COMPASS

OPTIMISED CO-MODAL PASSENGER TRANSPORT FOR REDUCING CARBON EMISSIONS

DELIVERABLE D6.2

AN ASSESSMENT OF THE POTENTIAL IMPACT OF ICT SOLUTIONS ON A CO-MODAL TRANSPORT SYSTEM

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EXECUTIVE SUMMARY

This deliverable is the synthesis of the work carried out in WP6 of the COMPASS project, centred on the assessment of ITS transport solutions to improve co-modality in Europe.

A framework for the assessment of solutions is provided in chapter 1 of this report. The assessment framework is based on the experience gained in the INTERCONNECT and ORIGAMI FP7 projects. This framework is both applied in the COMPASS Handbook of ICT Solutions (developed in WP5) and in the Local Assessment of ICT Solutions based on case studies (developed in WP6).

The Local Assessment of ICT Solutions is performed through a set of 11 case studies. Case studies are selected in order to cover a representative range of technological solutions applied in a representative range of different territories in Europe. Potential transferability of solutions is also discussed.

The European Assessment of ICT Solutions is analysed by modelling a set of alternative ITS scenarios at EU-scale by means of the network model MOSAIC developed in the INTERCONNECT FP7 project (also applied in ORIGAMI FP7). Hypotheses for scenarios are based on the findings provided by the Local Assessment of ICT Solutions and the COMPASS Handbook of ITS Solutions.

Local assessment of ICT solutions: case studies

The objective of COMPASS case studies was to test ICT solutions in the context of real world situations in order to assess their real impact on the transport system and user behaviour.

Selection of different setups for in-depth investigation started from the selection of ICT solutions. Then taking into consideration different types of solutions, a proposal for case studies was drawn up. The proposal was elaborated in order to ensure a harmonious distribution of case studies in Europe and among different kinds of regions, and of technical solutions analysed. While region and technology selection provided a variety of different EU settings, the case study selection was also influenced by other factors like the type of ICT solutions which could be researched in a given location and by the impacts the ICTs might have on users, transport systems and society; also the availability of data and resulting possibility for conducting field research was an important factor in the selection process.

Case studies involved both deskwork and interviews with selected stakeholders. A number of case studies developed surveys.

A total of 11 case studies were finally undertaken in COMPASS. In brief, case studies deal with the following issues:

- **CS1 - An EU-Wide Multimodal Travel Planner: routeRANK**. Unlike other solutions that consider only one means of transport at a time, routeRANK addresses the entire travel route by integrating rail, road and air connections and their many multi-modal combinations. In a single search, routeRANK's patent-pending technology finds and ranks the best possible travel routes, allowing users to sort them according to their priorities such as price, travel time and CO2 emissions. This is done by checking websites of unimodal transport providers, combining the findings to multimodal transport chains and then displaying these travel suggestions with their attributes (route, schedules, prices é) together with a link leading the user to the website(s) where a distinct travel solution then can be booked.
- **CS2 - A Regional Multimodal Travel Planner: Marche Region of Italy**. This case study addressed the potential to serve sustainable transport policies as a result of the use of regional traveller information systems in applications situated at an intermediate level between the urban scale and the national/international one, with reference to the passenger transport segment. More specifically, the objectives of the regional case study on the Marche region traveller information systems were to address the following two issues: an assessment of their environmental impacts, based on hypotheses on modal shift from car to public transport; and an assessment of their contribution to the improvement of mobility in general, and accessibility to remote areas in particular. The reduced social costs from modal shift amount in total to about ú 47,000 daily (of which about ú 10,000 in urban areas and about ú 33,000 in extra-urban areas). The assessment

is carried out under the assumption that the diverted demand from road transport (car) can be met by public transport without additional costs (spare capacity available).

- **CS3 – Accessibility Applications for Disabled People.** This case study looked at a range of smart phone travel applications (apps) with a range of different attributes with the potential to improve accessibility to the transport system for disabled people. It is estimated that disabled people comprise approximately 15% of the population. Furthermore, it is widely observed that there is a strong link between ageing and impairment and that the proportion of older people in society is increasing over time. Apps are typically designed to offer a single service or task in a simple, direct, self-contained way, or to interact with a single service, task or website on the internet and, consequently, tend to be relatively simple to use. The apps considered in this case study target disabled car drivers, disabled car passengers, disabled public transport users and disabled pedestrians.
- **CS4 - ITS Solutions for Barcelona's Local Bus Network**. This case study dealt with the series of improvements the Barcelonaŝ bus operator TMB is carrying out in the organisation of the service operation, the comfort of vehicles, the equipment of bus stops and the information services to travellers (internet, smart phones, on-vehicle, at bus stops); all to increase the attractiveness of the bus in relation to other competing modes, e.g. metro or tramway. The operator is taking the opportunity of a major network reorganisation to test new concepts for bus stations that include several ITS features to assist the guidance of users in the Barcelona public transport network (touch screens with integrated travel planners, information on expected time of arrival for next services), as well as facilitating the sales of tickets (sales booths). At the same time, TMB is enhancing its smart phone application with innovative features aiming at becoming increasingly useful to users. This case study conducted a survey to assess the level of awareness and acceptance of these initiatives, as well as of other complementary services which can be provided with smart phones.
- **CS5 – Future Interurban Public Transport in Warminsko-Mazurskie Voivodship**. This case study used a test bed approach for identification of possibilities and barriers for introduction of a selected number of ITC solutions into rural areas in Poland. It was based on transport usersô response to the proposed ICTs as recorded through qualitative and quantitative surveys. The study area is characterised for being a low GDP rural area. ICT solutions tested in this setting are i) internet based travel planners; ii) electronic real time information at bus stops; iii) ticket purchasing via mobile phones / internet; iv) real time information on services via mobile phones / internet; v) real time information on estimated arrival times, stops, route on board of vehicles; vi) demand responsive services. The overall result of the study is that ICTs are very much sought after by local transport users, and that rurality and remoteness do not reduce demand for modern transport alternatives.
- **CS6 - Mobile Applications for Taxi Services**. This case study considered the use of mobile applications (apps) applied to the taxi industry using the experience of (different) apps in peer cities. The case study was motivated by the impacts that the taxi app may have on the industry. Four peer cities have been analysed: London, Edinburgh, and two representative US cities located on the East and the West coasts respectively. Apps have a demonstrable impact on the use of taxis and similar services served by taxi apps. They have been suggested to increase accessibility, ease of use and convenience of the taxi mode. The potential benefits of the taxi app extend to the (various) passenger(s) both current and intending, but should also be considered in terms of both positive and negative impacts on the industry and on the regulating authorities.
- **CS7 - Bike Sharing in Vienna and the Surrounding Region.** The focus here was on the bike sharing schemes in Vienna and the surrounding region Lower Austria (*Niederösterreich*). A computer assisted telephone interview (CATI) was carried out to capture user responses to two different bike-sharing schemes in and around Vienna. CityBike in Vienna has been in operation since 2003 and currently served with about 100 stations with in approximately 3km radius from the city centre. The survey revealed that more than 90% of citizens in Vienna know about system and 28% stated that they have already used it. nextbike in Lower Austria started in 2009, installed not only in cities but also in small towns and villages as well as in several rural touristy regions along Danube. Use of bike sharing is much lower for nextbike, under 5% of survey respondents. The most typical reason for not using a shared bike is the availability of an own bicycle.
- **CS8 - Car Sharing in Karlsruhe.** Car sharing in Karlsruhe, when measured by cars per inhabitant, probably is the most successful system of this kind of mobility concept in the world. It

is a system of classical car sharing (car club), where all cars have fixed locations i.e. when renting a car, the user has to pick it up at a distinct location and drop it off at the same point. An analysis of long-term booking behaviour showed that the annual mileage per user significantly decreases with the years to about 1,400 kilometres a year. Assuming a consistency in the number of trips undertaken per person, the conclusion can be drawn, that classic car sharing causes a switch in mode choice towards public transport and bike usage. This is backed up by results of a mobility survey undertaken in Karlsruhe in 2012. Comparing this system of classical car sharing with dynamic or floating car sharing, as provided e.g. by Daimler motor company in Ulm since 2009 under the brand car2go, shows severe differences between these systems in user behaviour, efficiency and therefore also in financial viability.

- **CS9 - Grass-Root Cooperative Smart phone-Based Car Sharing in Austria.** This case study is focussed on newly-appearing grass-root cooperative car-sharing in Austria called CARUSO. The system is such that users have to form a car-sharing group spontaneously based on their needs: the shared cars are provided by a group member (e.g. an individual, public organisation such as a municipality, private companies, etc.) or procured cooperatively by the group, and there is no car-sharing company owning and offering vehicles. The user fee can be set in a flexible way and each group adopts different pricing models such as linear per-km tariff with or without annual fee or just 6-month user fee divided based on the approximate usages by users. The system is mostly targeted at rural areas, having a smaller scale compared to conventional car sharing schemes: one or a few cars are to be shared by around 30 users. A special insurance policy package dedicated for CARUSO offered by a regional insurance company covers the mandatory insurance needed for this form of car-sharing.
- **CS10 - Sant Cugat Intelligent Motorway Toll System.** The motorway between Sant Cugat and Barcelona is a 13 km toll highway operating since 1991. The motorway, which includes a 2.5 km tunnel under the Collserola hills, had a great impact on the attractiveness of Sant Cugat and the Vallès Occidental county as levels of accessibility increased dramatically, inducing a significant migration flow of middle and upper class residents from Barcelona. Tabasa, a public operator, has managed the motorway until December 2012, at which time it was sold to the private sector. It traditionally pioneered the implementation of smart infrastructure equipment, enabling semi-automatic free-flow toll payment already in the 90s, then introducing automatic incident detection systems inside the tunnel, environmental toll reductions for clean vehicles linked to OBU devices, and more recently a computer based HOV recognition system at tolls allowing for automatic vehicle occupancy detection and fare reduction.
- **CS11 - Latis: ICT Modelling in Scotland Region 2007 to 2027**. This case study aimed to quantify some of the potential impacts on the reduction in CO2 emissions and traffic congestion levels through application of a number of ITS solutions. The first solution assesses the impact of in in-vehicle travel time on road-based public transport, which may be the result of e.g. smart ticketing measures, improved traveller information and bus signal priority. The second solution assesses the impact of increased car occupancy levels which may be achieved by e.g. lift-sharing initiatives. This quantification was made feasible by the existence of the LATIS model (Land Use and Transport Integration in Scotland) which is an integrated Land-use and Transport model for strategic assessment across the full Scotland Region. It was found that the impact of car sharing had a tenfold larger impact on emission reduction than that of smart ticketing.

Transferability of solutions considered in case studies is analysed in chapter 13. The objective of this activity is to inform on the transferability potential of the experiences investigated, as well as to provide a basis for the discussion on the potential barriers which might hamper the diffusion of such kind of solutions. The methodology for transferability analysis has been developed based on the experience of other transferability approaches recently developed in European research projects, namely INTERCONNECT, ORIGAMI and NICHE+. In the approach proposed by COMPASS three main dimensions are considered for the transferability assessment:

- The applicability of the solution; the spatial area and the demand segment addressed by the solution are to be sufficiently wide to allow for transferability
- The interest for the solution; the higher interest of a solution, the more likely to become transferable: three different groups of stakeholders are considered: the traveller, the operator and the government.

- The feasibility of the solution; only solutions easy to implement are likely to become highly transferable: it is investigated in relation to the following set of stakeholders: *financier*, *regulator*, *technology supplier* and *non-users*.

European assessment of ICT solutions: modelling

The assessment of long-distance ICT solutions is based on quantitative modelling using MOSAIC, the European-wide model developed in the INTERCONNECT FP7 research project, a modal choice and assignment module originally programmed to investigate how upgrading the interconnections between transport networks in Europe can impact on the European transport system.

From a demand side, ICT impacts both on trip substitution (e.g. teleworking, teleconferiencing...) and on trip induction (e.g. enlarged personal and business relations supported by ICT inducing to trip demand increases). The net impact of ICT in travel induction and substitution is difficult to assess isolated from other social, economic and technologic drivers. What can be stated, however, is that ICT allows for better real time transport management of user needs, transport conditions and externalities, creating incentives for more informed user choices leading to a more efficient transport system.

Increase in demand or decrease due to ICTs has not been considered in COMPASS.

From a supply side, ICT implementation in transport systems results in efficiency improvements, mainly in more reliable transport services and vehicles and more efficient traffic management leading to travel time reductions; more efficient infrastructure management, leading to operating cost savings and, to the extent that infrastructure managers transfer these savings to users, also to travel fee and user costs reduction; and more information to users, increased comfort and convenience, leading to a change in the value of the time perceived by users when travelling.

Some of the key findings are:

- The increased intensity of ICT solutions in COMPASS Scenarios leads to an increase in the road share. In the model, this effect derives from decreased costs in interconnections involving the road mode (representing ICTs in metropolitan motorways allowing improving traffic flow and safety). Travel costs and fees are assumed to decrease in the same proportion for all modes. Better performing interconnections could be behind the increase in road competitiveness.
- The rail mode increases modal share only when speed increase assumptions are made. Rail loses share between the Baseline and the MidICT scenario, but then recovers share as soon as rail speed is increased, for HighICT and VeryHighICT scenarios.
- The air mode loses share in all scenarios, even when speed increases in the air mode are the greatest among all modes.
- Changes in the modal shares result in more vehicles circulating on the network (more vehicle kilometres), more emissions released and more fuel consumption, but less overall network usage in passenger kilometres (trips per passenger are shorter).
- According to literature, the value users place on travel time varies depending on the type of trip, people's preferences, and travel conditions. The impact of "soft-factor" solutions addressing user comfort and convenience is assessed in COMPASS by testing how the model responds to reductions in the value of travel time of users. The impact of these hypotheses is again the increase of the road modal share, from 69.8% up to 71.1%.

Results confirm the hypothesis by Litman (2011) which points out that the road mode seems to be the mode that better understands the willingness of passengers to maximise their comfort and convenience. Once the basic engine and safety performance of vehicles is ensured, the initiatives by the vehicle industry address the "intangibles" addressed at increase the comfort of cars and driving. In this user targeted strategy, the car industry is successful in constantly reducing the perception of travel time cost by users.

1 INTRODUCTION

1.1 OVERVIEW OF DELIVERABLE 6.2

This report is the synthesis of the work carried out in WP6 of the COMPASS project, centred on the assessment of ITS transport solutions to improve co-modality in Europe.

A framework for the assessment of solutions is provided in chapter 1. This framework is the same as the one applied in the discussion of solutions in the *Handbook of ICT solutions for improving co-modality in passenger transport developed* in WP5.

Then, a set of representative solutions are identified at local scale and assessed under this framework in 11 case studies. Case studies have been selected in order to cover a representative range of technological solutions applied in a representative range of different territories in Europe. Transferability of solutions is discussed in Chapter 13, just after the description of Case studies.

Based on the findings of these in-depth cases studies, along with previous insights from the *COMPASS handbook of ITS solutions*, the impacts of alternative scenarios at the European scale of ITS implementation are analysed. This analysis is undertaken by means of transport modelling activities.

1.2 A CASE STUDY APPROACH

1.2.1 Case Studies at a Glance

The objective of COMPASS case studies was to test ICT solutions in the context of real world situations in order to assess their real impact on transport system and user behaviour. The analysis of a balanced set of cases in terms of topics and geographical coverage as well as diversity of ICT solutions applied allows for the discussion of the effects of different conditions existing at different urbanisation levels on proposed ICT solutions. COMPASS developed a methodology for case studies selection in order to choose finally well diversified case studies to be further researched deeply.

A total of 11 case studies were undertaken in COMPASS. These are described in brief below:

Case Study 1 - An EU-wide multimodal travel planner: routeRANK

Unlike other solutions that consider only one means of transport at a time, routeRANK addresses the entire travel route by integrating rail, road and air connections and their many multimodal combinations. In a single search, routeRANK's patent-pending technology finds and ranks the best possible travel routes, allowing users to sort them according to their priorities such as price, travel time and CO2 emissions. This is done by checking websites of unimodal transport providers, combining the findings to multimodal transport chains and then display these travel suggestions with their attributes (route, schedules, prices é) together with a link leading the user to the website(s) where the travel solution then can be booked.

Case Study 2 - A regional multimodal travel planner: Marche region of Italy

This case study addresses the potential for sustainable transport policies as a result of the use of regional traveller information systems in applications situated at an intermediate level between the urban scale and the national/international scale, with reference to passenger transport. More specifically, the objectives of the case study on the Marche region traveller information systems address the following two issues: an assessment of their environmental impacts, based on the hypothesis of modal shift from car to public transport, and; and an assessment of their contribution to the improvement of mobility in general, and accessibility to remote areas in particular. The reduced social costs from modal shift amount in total to about ú 47,000 daily (of which about ú 10,000 is in urban areas and about ú 33,000 is in extra-urban areas). The assessment was carried out under the assumption that the diverted demand from road transport (car) can be met by public transport without additional costs (spare capacity available).

Case Study 3 – Accessibility applications for disabled people

This case study looked at a range of smart phone travel applications (apps) with a range of different attributes with the potential to improve accessibility to the transport system for disabled people. It is estimated that disabled people comprise approximately 15% of the population. Furthermore, it is widely observed that there is a strong link between ageing and impairment and that the proportion of older people in society is increasing over time. Apps are typically designed to offer a single service or task in a simple, direct, self-contained way, or to interact with a single service, task or website on the internet and, consequently, tend to be relatively simple to use. The apps considered in this case study target disabled car drivers, disabled car passengers, disabled public transport users and disabled pedestrians.

Case Study 4 - ITS solutions for Barcelona's local bus network

This case study deals with a series of improvements the Barcelona bus operator TMB is implementing in the organisation of the service operation, the comfort of vehicles, the equipment of bus stops and the information services available to travellers (internet, smart phone, on-vehicle, at bus stops), in order to increase the attractiveness of the bus in relation to other competing modes, e.g. metro or tramway. The operator is taking the opportunity of a major network reorganisation to test new concepts for bus stops that include several ITS features to assist the guidance of users in the Barcelona public transport network (touch screens with integrated travel planners, information on expected time of arrival for next services), as well as facilitating the purchase of tickets. At the same time, TMB is enhancing its smart phone application with innovative features aiming at becoming increasingly useful to users. This case study conducted a survey to assess the level of awareness and acceptance of these initiatives, as well as of other complementary services which can be provided with smart phones.

Case Study 5 – Future interurban public transport in the Warminsko-Mazurskie vovoidship

This case study used a test-bed approach to identify possibilities and barriers for the introduction of a selected number of ITC solutions into rural areas in Poland. It is based on transport usersôresponse to the proposed ICTs as recorded through qualitative and quantitative surveys. The study area is characterised for being a low GDP rural area. ICT solutions tested in this setting were: i) internet-based travel planners; ii) electronic real-time information at bus stops; iii) ticket purchasing via mobile phones/internet; iv) real-time information on services via mobile phones/internet; v) real-time information on estimated arrival times, stops, route onboard vehicles; vi) demand-responsive services - possibility for direct pick-up/delivery of passengers in response to prior demand. The overall result of the study is that ICTs are very much sought after by local transport users, rurality and remoteness do reduce demand for modern transport alternatives.

Case Study 6 - Mobile applications for taxi services

This case study considers the use of mobile applications (apps) applied to the taxi industry, using the experiences of (different) apps in peer cities. The case study was motivated by the impacts that the taxi app may have on the industry. Four peer cities were analysed: London, Edinburgh, and two representative US cities located on the east and the west coasts respectively. Apps have a demonstrable impact on the use of taxis and similar services served by ôtaxiô apps. They can increase accessibility, ease of use and convenience of the taxi mode. The potential benefits of the ôtaxiô app extend to the (various) passenger(s) both current and intending; but should also be considered in terms of positive and negative impacts on the industry and on the regulating authorities.

Case Study 7 - Bike sharing in Vienna and the surrounding region

The focus of this case study is on the bike-sharing schemes in Vienna and the surrounding region Lower Austria (*Niederösterreich*). A computer-assisted telephone interview (CATI) was carried out to capture user responses to two different bike-sharing schemes in and around Vienna. Citybike in Vienna has been in operation since 2003 and currently served with about 100 stations within approximately 3km radius from the city centre. The survey revealed that more than 90% of citizens in Vienna know about the scheme and 28% stated that they have already used it. nextbike in Lower Austria started in 2009, installed not only in cities but also in small towns and villages as well as in several rural tourist regions along the River Danube. Use of bike sharing is much lower for nextbike, at under 5% of survey respondents. The most typical reason for not using a shared bike is that an individual respondent owns their own bicycle.

Case Study 8 - Car sharing in Karlsruhe

Car sharing in Karlsruhe, when measured by cars per inhabitant, is probably the most successful system of this kind of mobility concept in the world. It is a system of classical car sharing (car club), where all cars have fixed locations i.e. when renting a car, the user has to pick it up at a distinct location and drop it off at the same point. An analysis of long-term booking behaviour showed that the annual mileage per user significantly decreases with the years to about 1,400 kilometres a year. Assuming a consistency in the number of journeys undertaken per person, the conclusion can be drawn that car classical sharing causes a switch in mode choice towards public transport and bicycle usage. This is backed by the results of a mobility survey undertaken in Karlsruhe in 2012. Comparing this system of classical car sharing with dynamic or floating car sharing, as provided, e.g. by Daimler motor company in Ulm since 2009 under the brand car2go, there are distinct differences between these systems in user behaviour, efficiency and therefore also in financial viability.

