
- Swedish participants were not worried about privacy aspects, especially if personal information was not compulsory. One participant highlighted that it would be good if details concerning payments were separated from information dealing with, for instance, restaurant visits. This would reduce the risks of others abusing the system. However, there was the opinion that

confidence in transactions is generally high, which is why the question about integrity was not that relevant.

- Participants were asked for their willingness to pay for an app with the type of information that has been discussed during the focus group meeting. Some of them expect it to be free, while others are willing to pay a subscription fee just to avoid having to find out all the information themselves from different sources. One participant argued that from a fairness perspective this kind of information should be provided free and paid through tax.

The participants in Sweden also discussed about WDs:

- A disadvantage of SmartWatches or SmartBracelets is that they are very sensitive to what is fashionable at present, more sensitive than a Smartphone.
- An activity SmartBracelet or SmartWatch offers advantages with regard to ticketing since the payment procedure would be easier compared to a Smartphone. They are also better protected against theft than Smartphones.
- Of the WDs displayed during the focus group meeting it was primarily the bracelet that participants would be willing to buy and use.

### *Further aspects*

In **Leuven**, the selection for the G2W-prototype was subject of a vivid discussion. The application is very focused on finding the fastest or shortest connection from one point to another and thus targets people who really plan their travel activity very well and want it to end as fast as possible. However, in reality, people often do not want to go as fast as possible from A to B. They might want to pass by a local shop, meet someone familiar and have a chat, or take a certain route just because they like it, etc. This would interfere with the travel time optimization as calculated by the Smart-way application. Also tourists often stroll around in a city and thus enjoy the travelling experience itself. They may not benefit from showing them the shortest or fastest route, but rather the 'nicest route' which passes by interesting sights and gives them an explanation of the monuments and historical buildings which they are passing.

The participants consider the vibration for updates about public transport interchanges at risk and related features as very useful, but wonder whether the scope of this functionality could not be broadened. Tourists could for example indicate that they want to attend a certain event (a play, a concert, a game, etc.) at a certain time and at a certain location in the city. The application would then start buzzing when they stroll around too much or too far urging them to take on their route towards their location. For business people who visit a foreign city for a business meeting, the application will be synchronized with their agenda and notify when they have to start heading towards their meeting place and what is the best route for that. In sum, participants would broaden the scope from shortest route to nicest route and from an origin – destination focus towards a destination- and time-based arrival focus.

The participants find the local navigation using an arrow on a smart watch a very useful feature. A similar type of functionality was already raised independently beforehand. They think that such a feature would allow them to save significantly on navigation time when they are in a large transport hub which is unknown to them, or when they leave a subway station for example.

## **2.4 Conclusion**

The participants' discussions of public transport in the future could be summarized with one word "simplicity". The participants' current mode of travel was to a large extent what they perceived to be the easiest and most practical option.

**The simplicity and ease-of-use of information plays an important role** in the choice of transport modes (offline and online information) and in the use of wearable devices when planning intermodal routes. This issue is critical **regardless the purpose of the trip (leisure or work commuting)**.

Another crucial point is the **integration of data**. It is important to integrate all the data received on different WDs **through the primary wearable device** (Smartphone) and is critical to put in common and **share in an unified platform/format all the information the transport service providers have** (beyond the official timetables) in order to get reliable information.

Most important is to **receive reliable and updated information** taking into account certain contingencies (diversions, delays...). **Collective Intelligence** could respond to these problems in the sense that users' smartphones could be sending updated information to the system passively.

**In terms of barriers** or problems that could stop the increasing trend of using smartphones for supporting mobility behaviour are **privacy concerns and roaming fees**.

Talking about the future of Wearables, nearly all participants insist on simplicity and **less intrusive devices**. However, customisation was also mentioned several times.

### 3. Conclusion

Stakeholder workshops were held in Austria, Belgium, Germany and Sweden covering a broad range of experts from a wide variety of professional backgrounds including software and mobility information providers, public transport operators, governmental bodies, research institutes and associations representing affected groups such as car drivers or visually impaired people. The goal of these four national events was to discuss, based on a common structure, actual issues and problems of these new technological solutions on different levels. This included data needs, legislation, social acceptance and broad scale deployment which potentially prevent the implementation of WDs, but also their general potential to solve mobility issues was touched. This was done by assessing opportunities to use these applications to increase public transport use as well as general safety and comfort of vulnerable road users and make everyday mobility more efficient. Initiatives taken and planned in the context of wearable devices as well as the expected relevance of specific wearable devices in the mid-term perspective were discussed with the attending experts taking into account national and regional characteristics of European transport systems. As there are still open questions concerning market introduction and implementation of WDs, expected future developments in view of societal, organisational, legal and technical implications were subject of discussions. All of the expert workshops were successful in view of the good mix of attending experts with regard to their professional background and in view of the results obtained.