Case Study 9 - Grass-root cooperative smart phone-based car sharing in Austria

This case study focussed on a recent grass-root cooperative car-sharing initiative in Austria called CARUSO. The system is such that users have to form a car-sharing group spontaneously based on their needs: the shared cars are provided by a group member (e.g. an individual, public organisation such as municipality, private companies, etc.) or procured cooperatively by the group and there is no car-sharing company owning and offering vehicles. The user fee can be set in a flexible way and each group adopts different pricing models such as linear per-km tariff with or without annual fee or just 6-month user fee divided based on the approximate usages by users. The system is mostly targeted for rural areas, having a smaller scale compared to conventional car sharing schemes: one or a few cars to be shared by around 30 users. A special insurance policy package dedicated for CARUSO offered by a regional insurance company covers the mandatory insurance needed for this form of car sharing.

Case Study 10 - Sant Cugat intelligent motorway toll system

The motorway between Sant Cugat and Barcelona is a 13 km toll highway that opened in 1991. The opening of this motorway, which includes a 2.5 km tunnel under the Collserola hills, had a great impact on the attractiveness of Sant Cugat and the Vallès Occidental county as levels of accessibility increased dramatically, inducing an important migration flow of middle and upper class residents from Barcelona. Tabasa, a public operator managed the motorway until December 2012, at which time it was sold to the private sector. Tabasa pioneered the implementation of smart infrastructure equipment, enabling semi-automatic free-flow toll payment in the 1990s, then introduced automatic incident detection systems inside the tunnels, environmental toll reductions for clean vehicles linked to OBU devices and, more recently, a computer based HOV recognition system at tolls allowing for automatic vehicle occupancy detection and fare reduction.

Case Study 11 - Latis: ICT modelling in Scotland region 2007 to 2027

This case study aimed to quantify the potential impacts, in terms of reduction in CO2 emissions and traffic congestion levels, of a number of ITS solutions. The first solution assessed the impact of in in-vehicle travel time on road-based public transport, which may be the result of, e.g. smart ticketing measures, improved traveller information and bus signal priority. The second solution assessed the impact of increased car occupancy levels which may be achieved by, e.g. lift-sharing initiatives. This quantification is made feasible by the existence of the LATIS model (Land Use and Transport Integration in Scotland) which is an integrated land-use and transport model for strategic assessment across the full Scotland region. The nature of the LATIS model is such that the relative impact of possible ICT scenario effects could be assessed across different sub-regions; specifically urban regions, inter-urban and rural regions.

1.2.2 Methodology

Approach

The local assessment carried out through case studies follows the framework previously presented.

The selected case studies were conducted in different settings in which ICT solutions could be researched and tested. Case studies involved both deskwork and interviews with selected stakeholders. A number of case studies have developed add-hoc surveys, especially for those where important data was missing. Surveys were carried out in five case studies:

- Case Study 3 – Accessibility applications for disabled people
- Case Study 4 - ITS solutions for Barcelona's local bus network
- Case Study 5 – Future interurban public transport in Warminsko-Mazurskie vovoidship.
- Case Study 7 - Bike sharing in Vienna and the surrounding region
- Case Study 9 - Grass-root cooperative smart phone-based car sharing in Austria

The process for selection of case studies takes as its starting point the selection of ICT solutions. Then, taking into consideration different types of solutions, a proposal for case studies was developed. This proposal was elaborated in order to ensure a good distribution of case studies in Europe and among different kinds of regions, and of the technical solutions analysed. While region and technology selection provided a variety of different EU settings, the case study selection was also influenced by other factors like type of ICT solutions which could be researched in a given location and by the impacts the ICTs might have on users, transport systems and society; also the availability of data and resulting possibility for conducting field research had to be taken into account.

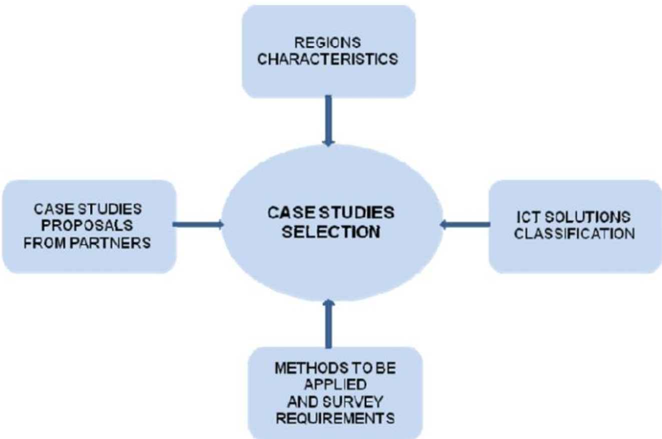


Figure 1-1 Determinants of case study selection

The analysis of case studies, together with findings derived from the COMPASS *Handbook of ICT Solutions*, form the basis for the European assessment. The case studies also constitute a body of work intended to draw conclusions and recommendations from the COMPASS project.

Criteria behind case study selection

The first element of the selection process was the identification of ICT solutions to be applied in case studies according to the classification of solutions developed in COMPASS. It was decided to cover all five categories of ICT solutions in case studies:

- transportation management systems,
- traveller information systems,
- smart ticketing and tolling,
- smart vehicles and infrastructure,
- demand responsive transport services.

The next element of the selection process was the choice of regions. The differences between European regions will lead to different reception of ICTs by local citizens, authorities, transport organisers and planners. In COMPASS the region selection process, to ensure full social, economic and geographic coverage, was based on the principle of selecting as many different region types as possible. Regional differentiation was based on major factors which are responsible for creating regional differences, including economic, geographic and culture/tourism factors.

Economic factors are represented by the *GDP per capita indicator* (1st criterion). The rationale behind this selection is that it allows for establishing which regions are wealthy and which are poor in regard to the EU average. This criterion has significant impact on the possibility for ICT introduction. ICTs are usually capital intensive tools and as such are more likely to be considered by transport planners and organisers active in wealthy regions. Lack of capital and general poor financial ability of transport users have been often perceived as serious barriers to the introduction of ICTs.

Geographic factors are represented by a number of features impacting the need for ICT solutions. Among those *accessibility* (2nd criterion) is crucial as it is often a function of peripherality. As such it dictates the need for efficient long-distance travel and increases the need for ICT solutions to improve long trips. Core areas tend to be heavily congested, thus needing ICT solutions that allow better handling of large numbers of passengers using transport in short periods of time.

Different ICT tools are necessary for *urban and rural areas* (3rd criterion). Here the differentiation should be even more detailed as metropolitan areas tend to create different demands on transport systems than cities. Similar distinction could be drawn between rural regions close to the cities and those which are remote.

Specific locations on coastal, mountain or border (4th criterion) territory contribute to differing needs for ICTs. Those special locations often add burdens to the transport system and use of ICTs in them is more likely to occur than in other region types.

Cultural factors have a strong impact on the behaviour of users (5th criterion). Culture, when it manifests itself by various national heritage sites or through historical landmarks, impacts tourism. Areas which happen to be main tourist destinations require more ICTs and more advanced ICTs to handle increased traffic and very diverse needs of international travellers.

The indicators that represent the above mentioned factors were applied to the proposed case study locations and the resulting analysis allowed for selection of most differentiated setups for detailed study. The resulting multilevel matrix allowed for the selection of the best-fitting case studies, which have the potential to cover most ICT applications and which are "researchable" due to the partners' knowledge, contacts and ability to collect data.

On this basis the final proposal of 11 case studies for detailed research was formulated.

1.2.3 Surveys for Case Studies

Case studies have to build upon well researched data about user responses to proposed ICT solutions. To this effect within five case studies in-depth surveys were conducted in different (accordingly to COMPASS criteria) setups across Europe. The survey methodologies were dependent on the needs of each particular case study. Surveys were based on various tools like questionnaire (field work, internet based, telephone based), and interviews (focus groups, telephone interviews). Both qualitative and quantitative approaches were utilised.

The surveys were designed to provide maximum missing information needed for each of the case studies. Hence the unequal number of surveys per case study. Some of the case studies are in the well-researched areas where basic information is already known (e.g. London, Barcelona), while others are in peripheral and rural areas (e.g. Warminsko-Mazurskie or rural Austria). The most important information collected through surveys for each case study could be summarised as follows:

- For the case study on accessibility applications for disabled people the user acceptance, usage and problems which can be solved with the use of specific (directed at disable people) ICT solutions have been researched.
- For the case study on ITS solutions for Barcelona's local bus network the user opinions on positive and negative aspects of the TMB (Barcelona's bus operator) solutions and their willingness to pay for additional services provided through ICT have been researched.

- For the case study on future interurban public transport in Warminsko-Mazurskie vovoidship the user acceptance of proposed ICT solutions, barriers to their introduction, possibilities for modal shift due to the introduction of ICTs, user willingness to pay for ICT applications, transferability potential of ICTs to rural areas have been researched.
- For the case study on bike sharing in Vienna and the surrounding region user acceptance of different ICTs used for bicycle traffic and especially for bike-sharing schemes, conditions for development of bicycle related ICT's and features of ICT's which might attract more users to bike-sharing have been researched.
- For the case study on grass-root cooperative smart phone-based car-sharing advantages and disadvantages of solutions used alongside the car sharing schemes, user acceptance, interest to participate, impacts of employed solutions on user behaviours have been researched.

All data gathered through surveys has been used for the development of appropriate case studies.

1.2.4 Transferability of solutions

The objective of this activity is to assess transferability of the solutions analysed within case studies. Such analysis enables to inform on the transferability potential of the experiences investigated as well as to provide a basis for the discussion on the potential barriers which might hamper the diffusion of such kind of solutions.

Within COMPASS project the methodology for transferability analysis was developed and it is described in the report. The definition of COMPASS transferability assessment framework started with a review of transferability approaches recently developed in other European research projects (INTERCONNECT, ORIGAMI, NICHE+). In the approach proposed by COMPASS three main dimensions are considered for the transferability assessment:

- the applicability of the solution;
- the interest for the solution;
- the feasibility of the solution.

Within the dimension of ***applicability***, the spatial area and the demand segment addressed by the solution are the two main components to be investigated. Co-modality refers to solutions that can be implemented in an urban area, in a rural one or at a regional or corridor level and that can intercept different demand segments (i.e. short-distance or long-distance, the latter being also national or international).

Within the dimension of ***interest*** three different groups of stakeholders are considered: the *traveller,* the *operator* and the *government*.

The ***dimension of feasibility*** is investigated in relation to the following set of stakeholders: *financier*, *regulator*, *technology supplier* and *non-users*.

In order to make a cross-cutting analysis the 21 solutions have been clustered according to the categories of ICTs solutions identified in the COMPASS Handbook. 10 clusters are identified:

- CLUSTER 1 - Passenger orientation and guidance
- CLUSTER 2 - Automated fare collection systems (AFC) - Ticketing systems
- CLUSTER 3 - Access management
- CLUSTER 4 - Shared mobility
- CLUSTER 5 - Co-modal travel planners
- CLUSTER 6 - Strategic transport management for corridors and network
- CLUSTER 7 - Real time travel information services
- CLUSTER 8 - Electronic toll collection
- CLUSTER 9 - Demand Responsive Transport (DRT)

- CLUSTER 10 - Collective Taxis

Based on the cross-cutting analysis for all 21 solutions investigated by COMPASS case studies it could be concluded that transferability assessment can be considered a delicate matter which is strongly influenced by subjective perceptions and experiences of all stakeholders involved that might differ quite a lot from country to country and from zone to zone, making it very complex to reach an indisputable point of view. When taking into account different COMPASS transferability dimensions different types of barriers are more or less important in given setups. Yet it was possible to identify strongest influences - most significant and difficult to overcome barriers results from low interest for operators and low feasibility for financiers. Then also the lack of interest for travellers generates implementation barriers. Other factors like low interest for government or low feasibility for regulators, technology suppliers or non-users seem to be easier to overcome.

Applicability of ICT solutions tested shows that it is usually high regardless of region and context. Several of researched ICTs can be replicated in different contexts or geographic scales and for some of them the analysis already provided with an evidence of their high transferability. Moreover it seems that ICTs bundled together while more complex than single use solutions offer more benefits to the users due to the synergy effects and are still well transferable. Interest for travellers is varied and rather solution than location dependent. The level of interest of travellers for ICTs is strongly related to the perceived benefits deriving from their exploitation: the most of them is related to the quality level and to the timing the information is delivered to final users. Indeed, information is a high perishable good that should be provided to travellers at the right time and in the right place otherwise it might be useless. The interest of operators towards the diffusion of ICTs applications to transport is strongly influenced by the benefits achievable from their implementation and by the balance between the costs (financial and organisational on the operator side) and the expected operator benefits. Interest for governments is conditioned on the role of ICT in fulfilling policy objectives. Governments are more likely to promote and support those ICTs which contribute to the achievement of specific policy goals (e.g. reduction of CO_2 emissions) as compared to ICTs which only contribute to user wellness (those only increasing user comfort)

The financial side of ICTs is the most challenging issue in their development. Profitability - evaluated in terms of additional revenues compared with the overall magnitude of costs for the implementation of the solution - for the most of investigated ICTs is low and it is further accompanied by a general low potential of benefiting from international and also national funding.

As far as concerns the technology supply, the analysis disclosed that the level of technology to be made available by the end-user for investigated solutions is different. For some solutions it is only a matter of development of non-resource consuming applications for existing technologies (e.g. applications for smartphones) for others investment in transport technology and/or increase in capacity of telecommunication networks is needed. In general terms it can be expected higher transferability potential for those solutions requiring null or limited provision of technology equipment by operator and/or end-users.

1.3 EUROPEAN ASSESSMENT OF ICT SOLUTIONS

Based on the findings at the local scale from case studies and from knowledge gained from the analysis of ICT transport solutions in the *COMPASS Handbook*, quantitative modelling is then used to assess to the potential impact of ICT solutions at European scale.

The assessment of long-distance ICT solutions is based on quantitative modelling using MOSAIC, the European-wide model developed in the INTERCONNECT FP7 research project, a modal choice and assignment module originally programmed to investigate how upgrading the interconnections between transport networks in Europe impacted on the European transport system. The model description is available in chapter 14 of this report, as well as in Annex I.

From a demand side, ICT impacts both on trip substitution (e.g. teleworking, teleconferencing) and on trip induction (e.g. enlarged personal and business relations supported by ICT inducing trip demand increases). The net impact of ICT in travel induction and substitution is difficult to assess isolated from other social, economic and technologic drivers. What can be stated, however, is that ICT allows for better real-time transport management of user needs, transport conditions and externalities, creating incentives for more informed user choices leading to a more efficient transport system. Increase in demand or decrease due to ICTs has not been considered in COMPASS.

From a supply side, ICT implementation on transport systems results in efficiency improvements, mainly through: more reliable transport services and vehicles and more efficient traffic management leading to travel time reductions; more efficient infrastructure management, leading to operating costs savings and; to the extent infrastructure managers transfer these savings to users, also to travel fees and user costs reduction; and more information to users, increased comfort and convenience, leading to a change in the value of the time perceived by users when travelling[1].

In synthesis, the following elements have been considered:

Optimised infrastructure and service management

- Road cost decrease due to:
    - better vehicle performance and more efficient driving regimes via semi or fully-autonomous vehicles;
    - less congestion due to more intelligent GPS routing avoiding congestion, traffic jam assistants.
- Air mode and long distance rail cost decreases due to more efficient management

Optimised intermodality

- Easier interconnections,
- Less time for formalities in airports,
- Road mode speed at connectors increases due to better management of metropolitan motorways.

Optimised traffic management

- Air speed increases obtained from more direct routing and better management of take-off and landing operations,
- Rail speed slightly lower due to more difficult implantation of ERTMS all over Europe,
- Road speed increase with more autonomous vehicle driving (e.g. SARTRE platooning, advanced cruise control).

Potential of ICT solutions

The potential of ICT solutions for improving the transport system is large. For instance:

- Access and egress by road from cities, airports or major high speed rail terminals can be achieved via a number of different ITS solutions applied to urban and metropolitan motorways, such as the implementation of dynamic speed limits, active hard-shoulder management, or ramp meters in accesses (infrastructure management dimension). It can also be addressed with smarter on-board route assistants for vehicles that consider real-time congestion on the network, advanced driver assistance systems (ADAS) that allow for more stable traffic flows, or with traffic jam assistants that allow quicker dilution of congestion waves (service management dimension).
- The speed increases in the air mode can derive from more direct routing of flights facilitated by more integrated air space management (already tested by EUROCONTROL's FRAM pilot initiative above the skies of Maastricht); it is also assumed that aircraft can fly closer to each other with more accurate radars (satellite based ADS-B successor to radar); and that take-off and landings are faster at airports as surface movements become optimally managed with new

[1] It has been analysed in the literature how the value users place on travel time varies depending on the type of trip, people's preferences, and travel conditions. The impact of "soft-factor" solutions addressing user comfort and convenience is assessed in COMPASS by testing how the model responds to reductions in the value of travel time of users.

initiatives such as A-SMGCS. Ensuring better punctuality of flights allows for faster terminal transits during "plane connections, which can be reduced from 90 to 30 minutes (according to ACARE's "Flightpath 2050" the goal is to reach that all flight arrive within 1 minute of the planned arrival time regardless of weather conditions).

- Speed increases in the rail and road modes can be driven by technologies ensuring safety at higher speeds. In the case of rail, ERTMS is to allow for greater operating speeds (as trains are able to autonomously regulate operating speeds and automatically break in case of emergency with lower reaction times) and services can operate closer to each other (more service frequencies in busiest corridors). For cars, many devices aimed at increasingly autonomous driving regimes (e.g. ADAS, car platooning like in SARTRE, robotically driven cars such as Audi's TT trial or Google's) allow for increased driving speeds at motorways without compromising safety, vehicle-to-vehicle communications on VANET platforms (Vehicular Add-hoc NETworks) allow anticipation of incidents on the road before vehicles reach hot spots, or even vehicle-to-infrastructure communications allow for vehicles anticipating bad road conditions or eventual traffic speed restrictions.
- On public transport modes (i.e. air, rail and ferry), there are many "soft factor" solutions which have an impact on the way users may perceive travel time. Real-time information to users on service operation reduces the uncertainty of passengers when waiting at stops. Collaborative P2P information networks on public transport service operation and eventual service disruptions allow passengers to search for alternatives, or to handle exceptional situations with lower levels of stress. Travel planners on smart phones allow users to seek routing assistance at all times, reducing the possibilities of using wrong travel choices or getting lost. Increased amenities in vehicles (e.g. WiFi internet) or allowing more informed pre-trip seat choices (e.g. seat allocation in planes based on social network profiles, or on collaborative P2P aircraft information as in SeatGuru) allow more convenient and comfortable journeys, especially on very long trips.
- The car industry initiatives to increase the levels of comfort while driving also impact on the way users perceive travel time costs: high-performance music or entertainment systems, and semi-automated solutions for certain aspects of driving, like automatic vehicle parking assistants, traffic jam assistants and smarter cruise control devices increase the overall comfort of drivers and passengers. Advanced GPS systems considering real-time congestion or upcoming VANET systems keep drivers informed at all times for best travel route choices or traffic disruptions. New ICTs like head-up display, night vision, automatic pedestrian detectors, pre-crash systems keep increasing vehicle safety in all traffic and weather conditions, reducing the levels of stress of drivers.

1.4 Assessment Framework

1.4.1 Background and Approach

The evaluation framework of COMPASS was determined following the principles of evaluation of the INTERCONNECT toolkit[2] and taking account of the considerations made for the ORIGAMI[3] project.

INTERCONNECT listed a 12 assessment criteria, including costs of implementation, technical, financial, organisational-legal feasibilities, user and political acceptance, impact on travel time, travel cost, comfort and convenience, safety, security, and detectable increased accessibility for people with impairments. These 12 criteria were used in qualitative terms, although for project costs, travel time and travel costs quantitative thresholds were defined.

Additionally, ORIGAMI used this thematic approach in combination with a discussion on stakeholders involved, based on RailPAG's[4] assessment framework by the European Investment Bank, to define a

[2] INTERCONNECT FP7 project (www.interconnect-projet.eu).
Bonsall, P., Abrantes, P., Bak, M., Bielefeldt, C., Borkowski, P., Maffii, S., Mandel, B., Matthews, B., Shires, J., Pawlowska, B., Schnell, O., and de Stasio, C. "Deliverable 3.1: An Analysis of Potential Solutions for Improving Interconnectivity of Passenger Networks", WP3, INTERCONNECT, Co-funded by FP7. TRI, Edinburgh Napier University, Edinburgh, March 2011

[3] ORIGAMI FP7 project (www.origami-project.eu).
Ulied A, Biosca O, Bielefeldt C, Calvet M, Rodrigo R, Carreno M, Cullinane K, Condie H, Bak M, Borkowski P, Mandel B, Schnell O, Shepherd S, Matthews B, Bonsall P, Enei R, Lemmerer H, Emberger G, "Finalised Collection of Best Practice Examples", Milestone MS6 of ORIGAMI, Co-funded by FP7. TRI, Edinburgh Napier University, Edinburgh, January 2013

set of criteria to assess transferability of best practices. A solution was considered to have a high transferability potential when it had a manifested interest for a wide range of stakeholders (users, operators, government), and when conditions were such that there were no feasibility barriers to its transferability. The analysis of interest and feasibility for different stakeholders was based on the INTERCONNECT criteria.

In addition to these previously exposed, COMPASS incorporated also assessment criteria in line with criteria used by the European Comission in the transport White Paper[5], in the EU2020 strategy[6] and in the Cohesion Policy[7]. These additional criteria include modal shift, increased mobility, congestion, CO2 emissions, contribution to user-pays-principle, European economic progress and territorial cohesion.

Table 1-1 Assessment criteria in COMPASS

Feasibility	Interest for Travellers	Modal change	Other Impacts
Investment Costs	D2D travel time	Car usage	Increased Mobility
Operation and Maintenance Costs	D2D travel cost	Bus and Coach usage	Congestion
Financial Viability	Comfort and convenience	Rail usage	CO2 emissions
Technical Feasibility	Safety	Ferry usage	Contribution to User Pays Principle
Organisational Feasibility	Security	Aerplane usage	European Economic Progress
Administrative Burden	Access. for impaired pax.		Territorial Cohesion
Legal feasibility			
User Acceptance			
Public acceptance			

Solutions identified both in the COMPASS Handbook of ICT Solutions and in the COMPASS Case Studies[8] are discussed qualitatively for each of the assessment criteria considered above, then synthesised using a set of scores which follow the rules exposed below. Scores are aimed at providing quick portraits of solutions and allowing for quick comparison between solutions.

1.4.2 General Rules for Assessment of Solutions in COMPASS

Feasibility

Investment costs

There are two aspects concerning investment costs considered in COMPASS: subsidies and the relative scale of the total cost of implementation of a solution.

If the development of a system is a) subsidised by the State of e.g. by the European Commission AND it is then b) made available to multiple users, as in the example of ADS-B that is meant to replace flight radar, then these development costs are not counted as investment costs. Investment costs are then the costs that are being actually paid by each of the bodies that are installing / implementing one of these systems. If only a) applies, for instance in the case where a tram system that is later to be operated by a private company, then the total cost of the system counts independent of which part of it was funded privately or publicly.

[4] Turró et al.; "Railway Project Appraisal Guidelines *RailPAG*", European Investment Bank EIB, 2005
[5] WHITE PAPER "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system", EC 2011 (COM(2011) 144 final)
[6] COMMUNICATION FROM THE COMMISSION EUROPE 2020 "A strategy for smart, sustainable and inclusive growth", EC 2010 (COM(2010) 2020 final)
[7] Green Paper on Territorial Cohesion "Turning territorial diversity into strength", EC 2008 (COM(2008) 616 final) and Territorial Agenda of the European Union 2020 "Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions" agreed at the Informal Ministerial Meeting of Ministers responsible for Spatial Planning and Territorial Development at Hungary, 2011
[8] Deliverable D6.2 of COMPASS "An Assessment of the Potential Impact of ICT Solutions on a co-modal Transport System"

The only scores available for investment costs are ú, úú, and úúú, meaning in turn cheap, expensive, very expensive. Exact costs are not known in most cases, normally at best a possible range of costs, and only rarely precise costs, hence it is impossible to define precise borderlines between them. What is even more pertinent, is that costs are relative to the type of user and system: ú 1,000 for a mobile app is forbiddingly high, ú 1,000 for a system installed in a luxury car is not particularly notable for the buyer, and ú 1,000 for a roadside sign is regarded a cheap measure by a road authority. All scores given here have to be seen in this context.

Operation and maintenance costs

The same as has just been said about the relativity of investment costs is also true for operation and maintenance costs. Even an annual fee of ú1 may be regarded by many as expensive for a mobile app, while it is a non-issue in most other contexts.

But here is another aspect to be considered. If a new ramp metering system is installed, then all specific operational and maintenance costs count against the new system. These may depend to some extent on whether the ramp meter is a stand-alone system or part of a larger motorway control system, but the differences between these two circumstances are in most cases somewhat limited.

Where, as in the case of the improved weather information with a four-dimensional weather cube, one existing system is replaced by a better, the score is determined through the comparison of the operation and maintenance costs: if the new system is more expensive to run then the old one (even if it produces much better results), it gets úúú, if the costs are roughly the same úú, and if the new system is cheaper to run than the old one, then it gets ú, even if it might still be expensive in absolute terms.

Things become more difficult if the old systems cannot be phased out as the new one comes in, as in the case of ADS-B replacing flight radar. Until all planes are equipped with the new system, both systems have to operate in parallel and the running costs of both systems are incurred for a considerable time period. The general time horizon of COMPASS is 20 years, and in such a case the operation and maintenance costs have to be judged in total over the next 20 years and compared with the costs of the existing system, in this case radar, over the 20 years. If the new plus the old systems become cheaper in total over the 20 years, then it is ú, if it is the same in average úú, and more expensive then it is úúú.

Financial viability

A √ for financial viability means that the system is not just socially beneficial, but actually raises income that is higher than the running costs and √√ means a significant surplus. It is judged as 0 if there is no direct return of investment or if the return is too low to pay back the investment, operational and maintenance costs within a reasonable time period. It also gets 0 for public investors, if the social overall social benefit is greater or at least in the same range as the systems costs. X or XX are only applied if a private investor is not expected to see a return for his investment in any shape or form. For instance a car driver, who invests in a safety system as an extra to his car, might not have had any accident in the future anyhow, but the system might save him from an accident that he would have had; so in this case the score would still be 0, because there is a real chance of a personal gain (which is the reason why the driver invested in the system in the first place) even if no guarantee for it.

Technical feasibility

If there are technical problems that have not yet been solved in relation to the exposed solution, then this gets a X. Whether there were no problems in the first place or whether the initial problems have already been overcome does not make a difference, in both cases it is considered a 0.

Organisational feasibility

If there are organisational problems that have not yet been solved in relation to the exposed solution, then this gets a X. Whether there were no problems in the first place or whether the initial problems have already been overcome does not make a difference, in both cases it is considered a 0.

Administrative burden

If the administrative burden increases through the introduction of the system, the solution is scored with an X; if the administrative burden decreases, it is a √; and otherwise it is a 0.

Legal feasibility

If there are legal problems that have not yet been solved, then this gets a X. Whether there were no problems in the first place or whether the initial problems have already been overcome does not make a difference, in both cases it is a 0.

User acceptance

The users for each of the solutions in COMPASS are not necessarily the travellers, but those who buy and install the system, i.e. those identified as targeted users. If they take it because somebody forces them to, but they have no objections against it either, user acceptance is granted a 0. If they object to the system and therefore either not agree to install it or have to be forced to install it, that will be X or even XX. If they welcome and embrace it, it will be a √.

Public acceptance

If the public is not even aware of the system, as for many of the aircraft related ones, then it is always a 0. If there can be positive comments expected in the press or it can be generally expected that the public will welcome the idea, it will be a √, and if the public do not like the idea, then it is a X or in case of a public outcry even a XX.

Synthesis of performance scores

Table 1-2 Performance criteria in relation to feasibility issues

Investment costs	Operation and maintenance costs	Financial Viability	Technical Feasibility	Organisational Feasibility	Administrative burden	Legal feasibility	User acceptance	Public Acceptance
		XX	XX	XX		XX	XX	XX
		X / XX	X / XX	X / XX		X / XX	X / XX	X / XX
úúú	úúú	X	X	X	X	X	X	X
úú / úúú	úú / úúú	(X)	(X)	(X)	(X)	(X)	(X)	(X)
úú	úú	0	0	0	0	0	0	0
€ / úú	ú / úú	(√)		(√)	(√)		(√)	(√)
ú	ú	√		√	√		√	√
		√ / √√						
		√√						

Interest for travellers

D2D travel time

A significant change in travel time is a √ (travel time savings) or an X (travel time increases). If the changes in travel time are about a few minutes in rare situation, then it is left to 0. Frequent borderline cases of 10 minutes are identified with (X) or (√).

D2D travel costs

A significant change in door to door travel cost is a √ (travel cost savings) or an X (travel cost increases). Travel cost can increase or decrease due to e.g. a change in fuel and vehicle operating costs (for roads) and/or to fees and charges e.g. rail or flight tickets, or road toll. The installation cost of a new on-board system has already been taken into account under the investment costs, and does not come up here again the form of costs of depreciation. Similarly, savings due to the value of travel time savings are accounted for under travel time, and cost savings from the prevention of accidents are accounted for under safety, and neither are double counted here again.

Comfort and convenience

A typical example for an increase in comfort is the situation where a better weather forecasting system allows pilots to avoid areas of turbulence. Another is the seat choice via facebook, where the passenger has a better chance to sit next to somebody who wants to talk on a long flight, as he does, or be silent and read a book, as he does.

An increase in punctuality and reliability and a reduction in delays have already been scored under D2D travel time and eventually under congestion reduction, and do not score again here.

Safety

An increase in transport safety is given a √ and a reduction is a X.

Security

An increase in transport security is given a √ and a reduction is a X.

Accessibility for impaired passengers

An increase in accessibility for impaired passengers is given a √ and a reduction is a X.

Synthesis of performance scores

Table 1-3 Performance criteria in relation Interest for Travellers

D2D travel time	D2D travel cost	Comfort and convenience	Safety	Security	Accessibility for impaired
XX	XX				
X / XX	X / XX				
X	X	X	X	X	X
(X)	(X)	(X)	(X)	(X)	(X)
0	0	0	0	0	0
(√)	(√)	(√)	(√)	(√)	(√)
√	√	√	√	√	√
			√ / √√		
			√√		

Modal Change

Car, bus and coach, rail, ferry, and aeroplane usage

Under this section, it is assessed if solutions have an impact on modal change. Therefore, for each mode, a **+** is given for an increase in the use of that mode, and a **-** for a decrease.

Synthesis of performance scores

Table 1-4 Performance criteria in relation to Modal Change

Car usage	Bus and coach usage	Rail usage	Ferry usage	Aeroplane usage
- -	- -	- -	- -	- -
- / - -	- / - -	- / - -	- / - -	- / - -
-	-	-	-	-
(-)	(-)	(-)	(-)	(-)
0	0	0	0	0
(+)	(+)	(+)	(+)	(+)
+	+	+	+	+
+ / ++	+ / ++	+ / ++	+ / ++	+ / ++
++	++	++	++	++

Other Impacts

Mobility

Increases in mobility get √ and decreases X.

Congestion in overcrowded corridors

A reduction in overall congestion gets √. When reduction of congestion is only very localised, it is given a (√). It should be borne in mind that congestion reduction also means decreases in D2D travel time.

CO2 emissions

A reduction in CO2 emissions can come from two main sources: one is the reduction in congestion and concurrent reduction in fuel consumption and the other one is a shift towards more sustainable modes. CO2 emissions are granted √ for reductions (or even √√ in cases where impacts are very wide ranging indeed), and X or even XX for increases (e.g. in solutions promoting an increased use of the road or air mode in relation to rail).

Contribution to user pays principle

This is a simple case of √ if there is a contribution, 0 if there is none, and X if the system is counterproductive to this target.

European economic progress

Improvements through a system must be very wide ranging and of large scale to allow the judgement that it is making any significant progress towards European economic progress. In this case, solutions get a √.

Territorial cohesion

The main aspect that allows a √ for this is an improvement in cross-border connections or increased accessibility of remote territories.

Table 1-5 Performance criteria in relation to Other Impacts

Mobility	Congestion in overcrowded corridors	CO2 emissions	Contribution to User Pays principle	European economic progress	Territorial Cohesion
XX		XX			
X / XX		X / XX			
X	X	X	X	X	X
(X)	(X)	(X)	(X)	(X)	(X)
0	0	0	0	0	0
(√)	(√)	(√)	(√)	(√)	(√)
√	√	√	√	√	√
√ / √√		√ / √√			
√√		√√			

2 CASE STUDY 1 - AN EU-WIDE MULTIMODAL TRAVEL PLANNER: ROUTERANK

2.1 EXECUTIVE SUMMARY OF THE CASE STUDY

The multimodal travel planner routeRANK enables the user to plan and book trips by all modes throughout Europe (and worldwide for air transport). routeRANK identifies the best travel options per mode and ranks them by usersô choice, concerning time, costs, CO2 emissions and other attributes of the outlined travel options. As it displays travel alternatives for several modes in one search, it promotes co-modality - the usage of those means of transport on a specific trip that best fit the userõs needs - and helps to reduce the preference of the consumer towards a distinct mode. The system has been working since 2006 and with the help of premium versions, available in addition to a free of charge basic version, it shows financial viability. To assess user behaviour 100,000 searches on this tool have been monitored and analysed, the results showing a significant preference for minimising travel costs over other attributes of the travel suggestions, while ranking the travel options by emissions caused was the least chosen solution. Limitations identified are the lack of long-distance coach services in the travel alternatives displayed, and in some cases there is unavailability of data from some external travel information (train/public transportation) providers.

2.2 THE BACKGROUND OF THE CASE STUDY

2.2.1 Motivation for this Case Study

Although a multimodal travel planner was already a topic in the WISETRIP project, funded by the EC FP7-SST Programme, it was decided in COMPASS to include a case study on routeRANK as this travel-planner:

- Actually works;
- Covers all Europe and also air, road and increasing publish transport on other continents;
- Does not require user registration or annoying captchas;
- Identifies the best travel options per mode and ranks them by usersô choice, concerning time, (real) costs, CO2 emissions etc.;
- Combines information on travel options with booking facilities;
- Has an underlying business model to run this service permanently on an economically sustainable base;
- Offers customised versions (business applications) and;
- Provides the information really needed to prepare a trip and decide which route and which mode(s) to choose and where to book it.

2.2.2 General Description of the Region

The multimodal travel planner routeRANK covers the whole of Europe for rail, road and air travel with a combination of rail and road as feeder services on a region to region base. In addition an air travel search also works for worldwide destinations.

2.2.3 Stakeholders Involved

The first stakeholder involved in the case study is the provider of the travel planner: RouteRANK Ltd, Parc Scientifique EPFL, PSE-C, CH-1015 Lausanne, Switzerland. Furthermore users of the travel-planner, either with customised versions or with the open, freely available internet version, were involved through the monitoring and analysing a part of their usage of the system (in an anonymised way).

2.2.4 Methodology of the Case Study

The case study describes the existing system from the usersô point of view. It analyses the technical and organisational prerequisites necessary to set up and run the system. Furthermore, the business model behind this travel planner (including tailored applications for dedicated users) will be described. Limitations of the system, the reasons for them, and solutions how to overcome them will be identified. Collected logging data allows an assessment of what decisions in the light of a ögreenô mobility a user might have drawn concerning mode and route choice.

2.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

2.3.1 General Description of the Case Study

routeRANK provides a software solution for travel planning. Unlike other solutions that consider only one means of transport at a time, routeRANK addresses the entire travel route by integrating rail, road and air connections and their many multimodal combinations. In a single search, routeRANK's patent-pending technology finds and ranks the best possible travel routes, allowing users to sort them according to their priorities such as price, travel time and CO2 emissions. This is done by combining several unimodal transport options provided by external providers into multimodal routes and displaying these travel options with their related attributes (route, schedules, prices é) together with a link (most of the case a deep link) leading the user to the relevant portal where the selected travel option can then be booked.

In the Master thesis ñ*How much time, money and CO2 emissions could routeRANK save a typical travel planner?*ö the Statistical Laboratory of the University of Cambridge, finds that 'a typical user could stand to save around 35% when using routeRANK as well as around 2½ hours in research time, in addition to contributing to the environment.

The necessary input from the user to the web form is displayed in Figure 2-1 below.

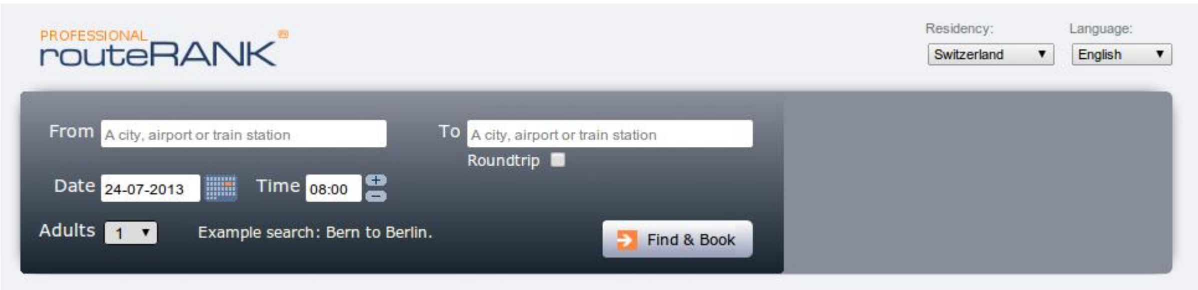


Figure 2-2 Input template of the travel planner

The user indicates origin and destination city, if itös a one way or return trip and the date(s) and day time(s) of the trip. The user may also indicate the country of residence and the language.

For each solution time of departure and arrival, means of transport, number of changes within each mode required, total travel-time, CO2 emissions and price are displayed. The user then may sort the solutions to a criterion of his choice (here: time), and check details for a distinct travel option. The detailed view of a specific travel option shows the attributes mentioned above for each mode used on the trip and furthermore indicates the carrier and a link to the internet booking portal selected with respect to country of residence and language indicated by the user. Prices are indicated in the currency of the userös country of residence. For road segments of the specific travel option a link is provided to a route planner for road displaying the driving path with all details. A link to an organisation is provided where the traveller can voluntarily contribute to carbon offsetting for the compensation of the CO2 emissions calculated for the trip.

An in-depth description documentation of how to use the basic public version of routeRANK is available in English, German, French, Spanish, Italian, and Dutch and can be found at http://www.routerank.com/en/faq/ .

Figure 2-2 below displays the best search results for a trip from Karlsruhe, Germany, to Copenhagen, Denmark, ordered by total travel time. In addition a selection of modes to be used for access/egress has been chosen and also attributes concerning car travel have been selected.

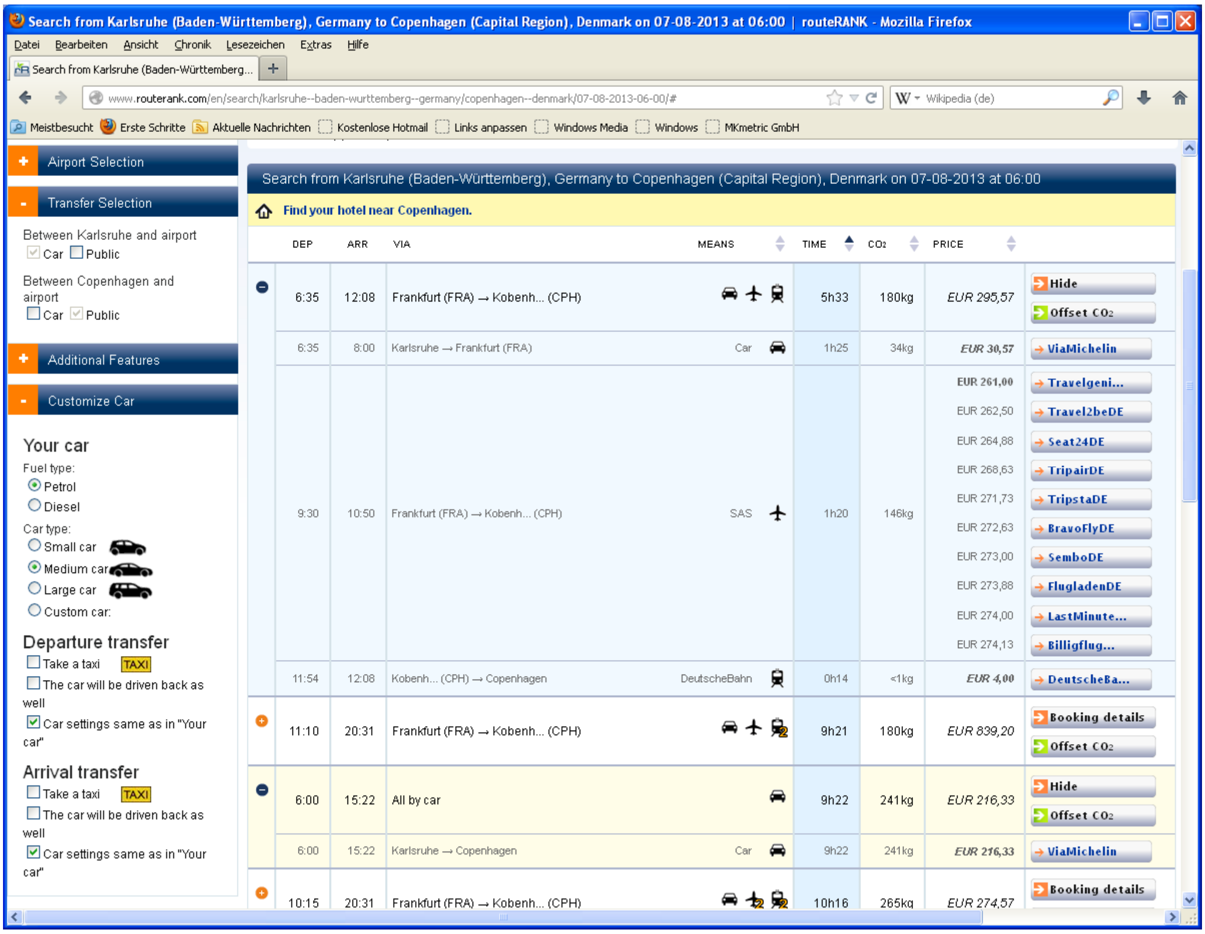


Figure 2-3 Detail view of route search results (public version)

Besides the publicly available version on routeRANK's website www.routerank.com, corporate customers can easily sign up for the Standard Professional version or use the API (application programming interface) to implement routeRANK functionality into their own system or portal. Figure 2-3 shows the Standard Professional version with some additional functions, like filters concerning the maximum number of flight stops, the total trip duration, and the ranking functionality allows weighting the attributes of the trip individually by the user.