Barriers and problems regarding WDs are mainly seen in the fields of needed or missing data for accurately providing information to travellers, which are not only needed for seamless navigation. In addition a major obstacle that needs to be tackled are usability issues relating to reliability, lack of comprehensive integration of different transport options and the wide variety of different ticketing schemes preventing a broad scale integration of best-price offers or transferability of tickets. Besides these rather negative aspects, the potential of WDs is generally considered to be very positive regarding public transport uptake or increasing efficiency and safety. German experts concluded that there is a high potential to sustainably facilitate the use of public transport based on different incentives and advanced functions, (i.e. gamification, voice control, real-time navigation) integrated into WD applications. In Vienna attending stakeholders were actively discussing future interfaces of WDs besides what is already available on the market. WDs were not only seen as a potentially beneficial gadget, but rather a prerequisite for the successful and efficient use of intermodal transport options, with impaired road user being one of the target groups of these supporting devices. In Belgium experts remained critical, especially in view of already existing (infrastructure-based) information systems in the public transport context. However WDs can close the gap between new travel solutions (i.e. autonomously driving cars) and needed information.

Discussion on ongoing initiatives and projects in the WD context showed that Smartphones are currently the most important aspect for intermodal travel information including mobile ticketing. Other WDs are seen as rising in relevance with functions such as access control and ticketing being major functions. Overall research on providing accurate and timely information to travellers is a central aspect in European transport systems. The Leuven event showed that door-to-door intermodal route planning is currently the focus of transport companies, by also utilizing the benefits of mobile applications to provide real-time information.

Discussion with the experts from these four countries clearly showed that certain WDs provide very specific benefits but are only rather suitable for certain applications (i.e. smart glasses for navigation, smart rings for access control, etc.). The Smartphone however is perceived as the main device in the travel context in the mid-term until other devices are more matured and ready for market introduction. Besides the discussed pitfalls of privacy issues, the potential of the solutions especially for impaired people were touched upon several times.

Overall the involved experts from different countries clearly highlighted the potential of WDs, not only to facilitate public transport use, but also the potential to increase general mobility and comfort for the different target groups. Obstacles that still need to be tackled include data availability and quality, legal and privacy issues that need to be solved also on a societal level and the high heterogeneity in regards to aspects such as ticketing and data sources. Nevertheless one of the outcomes most experts agreed upon was the fact that focus needs to be on the application rather than the device it is used on.

Focus groups were carried out in the four cities Donostia (ES), Leuven (BE), Linköping (SE) and Vienna (AT). In total 34 participants discussed their mobility behaviour with focus on intermodality as well as their needs for and use of information when travelling. The main focus was on their attitudes, expectations and current use of WDs as well as potential and barriers keeping them from using WDs. The focus groups were moderated by the responsible national partner(s) and carefully documented and analysed based on a common guideline. The participants were selected based on their mobility behaviour, technology use and information needs to assure a broad level of considered point of views. Most participants were experienced Smartphone users, who had already used a variety of different mobility-related applications.

Current mobility habits of all participants vary, including participants bound to a specific mode of transport and those always travelling intermodal. Both, the use of cars and alternative forms of transport depend on different push and pull factors that need to be taken into account when aiming at changing the modal split. Transport costs and comfort (i.e. very crowded, low periodicity, etc.) were highlighted as deciding factor for mode choice of most participants. However, transport costs do not only have to be low, but information on prices and ticketing schemes needs to be clear and easily understandable. Trip purpose also seems to be a relevant factor, especially regarding intermodality. Cultural aspects are potentially an inhibiting factor in Spain, where a stronger policy support fostering alternative forms of transport is needed. Intermodality can more easily be fostered in cities with a good public transport system such as Vienna.

Regarding information demand when travelling most participants ask for reliable, timely and accurate information. This is not only important for car drivers, but also for those using public transport where information on schedule changes, delays or other unforeseen changes need to be accurate. Discussion showed that the device itself is perceived as being secondary to the information provided. Most persons want easy to handle information apps, but they should also offer the possibility to individually adapt the app by adding or removing functions depending on the specific needs of the trip. This customisation in combination with simplicity and integration of different functions (navigation, ticketing, points of interest) to avoid having to switch between applications and devices is perceived as being essential for a high degree of usability. Privacy aspects were discussed especially in the context of location based services. In all of the countries except for Sweden participants expressed some scepticism mainly about how data is handled. On the other hand, the Swedes who are less worried about this felt that they had a lot to gain from getting the information tailor made to their own needs. In addition involved costs (i.e. costs for devices and roaming costs when travelling) are seen very critical with rather obscure policies of the providers in need of clarification.

The Smartwatch is perceived as 'the' innovation for years to come. Smart bracelets and rings are seen as add-ons to the Smartphone, with the Smartphone remaining the central device. Smart glasses are discussed critical with the potential to distract or having a detrimental effect on the privacy of all travellers being a rather common factor for all participants. WDs in general and smart clothes specifically are also discussed in regards to their potential benefits for the health sector, supporting monitoring of sick people and those in need of immediate medical attention by informing rescue services.

Overall the results of expert workshops and focus group discussions not only provided a comprehensive set of aspects covering the state of the art, as well as actual experiences and attitudes towards these solutions, but also provide insight in expected changes and upcoming challenges for WDs on societal, technological, organisational and political actors. The Smartphone is the central WD for the

time being with reliability and ease of use being major aspects that need to be supported by integrating different sources and ticketing schemes into one central app. Hence the actual applications and their functions are more important than the device they are used on with the opportunity to adapt the provided information and user experience to trip purpose and user group. Open questions mainly remain in view of data sources and privacy issues.