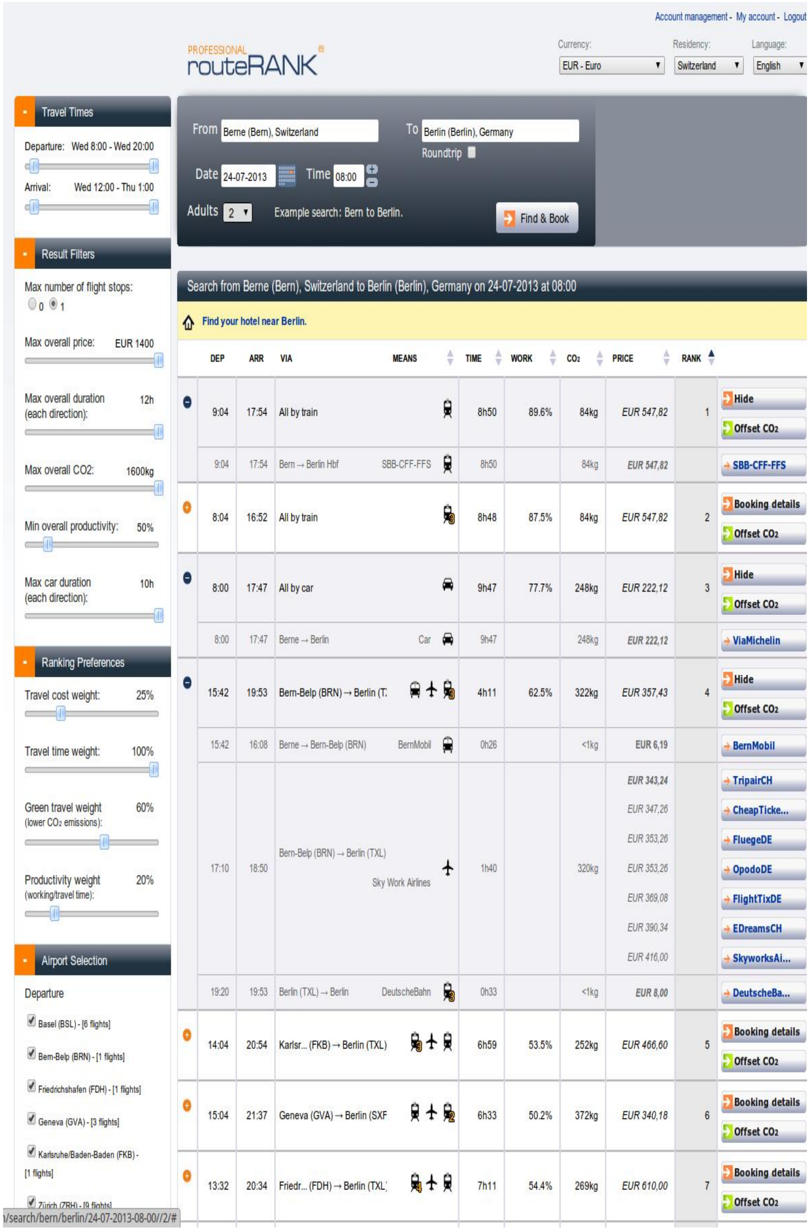
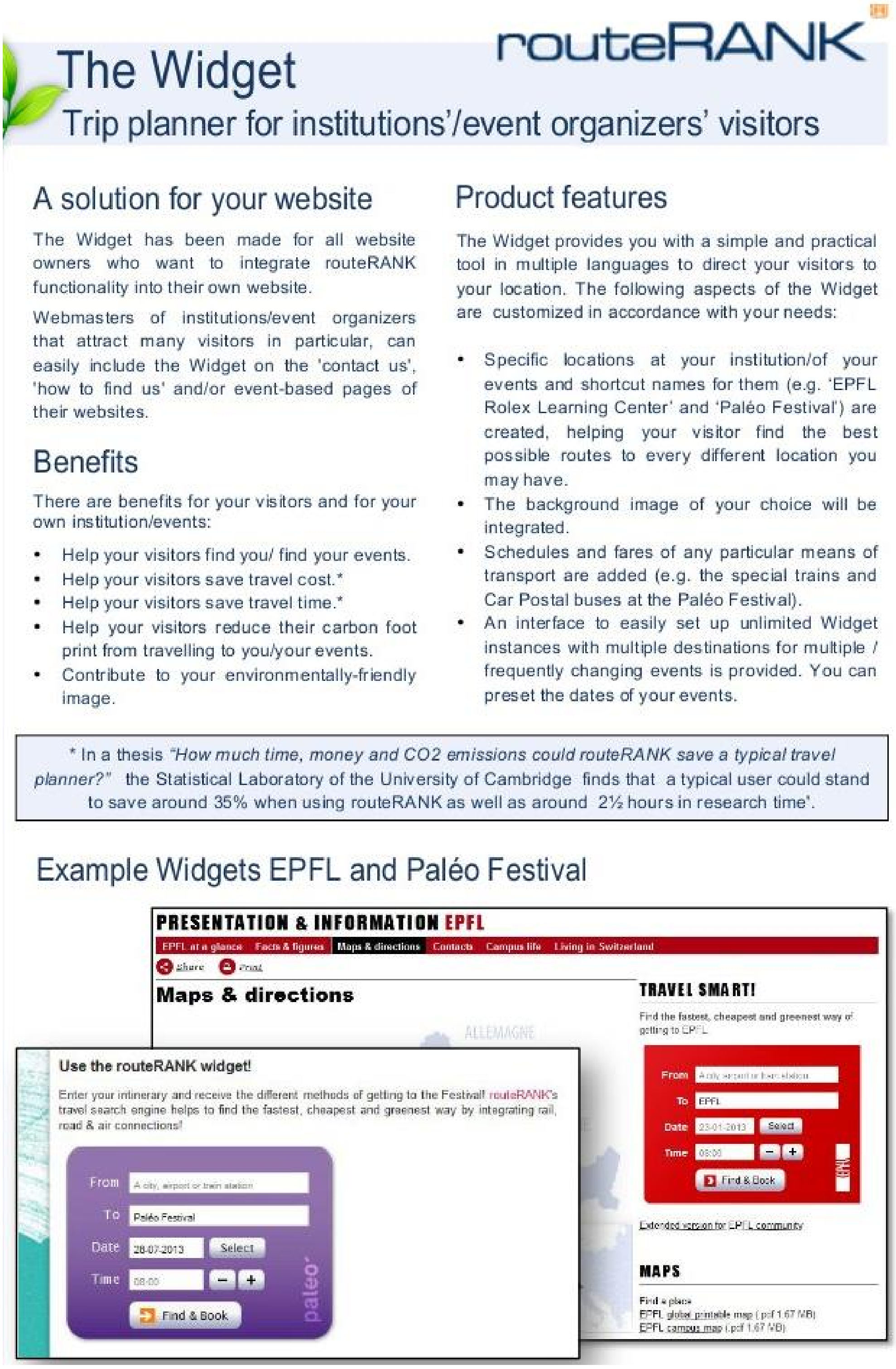


Figure 2-4 Detail view of route search results (Standard Professional version)

Alternatively, custom developed versions of the proprietary software are offered to corporate customers and organisations for their internal use or use on their own website, in both travel and logistics. And finally website owners can benefit from the routeRANK widget, see Figure 2-4 as an example.



routeRANK

The Widget

Trip planner for institutions'/event organizers' visitors

A solution for your website

The Widget has been made for all website owners who want to integrate routeRANK functionality into their own website.

Webmasters of institutions/event organizers that attract many visitors in particular, can easily include the Widget on the 'contact us', 'how to find us' and/or event-based pages of their websites.

Benefits

There are benefits for your visitors and for your own institution/events:

- Help your visitors find you/ find your events.
- Help your visitors save travel cost.*
- Help your visitors save travel time.*
- Help your visitors reduce their carbon foot print from travelling to you/your events.
- Contribute to your environmentally-friendly image.

Product features

The Widget provides you with a simple and practical tool in multiple languages to direct your visitors to your location. The following aspects of the Widget are customized in accordance with your needs:

- Specific locations at your institution/of your events and shortcut names for them (e.g. 'EPFL Rolex Learning Center' and 'Paléo Festival') are created, helping your visitor find the best possible routes to every different location you may have.
- The background image of your choice will be integrated.
- Schedules and fares of any particular means of transport are added (e.g. the special trains and Car Postal buses at the Paléo Festival).
- An interface to easily set up unlimited Widget instances with multiple destinations for multiple / frequently changing events is provided. You can preset the dates of your events.

* In a thesis *"How much time, money and CO2 emissions could routeRANK save a typical travel planner?"* the Statistical Laboratory of the University of Cambridge finds that a typical user could stand to save around 35% when using routeRANK as well as around 2½ hours in research time'.

Example Widgets EPFL and Paléo Festival

Figure 2-5 Widget examples of the travel planner

Business model

While the usage of the public website www.routerank.com is free of charge and generates income via advertisements on the website or commissions for bookings via the provided links, routeRANK also provides a range of premium products based on its patent-pending technology to companies and organisations. Each version of the proprietary software solution addresses their respective requirements.

- Smaller institutions in particular can sign up for the Standard Professional version to optimise their travel planning with minimal effort.
- Custom developed versions of the proprietary software are offered to corporate customers and organisations, for their internal use or use on their own website. This might entail adapting the branding, integrating their own data sources and existing online booking tool as well as additional features. See http://travel.panda.org/en/ as an example.
- Webmasters can easily integrate the Widget on the 'contact us' or 'how to find us' pages of any website. Event organisers can use it on their dedicated event websites. See the figure above as an example.
- Transport companies can benefit from the Logistics version for the optimal, end-to-end shipment of freight. See http://www.routeRANK.com/en/logistics/ for details.

A detailed comparison of the features offered in different versions is shown in Table 2-1 below.

Table 2-1 Overview of available versions and their attributes

Version	Custom developed	Standard Professional	Public
Layout and usage			
Branding	any branding	routeRANK	routeRANK
Commercial use	yes	yes	no
Unlimited searches	yes	yes	no
Ads-free	yes [1]	yes	no
Account management	yes [1]	yes	no
Search parameters & criteria			
Search scope	custom	expanded	standard
Schedule and fare data	any available interface	standard	standard
Price, duration, CO2	yes [1]	yes	yes
Work time/productivity	yes [1]	yes	no
Risks assessment	yes	no	no
Additional locations[2]	yes	no	no
Features			
Results filters	all criteria [1]	all criteria	airport and time
Additional car types	taxi & rental [1]	taxi & rental	taxi
Car customisation	yes [1]	yes	yes
Train customisation (½, etc.)	yes [1]	yes	no
Customised results ranking	yes [1]	yes	no
Multiple travellers	yes	yes	no
Additional features[3]	yes	no	no

[1] Customisable
[2] Additional locations such as villages, stations, points of interest including office or event location and street addresses.
[3] Additional features such as map illustration, street addresses search precision (door-to-door), API-access, etc.

Subscription fees for the Standard Professional version start from a few hundred euros per month and may vary on the usage.

Capabilities

Compared to other multimodal journey planners, routeRANK offers the widest coverage in terms of travel information at its deep level of integration and thus computes optimal travel plans based on relevant criteria.

Detailed coverage depends on the version in question, however generally speaking there is world-wide air coverage, car routing for Europe, North America, Asia, train transportation information for most parts of Europe and increasingly North America. In addition, airport shuttle and transfers via buses, taxi, rental cars and car sharing are readily available. Diverse localisations are supported as well as currently six languages (English, German, French, Dutch, Spanish and Italian). This includes the localised booking information in the language of the relevant provider, for example not only is the routeRANK website supporting Spanish on the public version, but for booking a user will also be forwarded to the Spanish version of Expedia.es, say, typically a different commercial organisation from Expedia.fr.

routeRANK also developed and operates dozens of customised versions of its journey planner, both its own versions and customised ones for corporations. A wealth of additional features is available with them, including a meeting optimiser and an accommodation optimiser.

Limitation

The current limitation of routeRANK is in its lack of content (schedule and fare) coverage in some parts of the world. While in general routeRANK provides worldwide coverage for flights, for other means of transportation the data is still not available for some countries, for example Asian train connections are not yet covered, car routes are not fully provided for Africa. routeRANK thus still provides an added value in these parts of the world over existing online travel agents or online booking tools, but does not yet fully exploit its potential there. In some cases train fares for international journeys cannot be displayed exactly but only as an approximation because railway companies often do not provide international rail fares on their own websites. At present (inter)national bus services are provided only if incorporated into the database of the railways websites that are incorporated into routeRANK¢s search routines.

2.3.2 Data Used

For the case study an extensive logging system has been implemented and usage data from real users (randomised 100,000 searches from mid of February to end of May 2013) has been retrieved to provide the statistics described in the assessment section below.

Results of the specific survey

The survey was the analysis of the usage of the system and how search results have been sorted by the users. The focus of the analysis is on the users' behaviour concerning search criteria.

User behaviour statistics

Approximately 75% of business travellers were searching long-distance trips (that is, the search results included flight options), while for non-business travellers this was only the case in 47% of all searches, so any conclusions drawn have to consider this difference.

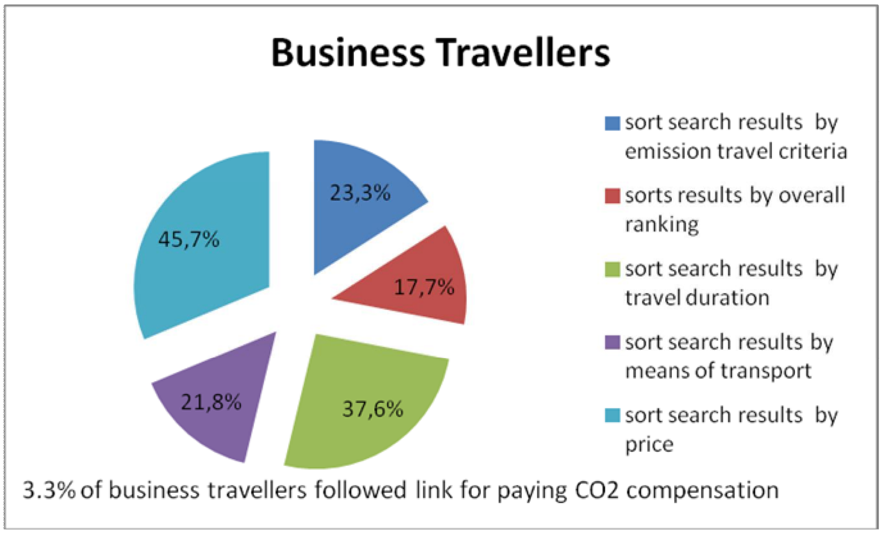


Figure 2-6 Relevance of trip attributes for business travellers

Both user groups have in common that sorting the search results by price turned out to be the most popular search criteria, which has been chosen in almost the half of all trip investigations. Concerning business travellers this is surprising as they are using the customised version, which exclusively enables them to sort identified travel solutions by an overall ranking, which is a kind of generalised cost function, weighting the distinct attributes of each travel solution (time, costs, emissions, productivity = how much of the travel-time can be used for work) individually by the customer.

Sorting by trip time is chosen by business travellers as the second most common criteria. This is different to the behaviour of non-business travellers who prefer means of transport as their number two criterion. In consequence the number three in popularity of sort criteria are the means of transport for business trips and travel duration for leisure trips. While this may be interpreted in a way that business travellers are less captive in using a distinct mode of transport and more focus on the attributes applying for a distinct trip (time, costs), one should have in mind, that in 50% of all non-business trip investigations observed air transport is not an option, while this is valid only on 25% of the business trips checked with the system. So when business travellers sorting travel solutions by time, in many cases the options including flight usage are on top of the list anyway.

Finally sorting the search results by travel emissions is the least chosen option, irrespective of the trip purpose. But unexpectedly business travellers use this criterion much more (in 23.3% of all searches) than non-business travellers do (7.7% of all searches). Also in this context it should be mentioned that the business trip investigations observed include flight options more often that is travel alternatives which cause relatively high emissions, but also with significant differences between the distinct flight routings displayed. So for trips where air transport is the way to go due to unacceptable travel times in surface transport, optimising air travel by considering the emissions makes sense in more cases, compared against leisure trips, where in 50% of all cases air transport isn't an option at all.

That business travellers in general do not have a higher solidarity to "green travel" than non-business travellers – a conclusion which otherwise could be drawn from the shares of sorting criteria – can clearly be seen in the percentage of trips where users actually follow the link for paying a CO2 compensation for their planned trip. Only 3.3% of business users do that, while for leisure travellers the value is about 20% higher and CO2 compensation is applied for 4.0% of all trips.

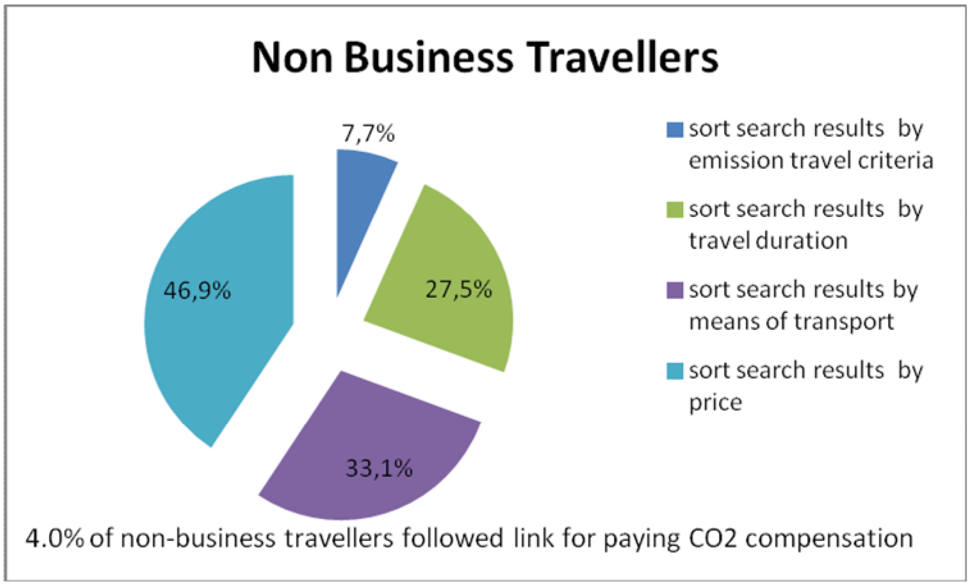


Figure 2-7 Relevance of trip attributes for non-business travellers

Note that the statistics for business travellers were collected from certain custom developed versions, whose number and settings have evolved – even during the duration of data collection – based on customer requests. This includes, for example switching the order of certain result filters, enabling and emphasising the importance of certain features and going live with a new version altogether (which in turn might have different filtering and search parameters). As a result, a lot more variation due to system-external changes can be expected and observed in the numbers for business travellers compared to the non-business statistics.

This also illustrates that the ultimate user behaviour can be steered through appropriate choice of parameters. And, indeed, extremes observed in some routeRANK versions are above 16% sorting by emissions in some versions, while less than 1% of users were sorting by emissions in others.

Information received from other surveys for this case study

No data from other surveys has been used.

2.4 ASSESSMENT OF THE SOLUTION - AN EU-WIDE MULTIMODAL TRAVEL PLANNER: ROUTERANK

2.4.1 Assessment of Applicability

It should be noted that the assessment of applicability for routeRANK has been carried out from the userӳ point of view, while for the next case study, the travel planners for the Marche region, the assessment has been made from the operatorӳ point of view. The main reason for that is that in the Marche case the planners are being run by public bodies, and data on costs and complexity is readily available, while routeRANK is privately owned and several of the applicability criteria are commercially sensitive and therefore confidential.

Investment costs

While the usage of the public available version at www.routerank.com is free of charge, customised versions require additional payments.

Operation and maintenance costs

While the usage of the public available version at www.routerank.com is free of charge, a subscription fee for a Standard Professional account and also for customised versions applies. It varies depending on the usage (searches per month, long distance searches, etc.), with the monthly fee starting at a few hundred Euros.

Financial viability

For the users a positive financial effect materialises by identifying the most economical travel solutions fitting to their specific needs and especially for business travelling in saving time and therefore costs in travel planning.

Technical feasibility

The system is available and working so the technical feasibility is given. A premise for the system is that automatic data retrieval from the websites of the unimodal service providers (railway companies, airlines, online travel agencies) is enabled and not hindered by using captchas. From a user point of view, no special setup needs to be done to use routeRANKӳ web based versions. The user only needs an internet connection and a web browser.

Organisational feasibility

There is no organisational complexity.

Administrative burden

RouteRANK eases the burden of trip planning.

Legal feasibility

There are no legal barriers to using the system.

User acceptance

The high volume of searches per month on the web-based versions of routeRANK and the existence of numerous customers using the standard professional version or tailored versions for which a fee is required demonstrates that the user acceptance of this multimodal travel-planner is given.

Public acceptance

Non-users in the general public will have no objections against the system.

2.4.2 Assessment of Interest for Travellers

Door to door travel time

As the search results can be sorted by travel time the travel planner allows the user to identify easily the fastest travel option, which he might not have detected when using other routines for travel planning. Depending on the individual weights the user assigns to the other attributes (e.g. costs) of the distinct travel option, not in every case the fastest travel option may actually be chosen. So in general the system enables the user to save travel time, if his focus is on that.

Door to door travel costs

As the search results can be sorted by total costs the travel planner allows the user to identify easily the most economic travel option, which he might not have detected when using other routines for travel planning. Especially the indication of total costs when using air transport, including access/egress to/from the airport of origin and destination, helps the traveller to identify the total costs of a trip of which he might not be fully aware of, when just searching for flights via classic, solely on air transport focused booking platforms.

Depending on the individual weights the user assigns to the other attributes (e.g. travel time) of the distinct travel option, not in every case the cheapest option may actually be chosen. So in general the system enables the user to save travel costs, if his focus is on that.

Comfort and convenience

Concerning the organisation of a trip, an intermodal travel planner offers more convenience in comparison to the necessity of checking multiple different (unimodal) travel websites.

Concerning the trip itself the system displays all different attributes of the specific travel suggestions, e.g. the number of transfers required. So the traveller has the opportunity to opt for travel solutions which offer more comfort than others, if he considers this aspect of a trip as important.

Safety

There is no impact on safety by a multimodal travel planner.

Security

There is no impact on personal security by a multimodal travel planner.

Accessibility for mobility impaired passengers

There is no impact on accessibility for mobility impaired passengers by a multimodal travel planner.

2.4.3 Assessment of Modal Change

General remark: Being aware of all attributes of a trip (travel-time, costs and emissions, number of necessary changes irrespective if within a distinct mode or between modes ...) reduces the captivity of the traveller towards a distinct mode, caused by lack of information on alternatives. So using a multimodal travel planner actually promotes co-modality, i.e. use of those means of transport for a distinct trip, which best fit the user needs.

Car usage

Usually a traveller is aware on the option of undertaking a distinct trip by car. Using a multimodal travel planner may show alternatives to car travel, of which the traveller might not have been aware at all or it might point out the specific costs and travel time of alternatives to car travel, which the user could have judged to be more expensive or more time consuming than they actually are. Furthermore, this tool displays the emissions caused by using different modes of transport, which may make users more aware of the difference in emissions between car and rail use and therefore make it more likely that they switch to public transport.

Bus and coach Usage

As long distance buses are not yet covered by routeRANK and public road transport may be included only in the feeder services to airports or if operated by railway companies, there is no mode shift to be expected towards bus and coach usage.

Rail usage

Using a multimodal travel planner shows the total travel times, costs etc. between the city of origin and the city of destination. Therefore the user is enabled to assess the use of distinct modes for the whole trip better, and therefore the underestimation of air travel costs and time when only taking into account an airport to airport travel is avoided. This might lead to a change on mode choice towards rail transport. On the other hand, travellers who primarily may be focused on rail travel for various reasons (e.g. holding a rail card, a general positive attitude on emission friendly travelling by rail) may find that using other modes may show significant advantages concerning costs and or travel-time for a distinct trip, resulting in a reduced captivity to rail travel. However, the arguments for using rail instead of a car or instead of a short-haul flight should shift the balance towards rail.

Ferry usage

Ferries as a mode of transport are included in routeRANK only as part of the travel solutions going by car or going by rail. So there is currently no specific impact of this multimodal travel planer towards or against ferry usage.

Aeroplane usage

As mentioned before, using will avoid the underestimation of air-travel costs and time when only taking into account an airport -> airport travel, which may lead to a change on mode choice from air travel to surface transport. On the other hand, in the opposite to the way as mentioned for rail before, travellers who primarily may be focused on rail or car travel for various reasons could realise that using air transport may show significant advantages concerning costs and/or travel-time for a distinct trip. But again, on balance, there should be a shift from air to rail usage.

2.4.4 Assessment of Other Impacts

Increased mobility

There is no impact of a multimodal travel planner towards increased mobility, beside a very small effect (if at all) that travellers may identify travel options they were not aware of before.

Congestion

Although a multimodal travel planner could influence mode choice from car travel to other means of transport, the overall effect on that is too small that it could imply any measurable effect on congestion.

CO2 emissions

As the analysis of the survey results showed, 23% of business travellers and 8% of non-business travellers sort the travel solutions by emission criteria, and although it is not known how many of these are then actually using the most environmentally friendly travel option, it can be assumed that most of them would not sort by this criterion in the first place, if they have no intention at all to follow the resulting travel advice given. Furthermore, as carbon offsetting is promoted by the system, some travellers will voluntarily contribute for the compensation of the CO2 emissions calculated for their trip, who might not do so if they would have planned their travel in a different way.

Contribution to user pays principle

Multimodal travel planners do not provide any contribution to the user pays principle in travelling.

European economic progress

Multi modal travel planners have no notable influence on the European economic progress.

Territorial cohesion

Multi modal travel planners have no influence on territorial cohesion. Nevertheless their usage may improve the awareness of the actual remoteness or centrality of regions.

2.4.5 Assessment against Main Criteria – Summary

Table 2-2 An EU-wide multi-modal travel planner: routeRANK - Point score for the criteria

	Score
Investment costs	ú
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	✓
Legal feasibility	*0*
User acceptance	✓
Public acceptance	*0*
D2D travel time	✓
D2D travel costs	✓
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	-
Bus and coach usage	*0*
Rail usage	+
Ferry usage	*0*
Aeroplane usage	-
Mobility	*0*
Congestion in overcrowded corridors	*0*
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

3 CASE STUDY 2 - A REGIONAL MULTIMODAL TRAVEL PLANNER: MARCHE REGION OF ITALY

3.1 EXECUTIVE SUMMARY OF THE CASE STUDY

This case study[9] addresses the potential in supporting sustainable transport policies as a result of the use of regional traveller information systems; these are applications situated at an intermediate level between the urban scale and the national/international scale, for passenger transport. At the urban scale, the multimodal passenger travel information system essentially aims to favour short-distance trips through the utilisation of public transportation modes, primarily buses and metro, including options to reduce walking distance to the destination point. At the national/international level, the multimodal passenger travel information systems cover in general all transport modes, focusing on long distance trips (including air and maritime transport means), for which the existence of effective interconnections (infrastructure, interchanges) between the trip legs can be considered as a necessary requirement (see, for more details, INTERCONNECT, 2011).

The case study on the Marche region traveller information systems intends to address the following two issues:

- An assessment of their environmental impacts, based on hypothesis on modal shift from car to public transport;
- As assessment of their contribution to the improvement of mobility in general, and accessibility to remote areas in particular.

There are two regional travel planners under examination:

1) The Regione Marche Orari TPL, which provides information on the main public transport timetables and transfer times at interchanges from an origin to a destination point across the region. http://orari.trasporti.marche.it/prod2/default.asp
2) The Mobilitami regional travel planner, which provides timetables, transfer time at interchanges and walking distance to the destination points of the regional public transport network (coaches, buses and regional trains). http://www.mobilitami.it/tp/mobilitami/home/index#

Data collected from the analysis of the two data sets relates to online access to the regional travel planners in 2012. Data analysis, after adjustments, has led to the following analyses:

- Identify the origin/destination paths through the usersô indication of public transport means in isolation or in combination (buses, train, coaches) to reach a given site or address.
- Estimate the origin/destination paths by car, corresponding to the origin/destination paths for which the user has not indicated any public transport means among the available options.

The assessment of the environmental impacts (transport external costs) is summarised in the following table, relating to the daily impacts at 2012 (ú) resulting from shifting 5% of daily car trips to public transport in the Marche Region.

Table 3-1 Impacts at 2012 (€) from shifting 5% of daily car trips to public transport

External costs	Urban	Extra urban	Total
Climate Change *(GHG emissions)*	1,148	6,077	7,225
Accidents	9,147	27,679	36,795

The reduced social costs from modal shift for climate change and accident savings amount to a total of about ú 44,000 daily (of which about ú 10,000 in urban areas and about ú 34,000 in extra-urban areas). The assessment is carried out under the assumption that the diverted demand from road transport (car) can be met by public transport without additional costs (spare capacity available).

[9] A special thanks to Monica Giannini, Alessandro Pettinari and Silvia Magnalardo of the PLUSERVICE S.r.l. company based in Marzocca (AN), in the Marche Region, for their assistance and information provided.

The improvement in mobility and accessibility emerges from the analysis of the access to the regional travel planners by month and destination.

Concerning mobility, data analysis on the monthly access to the regional travel planners shows the higher peak in correspondence of bad weather conditions (February), as showed in the following table. In fact in Italy, during the winter of 2012, particularly in February, the weather was characterised by storms and heavy snow. The Marche region, and in general the central-northern part of Italy, were affected, with transport activities strongly hampered by network disruption and service interruptions.

Table 3-2 Monthly access to regional travel planners

Months	Access	Daily average
Jan-12	3,314	107
Feb-12	9,564	342
Mar-12	3,332	107
Apr-12	3,018	101
May-12	3209	104
Jun-12	2,675	89
Jul-12	1,944	63
Aug-12	1,672	54
Sep-12	2,740	91
Oct-12	2,167	70
Nov-12	1,504	50
Dec-12	1,835	59
Average 2012	3,081	101

Compared to the annual daily average of 101 access in 2012, the use of regional travel planners in February was more than doubled, reaching an average of 342 daily access.

Concerning the contribution of the regional planners to the accessibility to remote areas, data analysis shows that during February, a critical month due to adverse weather conditions, the share of travel planners access from users living in the most remote areas (mountainous municipalities) has reached the peak (31%), as shown in the following table.

Table 3-3 Monthly access to travel planners: mountainous areas

Month	Access from users living in non-mountainous municipalities A	Access from users living in partly-mountainous municipalities B	Access from users living in totally-mountainous municipalities C	Share of access from users living in mountainous municipalities (B+C)/E	Total E
February-12	3,415	192	867	31.0%	4,474
March-12	1,667	81	391	28.3%	2,139
January-12	1,455	111	299	28.2%	1,865
October-12	1,050	83	187	25.7%	1,320
July-12	888	52	164	24.3%	1,104
May-12	1,562	43	332	24.0%	1,937
April-12	1,572	70	300	23.5%	1,942
June-12	1,278	61	234	23.1%	1,573
December-12	707	31	118	21.1%	856
November-12	754	58	86	19.1%	898
September-12	1,351	89	163	18.7%	1,603
August-12	875	21	61	9.4%	957
Total	16,574	892	3,202	24.7%	20,668

Concerning conclusions on transferability and relevant barriers, the following issues must be stressed:

- The importance of the public sector in favouring the coordination among stakeholders and the definition of viable business models;
- The importance of the definition of shared procedures among stakeholders for data collection;
- The importance of addressing the issue of data maintenance and updating;
- The need to integrate the services of travel planners in the more general sustainable transport policy.

3.2 THE BACKGROUND OF THE CASE STUDY

3.2.1 Motivation for this Case Study

Deliverable 3.1 of the COMPASS project about the identification of the potential role of Information and Communication Technologies (ICT) in favouring a seamless co-modal transport system (COMPASS, 2012), has shown significant potential in favouring co-modal seamless trips mainly from six ICT categories and applications:

1) Transportation management systems, helping to plan and running efficiently the transport system;
2) Traveller information systems, in which the key characteristic is to assist the traveller with several parts of information (travel time, routes, traffic conditions, etc);
3) Smart ticketing and tolling applications, addressing new ways to get tickets and to pay for using transport services;
4) Vehicle-to-infrastructure (V2I) applications, which are a form of wireless cooperative interaction between vehicles and infrastructure, based on systems that can improve safety and traffic management (UNECE, 2012);
5) Vehicle-to-vehicle (V2V) applications, allowing direct interaction between cars with the potential to increase safety and efficient infrastructure use;

6) DRT services, which provide a mechanism whereby passengers can be picked up and dropped off at their chosen locations, at a price usually closer to those of fixed route bus services than to taxis.

This case study addresses the "traveller information system" category, in particular the intermediate dimension between the urban scale and the national/international one related to passenger transport. At the urban scale, the multimodal passenger travel information system essentially aims to utilise existing transportation modes, which are mainly related to the public transport network, e.g. buses and metro, with options to reduce walking distance to the destination point, (an overview of applications at urban level can be found in Urban ITS Expert Group, 2013). At the national/international perspective, the multimodal passenger travel information systems cover in general all transport modes, focusing on long distance trips (e.g. rail, air), for which the existence of effective interconnections (infrastructure, interchanges, etc) between trip legs is becoming a necessary requirement (INTERCONNECT, 2011).

The regional travel planners are shaped by the socio-economic characteristics of the regional area. For instance, in terms of traffic flows by motorised transport means, their number and distribution over a 24 hour period are determined by the dimension of urban areas, as well as the presence of factories and infrastructure. At regional level, the volume of traffic flows can be significant; it has in fact been stressed, according to the studies made by DGMOVE (e.g. TRANSVISIONS, TENCONNECT, 2008), that regional traffic inside NUTS3 at EU level generates around 40% of road emissions (2005 data).

Furthermore, the geographical characteristics of the regional territory play an important role as well. For instance, in regions with a significant presence of municipalities located in mountainous and remote areas, the existence of a travel planner may assist transport users and citizens to better organise mobility, using transport modes at their best and improving in general accessibility.

The objectives of the regional case study on the Marche region passenger travel planners intend to address specifically the two issues above stressed:

- An assessment of the environmental impacts, based on hypothesis on modal shift from car to public transport.
- As assessment of the improvement of accessibility to remote areas.

3.2.2 General Description of the Region

The Marche region extends over an area of 9,694 km² in the central part of Italy, between Emilia-Romagna to the north, Tuscany and Umbria to the west, and Lazio and Abruzzo to the south.

The territorial landscape is characterised by the significant presence of mountainous areas. As showed in the following table, about 50% of the Marche Region municipalities are classified as mountainous (totally or partially).

In terms of resident population, about 25% of population (corresponding to about 300,000 persons) live in the mountainous areas, which account to about 63% of total area.

Table 3-4 Mountainous municipalities in the Marche Region

	Non Mountainous		Partly Mountainous (*)		Totally Mountainous (**)		Total
	Absolute values	%	Absolute values	%	Absolute values	%	
Number of Municipalities	122	51.0%	21	8.8%	96	40.2%	239
Area (Square Kilometre)	3,450.32	36.8%	959.24	10.2%	4,956.29	52.9%	9365.85
Resident Population	1,163,128	74.3%	137645	8.8%	264,562	16.9%	1,565,335

** Municipalities for which at least 80% of the territory is over 600 m above sea level
* Municipalities for which part of the territory is over 600 m above sea level

Tourism is an important component of the economic structure of the region, with 23 municipalities, accounting for 38% of the total resident population, classified as coastal. During the tourist season (from March to August), the population is likely to increase (2,599,314 arrivals in 2011, + 3.9% compared to 2010), in particular towards historical sites (33.6%), coastal areas (51.3%) and mountainous areas (4.8%), as shown in the following figure about tourists destination (Regione Marche, 2011).

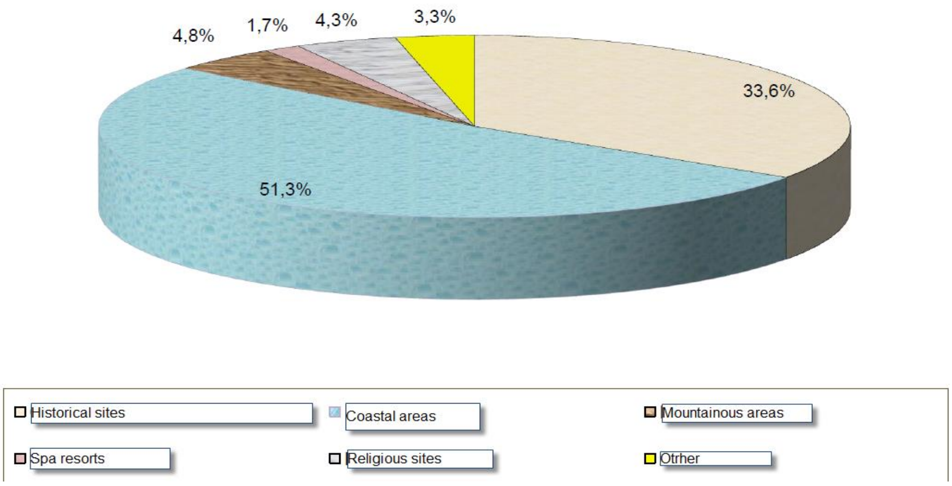


Figure 3-1 Tourist Destinations in the Marche Region (2011)

Population growth during the tourist season is deemed to increase transport activities and transport flows (trips) across all the region.

In terms of regional mobility, the role played by each municipality to the internal system of regional mobility (municipality "attractor", "generator" and "neutral") stresses the preponderance of municipalities whose mobility is characterised by higher trips generated compared to those attracted (ratio between trips generated and attracted trips > 1.1), as shown in the following figure (Regione Marche 2010).

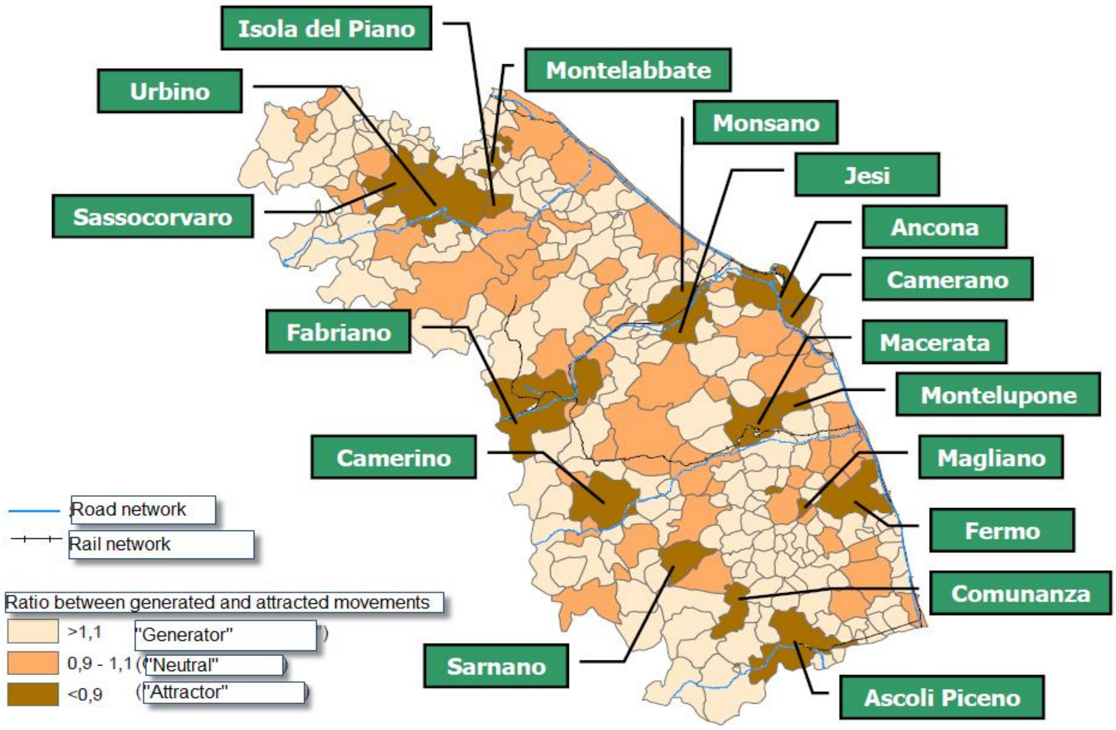


Figure 3-2 Trips generated/attracted in the municipalities of the Marche Region (2010)

The figure shows that the municipalities that attract the largest number of trips as destination (ratio < 0.9) are located along the coastline and in correspondence of the provincial main nodes (Ancona, the chief town of the region) and the municipalities chief towns at provincial level (Fermo, Urbino, Macerata and Ascoli) and along the axes of penetration of road and rail networks.

The significant presence of mountainous municipalities as generator (ratio >1.1) makes the presence of regional travel planners important, by improving the accessibility of transport means in such areas.

Concerning the modal share, as shown in the following table, private transport means (car, motorcycles) account for the grater share in 2010 (85.4%), compared to the national average of 84%. The mountainous and hilly characteristics of the regional territory makes the presence of rail transport low, compared to the national averages.

Table 3-5 Modal shares in the Marche Region

Transport mode	Marche Region	Italy
Private transport means (car, motorcycles)	85.4%	84%
Public transport (road)	13.3%	12%

3.2.3 Stakeholders Involved

The stakeholders involved in the case study and their roles are summarised in the table below.

Table 3-6 Marche region case study stakeholders

Stakeholders	Role in the case study
Public Transport operators (buses, train, ferry, coaches, airlines)	Transport operators provide timetables and origin/destination paths. Links to the most relevant destinations (in terms of public utility) as touristic sites, recreational facilities, hospitals, restaurants are also included. The transport operators update the timetables in order to take into account deviations, service interruptions, etc.
Local and Regional government	Public authorities at local and regional level represent a key stakeholder as far as data collection and data provision are concerned. Data collection is carried out via a back office activity. Public authorities coordinate the work of urban planners to locate pedestrian and cycle paths (urban level), the activity of departments, e.g. Tourism and Cultural Heritage, to locate points of interest as monuments and historic buildings or structures accommodation.
Transport users (citizens, associations)	Citizens, tourists or commuters feed the demand for the services of travel planners. They are the users of the platforms, which draw from that the information necessary for mobility purposes: interrogation of the public transport timetables, searching for information for leisure, etc..

3.2.4 Methodology of the Case Study

The methodology of the case study is based primarily on the analysis of different data set coming from two internet-based regional travel planners:

- the Regione Marche Orari TPL http://orari.trasporti.marche.it/prod2/default.asp
- the Mobilitami regional travel planner http://www.mobilitami.it/tp/mobilitami/home/index#

Furthermore, the insights from data analysis have been supported with interviews and contacts with stakeholders, i.e. data managers and policymakers (Marche Region); in order to get relevant background information on the regional transport system and technical characteristics of the travel planners (software & data managers).

The case study aims at the attainment of two objectives:

- The assessment of the potential environmental impacts arising from the use of the regional travel planners, based on hypothesis on modal shifts from car to public transport means.
- The assessment of the improvement of accessibility to remote, mountainous, areas, and mobility in general.

The two objectives have been fulfilled on the basis of the characteristics of the regional travel planners under examination.

The Regione Marche Orari TPL provides the time information of the main public transport stops and times of interchanges and transfer time from an origin to a destination point in the region. Connections by public transport for flights from/to the regional airport of Falconara-Ancona are also available.

The public transport modes available are buses, coaches and regional trains. Cycle paths can also be displayed on the regional planner map service. Walking time to the destination point are also included.

The Mobilitami regional travel planner provides the timetables, transfer time at interchanges and walking distance to the destination points of the regional public transport network (coaches, buses and regional trains).

Data collected from the analysis of the two data sets relate to the on-line accesses to the regional travel planners. Data analysis allows to:

- Identify the origin/destination paths by stand alone public transport means or in combination (e.g. buses, train, coaches).
- Estimate the origin/destination paths by car, corresponding to the origin/destination paths for which the user has not indicated any public transport means among the available options.

The environmental impacts of the use of the regional travel planners correspond to the hypothesis drawn from literature (Urban ITS Expert Group, 2013b) about the potential modal shifts from public transport modes.

From that, the application of the unitary values (per vkm) of transport external costs (IMPACTS, 2008) in urban and non urban conditions, actualised to 2012, allows the estimation of the environmental savings (in terms of avoided costs) corresponding to the use of traveller information systems in the Marche region.

The assessment of the improvement of accessibility derives from the data analysis; in particular, from the distribution of accesses during bad weather conditions, e.g. access in winter or during extreme bad weather period, and the analysis of the origin/destination paths, which is able to trace the destinations according to the geographical distribution of the origin/destination of municipalities (coastal, mountainous areas, city centre).

Information of future development of regional travel planners in the region, key problems and barriers to overcome are also part of the case study methodological framework.

3.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

3.3.1 General Description of the Case Study

The following figures describe the subjects of the case study, in terms of key information needed to assess the impacts of the regional travel information systems.

Regione Marche Orari TPL

The Region Marche Orari TPL traveller information system is an Internet-based tool that allows the user to select the origin/destination path and the transport modes (public transport modes in combination or in isolation), as shown in the following screenshot. The combination of public transport options are the following:

- Only train;
- Only bus/coach;
- Combination of bus and train.

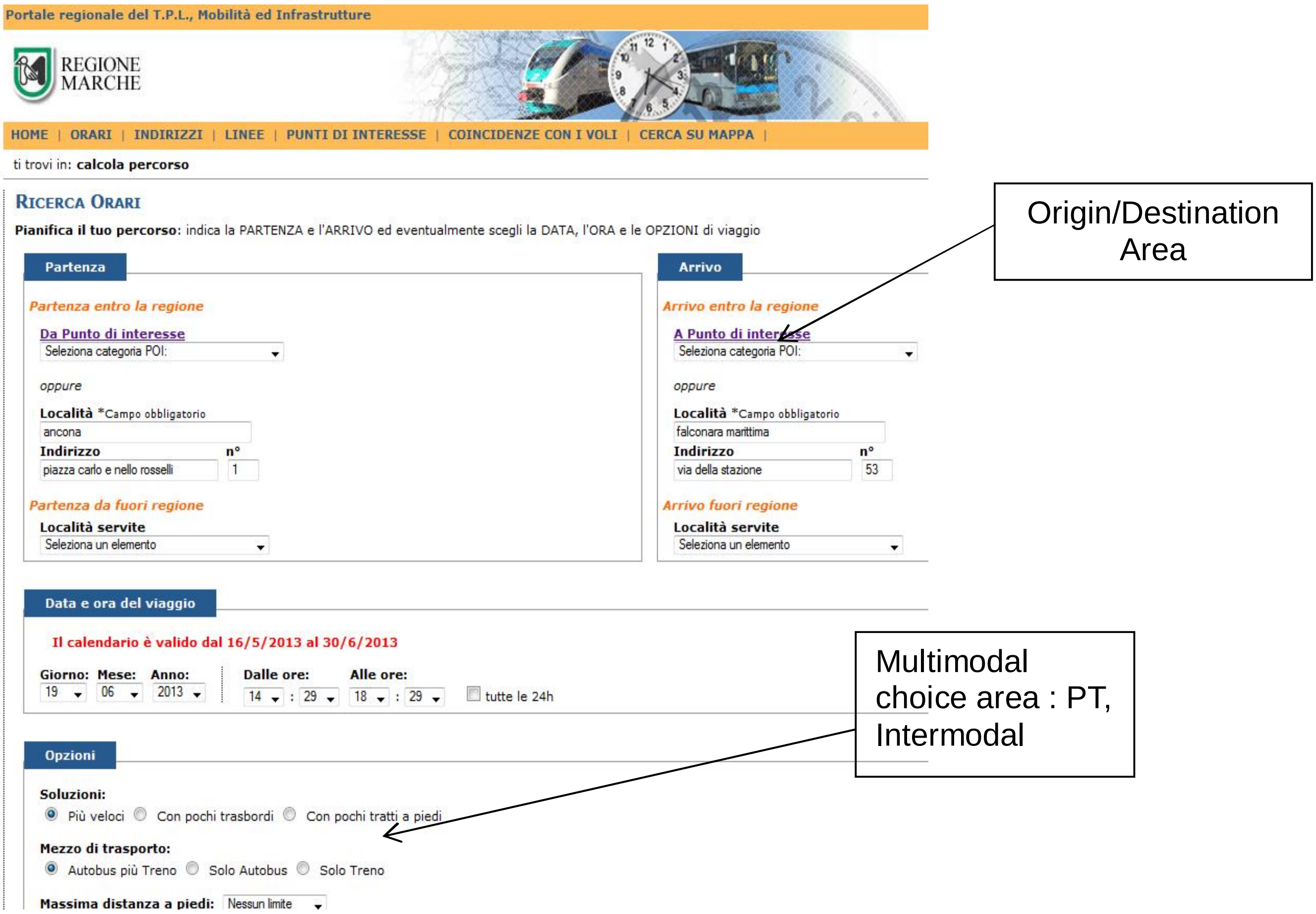
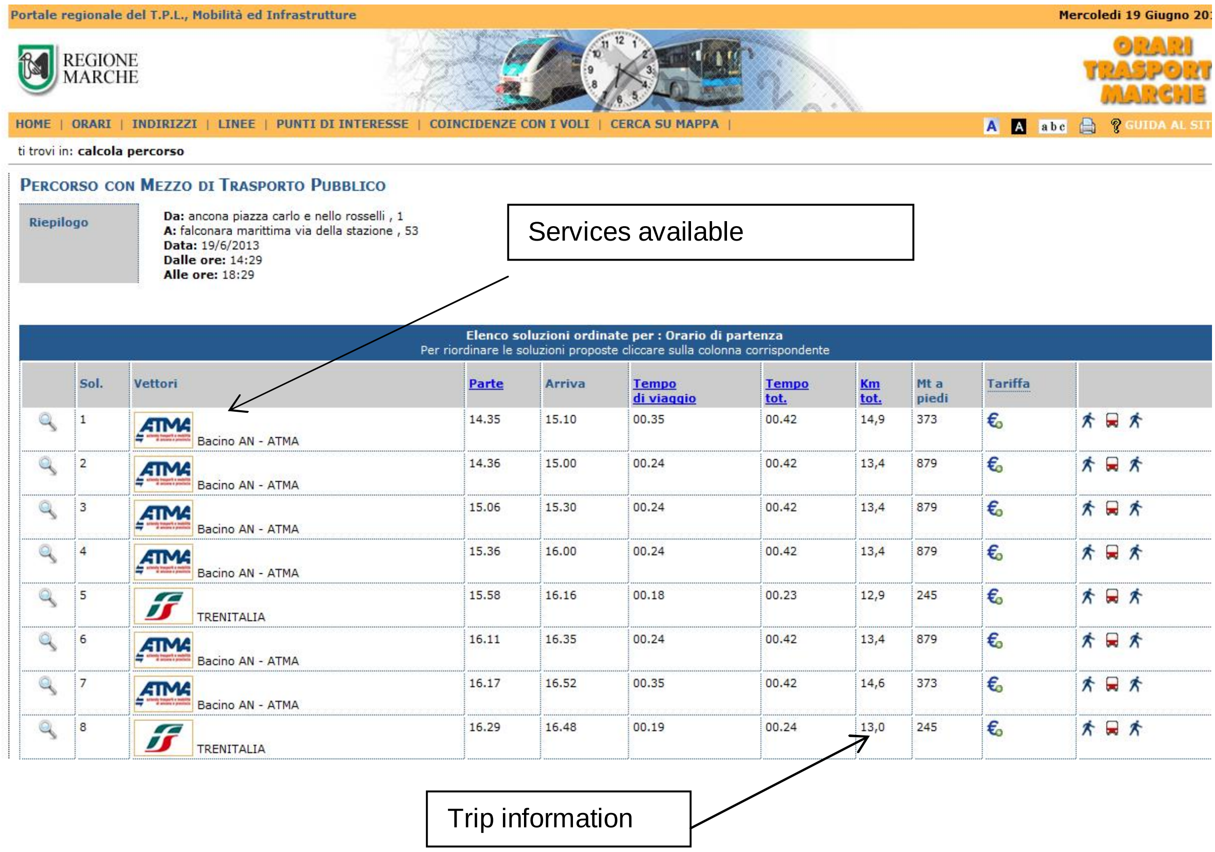


Figure 3-3 Region Marche Orari TPL traveller information system: screenshot 1

The travel information system also allows the user to select a limited number of origin and destination paths outside the boundaries of the Marche region. However, the main field of application remains the regional one.

Timetables of the transport modes involved in the paths and travel times are also included, as shown in the second screenshot.


Portale regionale del T.P.L., Mobilità ed Infrastrutture — Mercoledì 19 Giugno 20

REGIONE MARCHE — ORARI TRASPORTI MARCHE

HOME | ORARI | INDIRIZZI | LINEE | PUNTI DI INTERESSE | COINCIDENZE CON I VOLI | CERCA SU MAPPA | GUIDA AL SIT

ti trovi in: calcola percorso

PERCORSO CON MEZZO DI TRASPORTO PUBBLICO

Riepilogo

Da: ancona piazza carlo e nello rosselli , 1
A: falconara marittima via della stazione , 53
Data: 19/6/2013
Dalle ore: 14:29
Alle ore: 18:29

Elenco soluzioni ordinate per : Orario di partenza
Per riordinare le soluzioni proposte cliccare sulla colonna corrispondente

Sol.	Vettori	Parte	Arriva	Tempo di viaggio	Tempo tot.	Km tot.	Mt a piedi	Tariffa
1	Bacino AN - ATMA	14.35	15.10	00.35	00.42	14,9	373	€
2	Bacino AN - ATMA	14.36	15.00	00.24	00.42	13,4	879	€
3	Bacino AN - ATMA	15.06	15.30	00.24	00.42	13,4	879	€
4	Bacino AN - ATMA	15.36	16.00	00.24	00.42	13,4	879	€
5	TRENITALIA	15.58	16.16	00.18	00.23	12,9	245	€
6	Bacino AN - ATMA	16.11	16.35	00.24	00.42	13,4	879	€
7	Bacino AN - ATMA	16.17	16.52	00.35	00.42	14,6	373	€
8	TRENITALIA	16.29	16.48	00.19	00.24	13,0	245	€

Figure 3-4 Region Marche Orari TPL traveller information system: screenshot 2

Tariffs are not included. However, the traveller information system provides a link (by e-mail) to the infrastructure manager or transport operator involved, in order to send them requests for price information.

The path can be represented through maps, as shown in the third screenshot.

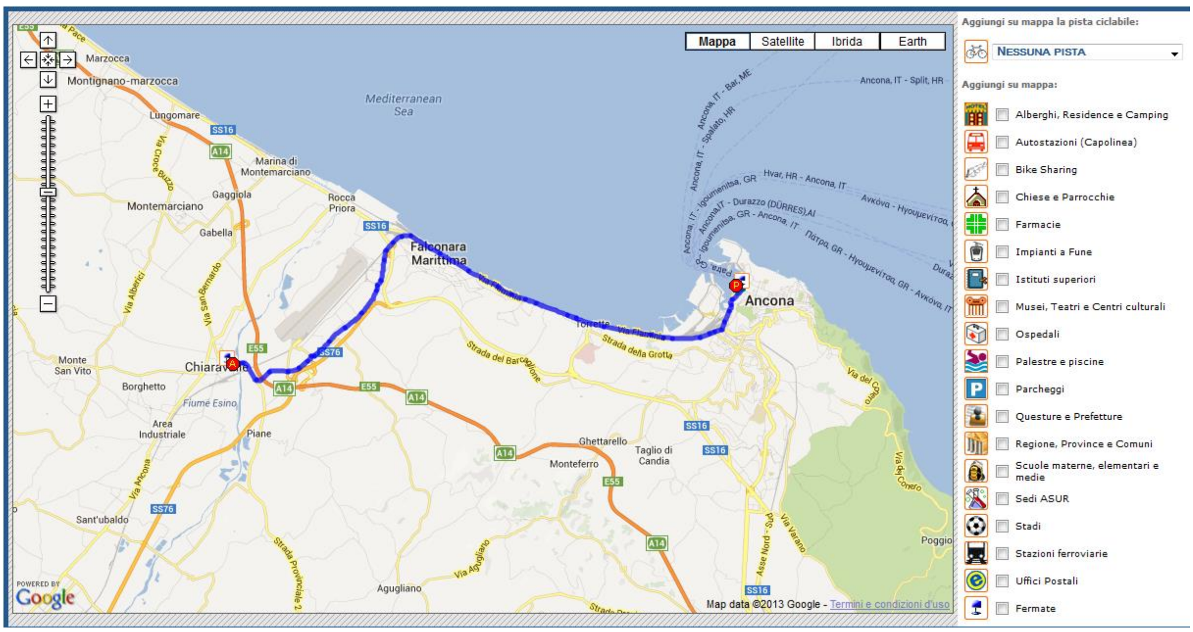


Figure 3-5 Region Marche Orari TPL traveller information system: screenshot 3

Mobilitami regional travel planner

The regional travel planner Mobilitami describes itself as a ñweb community for the sustainable transportà It was set up by the AMI (public transport operator of municipality of Pesaro) with the aim to increase the use of public transport and reducing CO_2 emissions.

The public transport options considered in the travel planner are the following:

- Only train;
- Only bus/coach;
- Combination of bus and train.

The Mobilitami regional travel planner has also been designed to inform the user of the main touristic events and historical sites. A list of events, sites and other locations of public interest (hospitals, universities, etc) guides the user to their identification and to the most efficient combination of transport modes to reach them.

The origin/destination area and the selection of transport modes area are shown in the screenshot below.

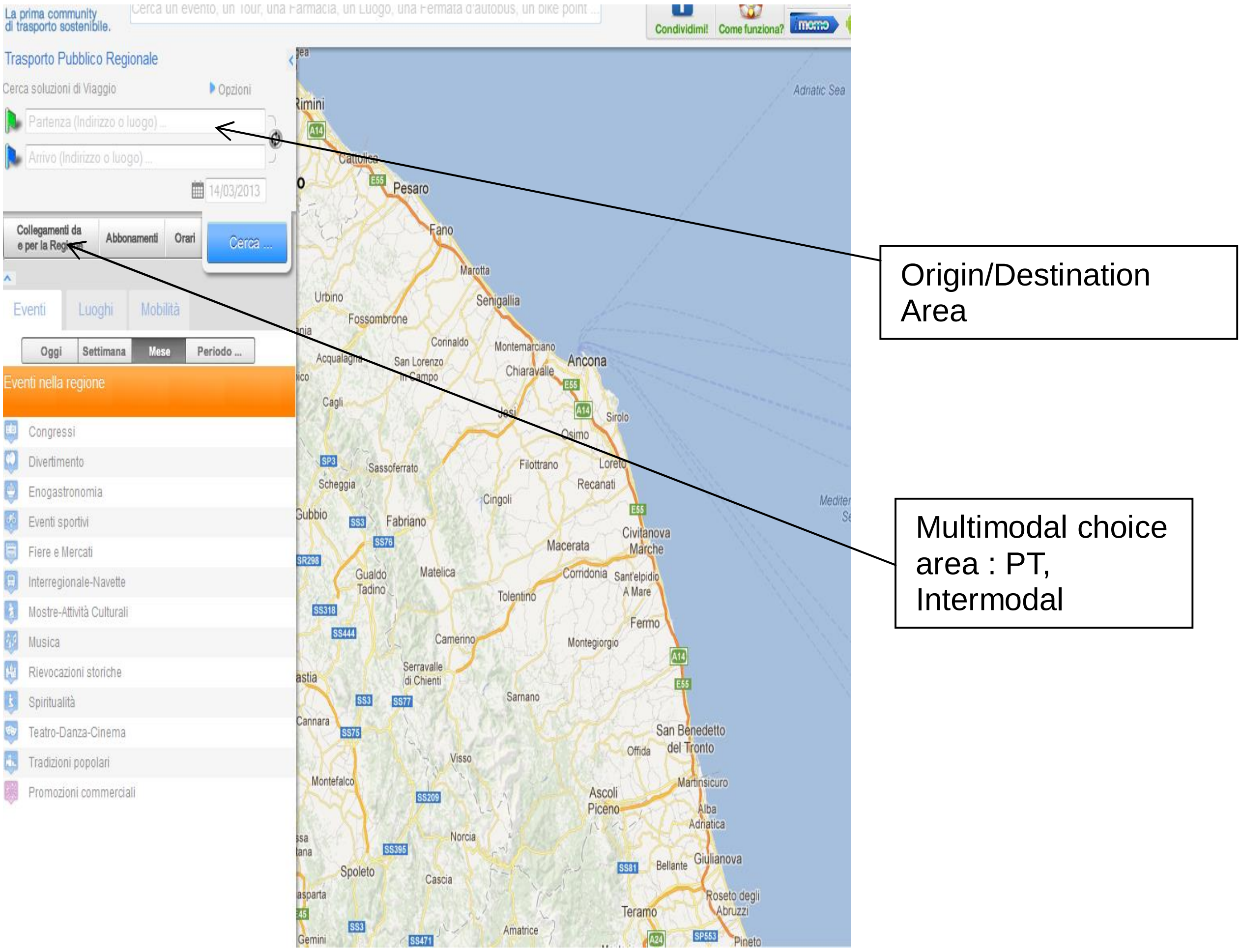


Figure 3-6 Mobilitami regional travel planner: screenshot 1

The timetables of the public transport modes involved (buses, regional trains, coaches), trip duration, and walking distances are shown in the next screenshot. As for the Region Marche Orari TPL, tariffs are not shown.

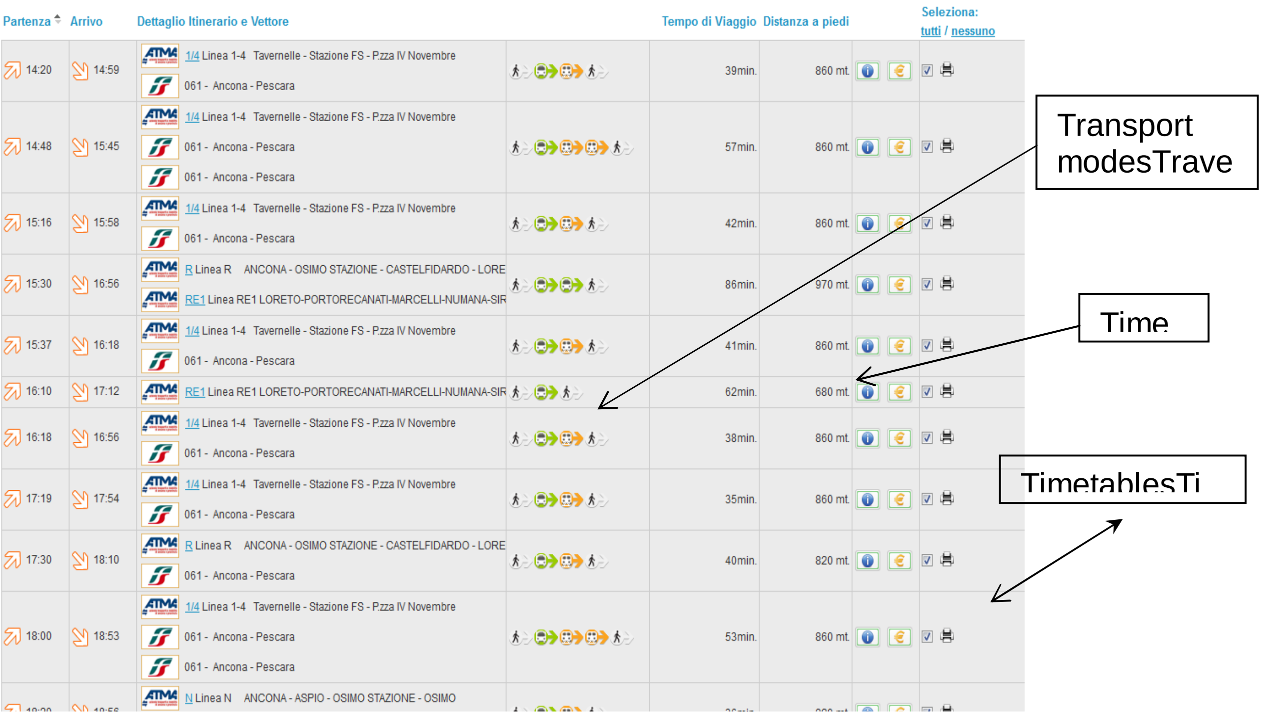


Figure 3-7 Mobilitami regional travel planner: screenshot 2

The origin/destination paths can be visualised through maps, as in the following screenshot.

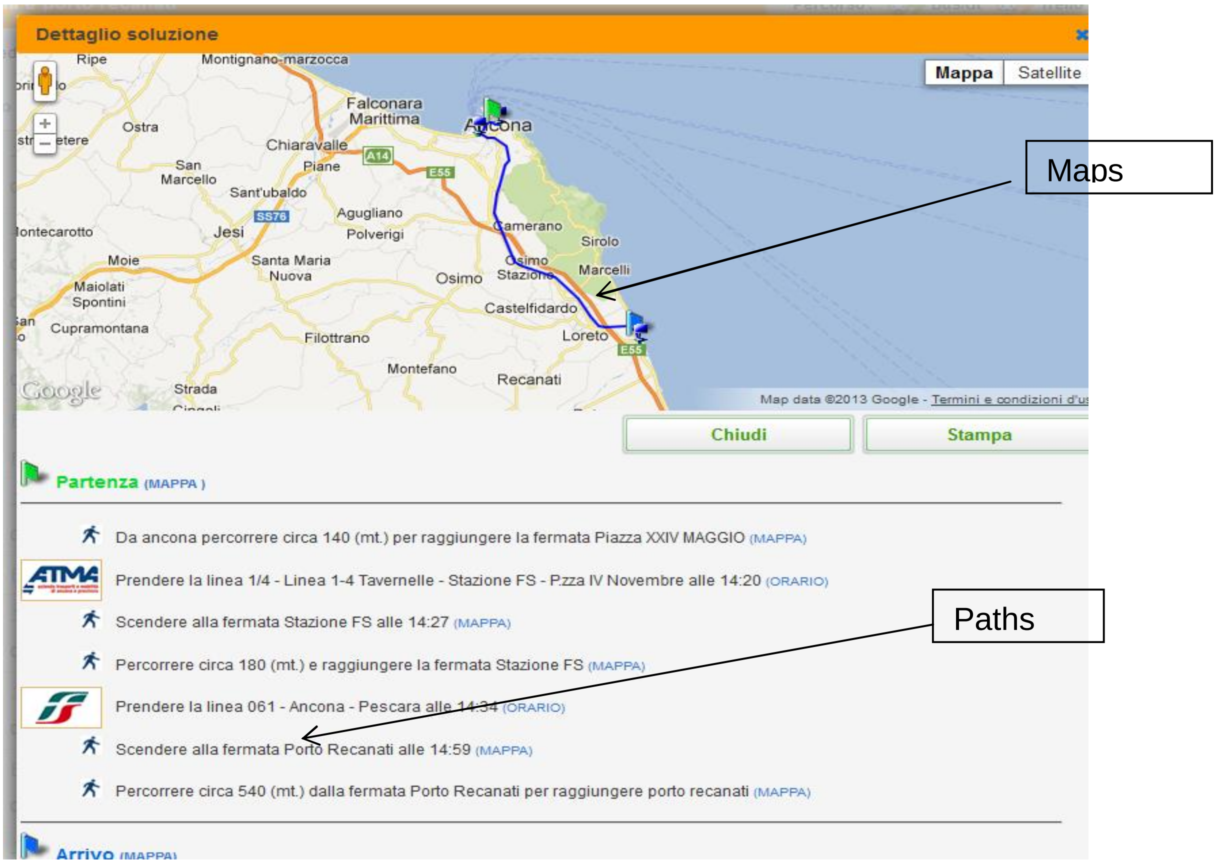


Figure 3-8 Mobilitami regional travel planner: screenshot 3

3.3.2 Data Used

The case study relies on the two regional travel plannersôdata sets. The two data sets share the same basic informational structure:

- Number of accesses to the travel planners;
- Distribution of access by month and day of the week;
- Origin/Destination sites (municipality);
- Mode of transport (bus, coach, train, combination of public transport means).

The two data sets have been combined and adjusted, in order to delete errors and inconsistencies, through the following steps:

- Deleting access indicating origin without destination, and vice versa;
- Deleting access indicating no transport means.

The underlying hypotheses behind the case study are the following:

- Data do not allow to infer whether trips actually happen. Therefore, the access can be considered as a virtual trip, in which each access represents the willing to move from one origin to a destination point across the region, using a combination (multimodal) or stand alone transport modes.
- Data allow to estimate the origin/destination paths by car, corresponding to the origin/destination paths for which the user has not indicated public transport means. It is assumed that when no public transport option is selected for a given O/D, the user intends to make the trip using private car.

The resulting data set is a database with about 37,000 records (access) related to 2012.

The following table and graph show respectively the distribution of access by transport mode and their share.

Table 3-7 Regional travel planners access by transport mode

	Intermodal solutions	Stand alone solutions				
	Public Transport combination	**Coach**	**Bus**	**Train**	**Car**	**Total**
Number of access /virtual trips	12,815	6,016	6,877	1,384	9,882	36,974

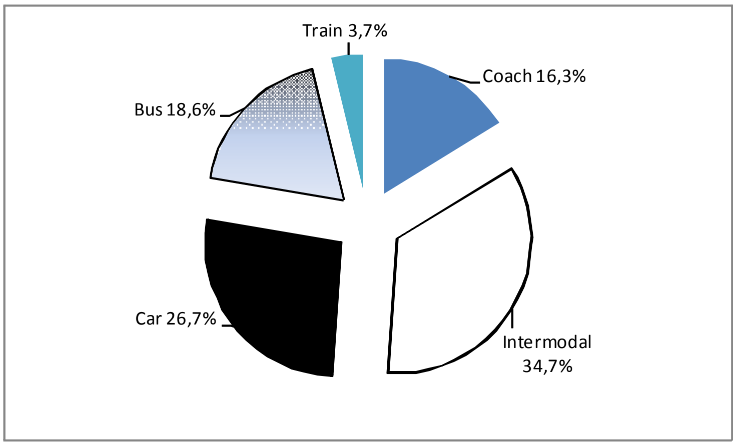


Figure 3-9 Regional travel planners share of access by transport mode

The willingness of the travel plannersôusers to use intermodal solutions (public transport) accounts for the higher share on the total access (about 35%).

Car is supposed to be used by 27% of the users, while road public transport modes (buses + coaches) account by about 35%. A residual share (about 4%, the same share recorded at national level) is related to the use of rail for regional mobility.

Data available also allows an estimate of the willingness to make trips inside the municipalities. They correspond in fact to the trips in which origin and destination zones overlap.

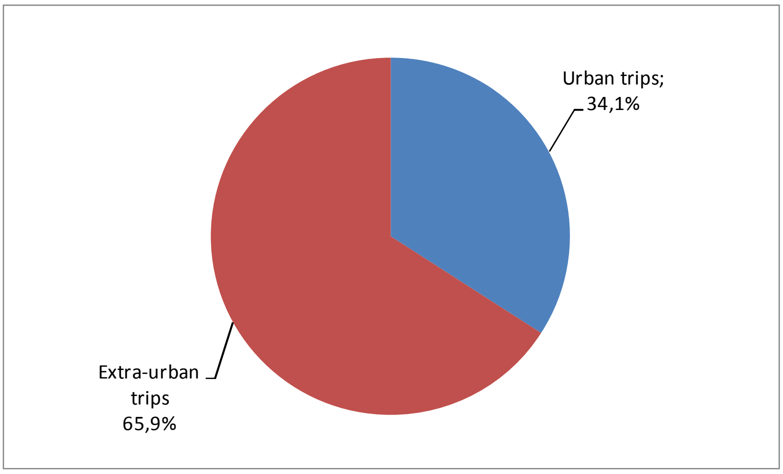


Figure 3-10 Regional travel planners urban and extra-urban trips

As it may be expected, due to the regional geographical coverage of the travel planners, interurban trips account by far the major share of the total trips: about 66% of the total access, corresponding to 24,362 accesses.

Concerning the urban mobility, the most significant share of transport modes is related to buses (by 33.5%) and intermodal solutions (buses and train), by 30%. Urban mobility by car accounts by another 30.1%, while the use of train in urban areas is about 5%.Coaches account by the residual share of 1%.

In general, data analysis shows that regional travel planners are used mainly for planning extra urban trips, using a combination of public transport. When using stand alone transport modes, rail transport is confirmed to play a minor role, at least in the medium-short distances.

The role of private motorisation is anyway important, even in the context of a regional public transport travel planner, both with reference to urban and extra-urban trips.

3.4 Assessment of the Solution - A Regional Multimodal Travel-Planner: Marche Region of Italy

3.4.1 Specific Description of the Solution

Internet-based regional travel planners allowing the user:

- To select origin and destination points;
- To select options to travel: public transport modes, intermodal or stand alone;
- To visualise paths on geo-coded maps, travel times and transit times at interchanges.

3.4.2 Assessment of Applicability

Investment costs

Costs of loading data (for the first year in which it is required the start-up): ~ ú 50,000. Information related to the Mobilitami application only.

Operation and maintenance costs

Maintenance costs require to hire personnel for data updating and technological upgrading (maps and data base licence, platform maintenance), which can outgrow investment costs, Maintenance costs / year: ú 60,000 ~ ú 150,000 (higher range). Information related to the Mobilitami application only.

Financial viability

An Internet-based application may raise revenues from sponsors, via commercial banners, subscriptions, personalised services, etc. At the moment, this objective is not attained.

Technical feasibility

From the technical side, it must be considered that 70% of the data used in the travel planners are acquired through the set up of web services for data import / export procedures. Therefore, web services have been designed and implemented according to the technical standards of data providers (e.g. transport operators) who have authorised such imports / exports. In general, since data access is basically carried out through multimedia (e.g. totem, smart phones, portal, multimedia monitors, etc), different systems interface between platforms and devices were need to be set up.

The remaining 30% of the data have been imported with different procedures, i.e. by interfacing with open data systems, for example with the Marche Region, as public data manager of the Local Public Transport operators. All data are managed by business intelligence systems and geo-marketing software.

It must be stressed that it may be possible that data are not provided correctly, for example creating discrepancies between the location of the centroid of the travel planners maps and the actual position of the points of interest.

Furthermore, there may be discrepancies between the address provided and the map database. In such a case, as for the discrepancies between the location of the centroid of the map and the actual position of points of interest, the problem must be solved manually, i.e. editing the centroids in order to correct the errors.

Organisational feasibility

Organisational problems arose depending on the type of data. Data of Local Public Transport buses were easily available because the platform for data collection was constantly interfaced with the transport companies.

A different situation was reported with reference to rail data, for which problems of interface with rail data provider has made the acquisition of transport data technically problematic, i.e. not possible via direct data import.

The same problem has been found when importing data from the aviation and maritime transport sectors.

In such cases, manual data input have been made necessary.

Administrative burden

In general, data must be constantly maintained and updated. The transport schedules may vary depending on the periods of the year and the events of the territory must be renewed weekly.

The administrative burden can be evaluated as follows: regarding the failure to direct data import of rail transport, it became necessary to import almost manually, according to the data provided by Trenitalia (the main national rail operator). The import must be performed every 6 months due of changes in schedules and takes about 1 week working each semester. The amount of resources used in the loading, therefore, corresponds to 2 weeks / person per year.

With regard to the maritime and air transport sectors, the import was made in response to a search of schedules on the websites of airlines and shipping companies and ports and airports in the region.

Regarding the ongoing data maintenance, it is necessary to consider the presence of specific resources to be devoted to the information renewal. To date there is no standard for data exchange with the appropriate sources (e.g. Statistical Offices Information, Pro Loco, etc.).

Legal feasibility

No particular legal barriers have been faced.

User acceptance

Data availability does not allow to get reactions from the users. All that is known is that the planners are consulted by 100 users per day.

Public acceptance

Acceptance by the wider public, who do not know about the planners, is not an issue.

3.4.3 Assessment of Interest for Travellers

Door to door travel time

The travel planner allows the user to identify easily the fastest travel option, which he might not have detected when using other routines for travel planning. So in general the system enables the user to save travel time.

Door to door travel costs

No impact expected.

Comfort and convenience

Concerning the organisation of a trip, the travel planner offers more convenience than consulting individual public transport timetables.

Concerning the trip itself the system displays the different attributes of the specific travel suggestions, in particular the number of transfers required. This allows the traveller to choose the most convenient option.

Safety

The impacts on safety are intended as the reduced accident costs arising from the reduction of 5% of road transport (passenger transport) (see explanation on car usage below).

The procedure for the assessment of road accidents costs for passenger transport is calculated using the recommended average costs, i.e. central values (ranging between a minimum and a maximum) to be used in absence of bottom-up or site specific assessment (IMPACT, 2008). Costs are expressed in ú ct/vkm at 2000, actualised at 2012 through the inflation rates in Italy (EUROSTAT, 2013).

The recommended values (úct/vkm) are the following:

Table 3-8 Assessment of road accidents costs: values

Passenger car 2000	Urban area 2012	Extra urban area 2012
Urban roads: 4.78 Other roads: 1.82	6.27	2.38

The resulting savings are about ú 9,000 (urban areas) and about ú 28,000 (extra urban) per day.

Security

There is no impact on personal security.

Accessibility for mobility impaired passengers

There is no impact on accessibility for mobility impaired passengers.

3.4.4 Assessment of Modal Change

Car usage

Literature review (Urban ITS Expert Group, 2013b), suggests that some studies have analysed the impact and the potential of multimodal information on modal shift. The conclusion was that reliable multimodal / intermodal information (on smart phones or other media) could lead to a significant (around 5% and more, in urban areas) modal shift in terms of numbers of daily travels.

On the basis of this assumption, the total daily trips by private cars in the Marche region in 2010 (Regione Marche, 2010) has been assumed as starting point (2,310,229). From CENSIS analysis (CENSIS, 2011), 37.9% of the Italian population use the Internet as a means to query ñroads and destinationsò. This sample, related to the total population, has been used as basis to derive the potential private trips by car, the 5% of that (about 42,000) has been assumed as the potential traffic volume that could be shifted to public transport using travellers information systems.

In order to transform the traffic volume in traffic flows (in vehicle kilometres ïvkm-), data from the origin/destination paths from the regional travel planners have been used. Concerning the trips inside the urban areas an average distance of 10 km has been assumed (car). With reference to the extra-urban trips, the following average distances by transport mode result from the regional planners data sets:

Table 3-9 Average distances by transport mode from travel planner data sets

Transport mode	Average distance (km)
Coach	40.9
Car	41.1
Bus	14.5
Train	39.7
Total	37.0

Multiplying the daily car trips by the average distances in urban and extra-urban contexts (assuming the share of urban/extra urban trips described above), the resulting daily vkm is the following:

Table 3-10 Daily vehicle kilometres for car trips

Transport mode	Average distance (km)	Total (vkm)
Car Urban	10	145,785
Car Extra-urban	41.1	1,157,404
Total		1,303,180

The reduced social costs from modal shift amount in total to about ú 67,000 daily (of which about ú 14,000 is in urban areas and about ú 53,000 in extra-urban areas).

Bus, rail, ferry and aeroplane usage

If the car mileage goes down, it can be assumed that this mileage is added to bus and rail travel, while no change to ferries or aeroplanes are to be expected.

3.4.5 Assessment of Other Impacts

Increased mobility

Travel planners may increase mobility, helping the users to plan trips in presence of adverse conditions, e.g. extreme bad weather.

In Italy, during the winter of 2012, particularly in February, the weather was characterised by storms and heavy snow. The Marche region and in general the Central-Northern part of Italy, were mainly concerned, with transport activities strongly hampered by network disruption and service interruptions.

Data analysis on the monthly access to the regional travel planners shows the higher peak in correspondence of bad weather conditions (February), as shown in Table 3.2 earlier in this chapter.

Compared to the annual daily average of 101 accesses in 2012, the use of regional travel planners in February more than doubled, reaching an average of 342 daily access. This is an indication that the travel planners helped increase the mobility of people when they were unable to use their cars due to bad weather.

Congestion

From the assumptions concerning the impacts of the use of multimodal traveller information systems on modal shift, a certain share of private transport flow (5%) may be assumed to be reduced and transferred to public transport modes.

However, the assessment of its impact in terms of reduced congestion costs in the region would require the application of a full transport model with the transport flows by each regional road network link, which is not possible to apply in the context of this case study.

CO2 emissions

The impacts in terms of CO_2 emissions are intended as the reduced climate change costs arising from the reduction of 5% of road transport (passenger transport).

The procedure for the assessment of road climate change costs for passenger transport is calculated using the recommended climate change costs, i.e. central values (ranging between a minimum and a maximum) to be used in absence of bottom-up or site specific assessment (IMPACT, 2008). Costs are expressed in ú ct/vkm at 2000, actualised at 2012 through the inflation rates in Italy (EUROSTAT, 2013).

The recommended values (úct/vkm) are the following:

Table 3-11 recommended values (€ct/vkm) to assess CO2 emissions

Passenger car 2000	Urban area 2012	Extra urban area 2012
1,4-2L Petrol metropolitan area: 0.6 1,4-2L Petrol interurban area: 0.4	0.8	0.5

The recommended values must be understood related to a typical medium car, fuelled by petrol. The resulting savings are about ú 1,000 (urban areas) and about ú 6,000 (extra urban) per day.

Territorial cohesion

The distribution of the access by geographical characteristics of municipalities is shown in Table 3.3 earlier in this chapter. Table 3-3 shows the access by month of the year and the geographical distribution of municipalities (origin). The users resident in municipalities partly and fully mountainous account for on average by 25% of the total. However, it can be observed that during February, a critical month due to adverse weather conditions, the share of users in the most remote areas (mountainous municipalities) increased to 31%, indicating that the travel planners improve the accessibility to and from remote locations in prohibitive weather conditions.

Table 3-12 shows the same access to travel planner information, but now with reference to the destinations points. In such a case, the higher access towards mountainous areas has been recorded during spring time, when mountainous areas can be considered among the preferred locations for touristic purposes.

Table 3-12 Access to travel planners by geographical characteristics of municipalities and month (destinations)

Month	Non mountainous municipalities A	Partly mountainous municipalities B	Totally mountainous municipalities C	Share of mountainous municipalities (B+C)/E	Total E
May-12	1,454	131	619	34.0%	2,204
April-12	1,569	139	538	30.1%	2,246
March-12	1,738	119	614	29.7%	2,471
January-12	1,623	136	431	25.9%	2,190
February-12	4,123	248	1068	24.2%	5,439
June-12	1,416	78	353	23.3%	1,847
December-12	770	54	171	22.6%	995
October-12	1,189	113	232	22.5%	1,534
September-12	1,513	96	275	19.7%	1,884
November-12	871	78	114	18.1%	1,063
July-12	1,110	29	215	18.0%	1,354
August-12	954	49	132	15.9%	1,135
Total	18,330	1270	4,762	24.8%	24,362

3.4.6 Assessment against Main Criteria – Summary

The following table summarises the scores allocated to the regional travel planners, as described in the above sections.

Table 3-13 Regional multi-modal travel-planner for the Marche Region of Italy - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	€€
Financial viability	X
Technical feasibility	0
Organisational feasibility	0
Administrative burden	X
Legal feasibility	0
User acceptance	(✓)
Public acceptance	0
D2D travel time	✓
D2D travel costs	0
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	+
Ferry usage	0
Aeroplane usage	0
Mobility	(✓)
Congestion in overcrowded corridors	0
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	✓

4 CASE STUDY 3 – ACCESSIBILITY APPLICATIONS FOR DISABLED PEOPLE

4.1 THE BACKGROUND OF THE CASE STUDY

4.1.1 Motivation for this Case Study

The World Health Organisation estimates there to be over 1 billion disabled people worldwide, and highlights that this figure is on the increase and is predicted to continue doing so in the coming years. The upward trend in disability stems from an ever ageing population and the higher risk of disability amongst older age groups, and the increasing prevalence of chronic health conditions, such as diabetes, cardiovascular disease, cancer and mental health disorders.

In most parts of the world the proportion of older people within the population is increasing. As the population ages, the incidence of impairment increases. How ‘disability’ is defined can become contentious, depending upon the extent to which it is viewed as a medical issue or a social issue; that is, whether the source of disability is viewed as emanating from the individual’s medical condition or from society’s failure to organise itself in a way that accommodates the diversity of the population. Nevertheless, there is a widespread acknowledgement that disabled people face a range of barriers to accessing everyday goods and services, such as transport, housing and education, and that these barriers result in diminished life opportunities for disabled people. For example, disabled people tend to have poorer health outcomes, lower educational attainment, lower employment rates and lower incomes than non-disabled people.

New technologies drawing on digital mapping and associated data sources (including crowd-sourced data) offer the potential for individuals to receive enhanced information and communications possibilities before and during travel. The potential for these enhancements to improve the travel experience is increasingly being realised, and a number of specific opportunities are seen to be opening up to improve access to travel for elderly and disabled people.

By tackling barriers associated with information and awareness in particular, enhanced information and communications provide the potential to instil greater confidence on the part of the traveller, a greater sense of security, an improved quality of the travel experience and, in some circumstances, reduced journey times.

A range of smart phone applications (here-after “apps”), designed to assist disabled people with independent travel, are now coming on to the market. These provide users with disability access information and support relating to specific aspects of the transport system and built environment. At present, different apps do different things – some relate only to one place (e.g. London), some focus on a particular mode of travel (e.g. separate apps for disabled drivers and for public transport users), and some rely on information from organisations while others ‘crowd-source’ their input information.

With this in mind, the objectives of our case study were set out as follows:

- To understand disabled peoples’ travel information demands;
- To understand what relevant information is being made available via smart phone apps;
- To identify and quantify the benefits of these apps, both to users and organisations – including the impact they have on levels of confidence and of personal travel;
- To investigate the potential benefits in integrating them and/or developing them beyond the provision of information through to methods of paying for travel and booking/requesting travel and personal assistance;
- To explore the scope for using the data created via the use of these apps as a data source for research, for example into how disabled people are using them, and the sorts of information that seem most used and, hence, most useful;
- To understand the limitations of this means of delivering information.

4.1.2 General Description of the Region

This case study has been thematic in nature and has not focused exclusively on one region. The smart phone apps investigated are often enabled for multiple regions across Europe, and sometimes beyond. The survey component of the case study, however, has focused on the UK, targeting UK respondents from a research companyꞌs online panel.

4.1.3 Stakeholders Involved

The key stakeholders associated with this case study are as follows:

- App developers (see below);
- Relevant disability stakeholder groups;
- Respondents to the online survey.

4.1.4 Methodology of the Case Study

Firstly, the ranges of apps currently available, and in the pipeline for development, were reviewed. This involved liaison with stakeholders (including developers) and users in order to understand what information and services are being offered and, if possible, what the take-up of such apps and how they are being used.

Secondly, and specifically with a view to the objective of identifying and quantifying the benefits of these smart phone apps, and to – more generally – gauge 'user reaction', it was decided to conduct a survey, including a stated choice experiment. Stated choice, or stated preference, is acknowledged to be a sound means of eliciting data reflecting how people would choose between different alternatives when given a described set of attributes of those alternatives. By asking respondents to choose, in a series of repeated scenarios (or choice tasks) in which the levels of the attributes are systematically varied, it is possible to uncover what the choices imply about how respondents value the different attributes.

Following an initial review of the available apps and the information requirements of different groups of disabled people, it was decided to focus on disabled people experiencing physical mobility impairments. Acknowledging the considerable diversity across the population of disabled people as a whole, the decision was taken to focus on this subgroup of disabled people because desk research had shown there to be some common features of the information needs and general travel patterns for this subgroup and also because it represents quite a significant proportion of disabled people. An alternative would have been to focus on sensory impaired people (vision and hearing impairments), but this subgroup is known to have very different information needs to otherwise disabled people and to rely on public transport to a much greater extent.

ITS designed the survey and sought quotes for its conduct. The available resources allowed for a survey with approximately 250 responses from an online research panel - the COMPASS survey was in fact completed by 259 respondents.

The survey itself was divided into various parts inquiring about respondents' mobility impairments and how these impairments affect individual travel behaviour. For example, information on the amount and type of assistance needed during a trip was sought, as well as details of more and less-frequently made journey types. The goal of the survey was then to examine the extent to which smart phone applications could enable the group of respondents to start travelling, that is to make journeys more accessible. The core element was a choice experiment focusing on willingness to pay for the provision of different types of information via the smart phone app.

The choice experiment itself was a decision between two mobility apps providing different levels of information services, and an opt-out option in case a respondent wished to select not to use the app. Thus, there were three alternatives to choose from – to buy one or other of the apps, or neither.

The apps were focused to provide information for a specific mode of transport (bus, car or train) and each respondent was presented with ten choice tasks each. Accordingly, the experiment can best be described as a 'within-mode' choice experiment. By selecting a within-mode choice experiment, the sample was split into three groups. Respondents could have been assigned to these three groups randomly, resulting in approximately 80 respondents in each group. However, it was determined that it would be preferable to include a section in the survey that inquires about available travel modes and recent trips and assign a particular mode to each respondent based on a recent trip. In doing so, it had to be noted that this might have resulted in an unbalanced division across the modes, likely to over represent car, the dominant mode. Since the design for each mode is generated independently, this was felt not to be too much of an issue (likely to be capable of being resolved by the joint analysis of the PT modes).

Each smart phone app in the survey had the basic feature of providing information on optimal route and the expected travel time to get from A to B. The additional information provided, described in more detail below, is split into a planning phase and an interactive phase during the trip. Information provided at the planning stage refers to static information provided by the app.

- Attribute 1: Accessibility information - options to provide information such as maps and directions regarding the accessibility of important places along the route, for example train stations, petrol stations, and also the availability of staff assistance or disabled parking spaces at those facilities.
- Attribute 2: Pre-booking options - the app allowed travellers to pre-book a disabled parking space, accessible taxis or assistance at stations before starting the trip.
- Attribute 3: Interactive phase - It was decided not to include this option in every app offered in the experiment, so there was a óyesôor ónoôoption in the design. All the following attribute levels were set to 0 or ónoôif the App did not provide real time information
- Attribute 4: Route information - for cars, this attribute operated like a satnav system with updated route and disruption information, including rerouting. For trains and buses this mainly focused on up-to-date arrival and departure times for connecting services, information on the next stop and estimated time of arrival, and accessibility of the approaching vehicle.
- Attribute 5: Time efficiency gain - the real-time option of the app will optimise the route for cars, but may also improve the efficiency for public transport users by sending them to the right platform and making sure station staff are notified in time for the arrival of the disabled person. This may result in decreases in travel time.
- Attribute 6: Assist me request - the app proposes to include an attribute which makes sure that the traveller is logged into the system such that assistance can be provided and that staff and organisations required to provide assistance will be warned in time. For cars, this relates to assistance at service stations and connection to break down services. In the latter case, leaving the car is sometimes not an option where the driver is experiencing physical mobility impairments. For public transport, the app enabled assistance personnel to be alerted that a traveller with specific needs is approaching the station and bus drivers to be alerted when these passengers need to access or leave the vehicle.
- Attribute 7: Cost for the use of the App.

The attributes used and the levels attributed to them for each mode are set out in Table 4.1. The full survey form is available on request.

Table 4-1 Attributes and levels in the SP exercise

Attribute	Mode	Level 1	Level 2	Level 3	Level 4
Accessibility information	Car	Map of arrival area	Location and number of disabled parking spots	Distance from (disabled) parking to destination	Assistance availability at service stations along the route and point of arrival
	Train	Station Map	Distance between and accessibility of platforms	Distance between and accessibility of connecting services	Staff availability on station and in train
	Bus	Localised maps	Accessible walking route to bus stop and destination	Distance between and accessibility of connecting services	Staff availability on main bus station
Pre-booking options	Car	No options	Pre-book disabled parking spot	Pre-book assistance at car park	
	Train	No options	Pre-book staff assistance at station	Pre-book accessible taxi	
	Bus	No options	Pre-book staff assistance at main bus station	Pre-book accessible taxi	
Real-time App	Car	No	Yes		
	Train	No	Yes		
	Bus	No	Yes		
Route information	Car	No	Directions during trip	Disruption info and rerouting	Both
	Train	No	Info on next station and estimated arrival time	Up to date connection info at interchange	Accessibility info of arriving train
	Bus	No	Info on next stop and estimated arrival time	Up to date connection info at interchange	Accessibility info and seat availability of arriving bus
Efficiency Gain in Time	Car	0.00%	5.00%	10.00%	15.00%
	Train	0.00%	5.00%	10.00%	15.00%
	Bus	0.00%	5.00%	10.00%	15.00%
Assist me request	Car	No	At service station	Road break down services	At car park
	Train	No	On-board assistance	Platform assistance	
	Bus	No	Assistance at main bus station	Warn bus driver on access and egress stops	
Purchase model	Car	Permanent license	Annual subscription	Pay as you go (per trip payment)	
	Train	Permanent license	Annual subscription	Pay as you go (per trip payment)	
	Bus	Permanent license	Annual subscription	Pay as you go (per trip payment)	
Cost (£)[10]	Permanent license	50	75	100	
	Annual subscription	15	25	35	
	Pay as you go (per trip payment)	1	2	3	

[10] £1 = ú1.2 at the time of edition of this document (October 2013)

4.2 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

4.2.1 General Description of the Case Study

ÓAppsÔare software applications designed to run on mobile devices such as smart phones and tablet computers. They are typically designed to offer a single service or task in a simple, direct, self-contained way or to interact with a single service, task or website on the internet and, consequently, tend to be relatively simple to use. By opening up information sources and support services, they offer huge potential to help and liberate individuals, including disabled and older people, who face challenges with other methods of communication and information-gathering. Nevertheless, where apps are designed in ways that make it more difficult for disabled and older people to use them, or do not provide disability or age relevant information or support, there is also the potential to further exclude people who are already at a disadvantage.

A review both of mainstream apps which offer information and/or support relevant to disabled people and of apps designed for and targeted directly to disabled people was carried out. This review of the range of disability apps has revealed differences according to broad type of impairment. In the case of wheelchair users and people with otherwise reduced mobility, apps focus on providing tailored accessibility-related information linked to digital maps (often provided in real time), as well as on enabling a communication link to those who might provide disability assistance. In the case of visually impaired people, apps have focused on providing route guidance, navigation and wayfinding information via large-print and/or text to speech enabled platforms. Thirdly, for those with hearing and other communications difficulties, apps focus on facilitating enhanced communications, via means of text, sign-language, synthetic speech or otherwise.

The key apps designed for and targeted directly to people with physical mobility impairments currently on the market are as follows:

Jaccede

Developed by jaccede.com, a French not-for-profit organisation established in 2006, this app was launched in 2012 and enables users to search for places that are accessible to those with a disability. Information such as whether the entrance is step-free and the accessibility of toilets is displayed alongside photos, user comments and other relevant information. Users can contribute by adding accessible places anywhere in the world, or by editing existing listings. This app won a Vodafone Smart Accessibility 2012 award, in the mobility category. It is free and available for both Android and iPhone.

Assist-Mi

Developed by DisabledAccess4All, this app can be used by disabled people to alert participating sites such as shopping centres, railway stations and airports to know when a disabled person is on their way and when they have arrived, while conveying all their access needs so they can be met by staff and properly accommodated. In addition, the Óparking space finderÔfunction can help locate nearby Blue Badge spaces and indicate how far away the space is, any special parking restrictions the space may have and what kind of parking it offers.

Go Genie

Developed by Pesky People, this app aims to help disabled and deaf people find access information online for any location such as a shop, cinema, cultural event or town centre, based on the recommendations and comments of others. Specific features include access information, contact details, maps, facilities to add reviews, photos and videos, and a Óreport-itÔfeature enabling people to complain directly to inaccessible venues and organisations. Go Genie is currently available for Symbian, iOS and Android.

Ldn Access

Developed by My UK Access Ltd, this app is designed to be used as a source of access-related information for places to eat, hotels, entertainment, attractions etc. throughout London. It is targeted slightly more broadly at disabled people (either physical or none physical or both), older people, families with young children, and visitors to London, and provides information on wheelchair access, disabled toilets, induction loops, baby changing facilities, customer parking etc.

Future development in apps drawing on information linked to place is thought to lie within the field of "augmented reality". Augmented reality apps will overlay all kinds of information onto live images or maps. For disabled people such as blind people or wheelchair users, this could greatly enhance the experience of getting about and navigating an area such as a high street: with the latest offer displayed or spoken when they are near a shop according to their own profiles and interests, for example, the disabled person could decide whether or not it is worth them making the effort to access that specific location.

4.2.2 Data Used

In this section the data collected in the survey of disabled people are presented and described. The dataset included 259 survey responses, but the total sample of those who completed the SP exercise is 207.

A key feature of the SP exercise is whether the respondent's recent occasional or infrequent medium- or long-distance trip related to car (driver, passenger and taxi) or public transport (PT, that is rail and bus); it may be expected that the attitudes to different aspects of the apps will differ between the two. Hence these two groups are shown separately in the tables below, which also provide figures for the sample as a whole. In total there are 159 car users and 48 public transport users in the survey respondents.

Table 4.2 presents the types of physical impairment represented in the survey sample. Walking difficulties are the most represented form of impairment, with sizeable proportions for both those who require the use of a walking aid and those who do not. The 'other' category is also significant. Those who need to use a wheelchair or have some kind of respiratory disease form low proportions of the total.

Table 4-2 Survey respondents: types of impairment

	All	Car	PT
Walking difficulties which require the use of a stick or some other walking aid (e.g. as a result of arthritis)	68 (33%)	58 (37%)	10 (21%)
Walking difficulties, though not to the extent of needing to use a walking aid	60 (29%)	42 (26%)	18 (38%)
Wheelchair user	14 (7%)	11 (7%)	3 (6%)
Chronic (heart or) respiratory disease	17 (8%)	15 (9%)	2 (4%)
Other	48 (23%)	33 (21%)	15 (31%)
Total	207 (100%)	159 (100%)	48 (100%)

Table 4.3 indicates that the sample contains slightly more females than would be expected in the population at large.

Table 4-3 Survey respondents: gender

	All	Car	PT
Male	85 (41%)	70 (44%)	15 (31%)
Female	122 (59%)	89 (56%)	33 (69%)

Regarding age group, Table 4.4 indicates that most of the population is in the older age categories, which is not surprising. The distribution across age groups is fairly similar for car and PT.

Table 4-4 Survey respondents: age group

	All	Car	PT
18-25	6 (3%)	4 (3%)	2 (4%)
26-34	5 (2%)	2 (1%)	3 (6%)
35-44	17 (8%)	12 (8%)	5 (10%)
45-54	43 (21%)	34 (21%)	9 (19%)
55-59	54 (26%)	38 (24%)	16 (33%)
60-64	44 (21%)	36 (23%)	8 (17%)
65-69	24 (12%)	21 (13%)	3 (6%)
70+	14 (7%)	12 (8%)	2 (4%)

The employment status of the sample is reported in Table 4.5. It is not surprising that a large proportion of respondents are in the unemployed and retired categories.

Table 4-5 Survey respondents: employment status

	All	Car	PT
Full time employee	33 (16%)	22 (14%)	11 (23%)
Part time employee	14 (7%)	9 (6%)	5 (10%)
Self-employed	12 (6%)	11 (7%)	1 (2%)
Student	3 (1%)	2 (1%)	1 (2%)
Retired	77 (37%)	67 (42%)	10 (21%)
Full time home maker	20 (10%)	15 (9%)	5 (10%)
Unemployed	48 (23%)	33 (21%)	15 (31%)

The income categories are reported in Table 4.6. It is not surprising that the PT users have larger proportions in the low income categories. Indeed, in general the sample has relatively low incomes, which is to be expected.

Table 4-6 Survey respondents: income categories[11]

	All	Car	PT
Less than £10,000	32 (16%)	20 (13%)	12 (25%)
£10,000 - £19,999	64 (31%)	45 (28%)	19 (40%)
£20,000 - £29,999	37 (18%)	30 (19%)	7 (15%)
£30,000 - £39,999	18 (9%)	17 (11%)	1 (2%)
£40,000 - £49,999	19 (9%)	16 (10%)	3 (6%)
£50,000 - £59,999	7 (3%)	6 (4%)	1 (2%)
£60,000 - £69,999	5 (2%)	3 (2%)	2 (4%)
Over £70,000	3 (1%)	2 (1%)	1 (2%)
Prefer Not to Say	22 (11%)	20 (13%)	2 (4%)

[11] £1 = ú1.2 at the time of edition of this document (October 2013)

Table 4.7 indicates that there is a reasonable spread across the different categories of mobility fluctuation. Most regard their mobility situation to be fairly constant but there are significant numbers in other categories.

Table 4-7 Does your physical mobility fluctuate significantly from one day to the next?

	All	Car	PT
No, it is fairly constant	72 (35%)	53 (33%)	19 (40%)
Yes, there are 'good' and 'bad' days, in roughly equal proportion	63 (30%)	50 (31%)	13 (27%)
Yes, there are 'good' and 'bad' days but more 'bad' than 'good'	50 (24%)	40 (25%)	10 (21%)
Yes, there are 'good' and 'bad' days but more 'good' than 'bad'	22 (11%)	16 (10%)	6 (13%)

Table 4.8 provides a distribution across different distance bands for the distance the survey respondents consider themselves able to walk. . Many respondents cannot walk very far without a rest but for many there is no problem with 150 metres or more. It is to be expected that PT users have less of a limitation here.

Table 4-8 On a good day, approximately how far can you comfortably walk without needing to take a rest?

	All	Car	PT
Less than 50 metres	58 (30%)	47 (32%)	11 (24%)
50 metres	38 (20%)	32 (22%)	6 (13%)
100 metres	20 (10%)	15 (10%)	5 (11%)
150 metres	15 (8%)	13 (9%)	2 (4%)
More than 150 metres	62 (32%)	41 (28%)	21 (47%)

Table 4.9 indicates how physical mobility impairment affects travel. The numbers are generally similar for car and PT, although surprisingly the proportion stating that they do not go out as much as they would like to is less for PT users.

Table 4-9 How does your physical mobility impairment affect your travel (% Yes)

	All	Car	PT
I'm only able to go travelling on 'good' days	42 (31%)	35 (33%)	7 (24%)
I can do local trips by myself, but need assistance during longer trips	48 (23%)	39 (25%)	9 (19%)
I always need assistance when going outside, irrespective of the trip	31 (15%)	26 (16%)	5 (10%)
I always have to plan my journeys really carefully	84 (41%)	67 (42%)	17 (35%)
Not specifically, but walking takes more time	85 (41%)	59 (37%)	26 (54%)
I don't go out as much as I'd like to	91 (44%)	77 (48%)	14 (29%)

Note: The first question was not relevant for 72 of the total, made up of 53 car users and 19 PT users.

Table 4.9 indicates that the majority of respondents are able to travel by public transport without assistance. As might be expected, this figure is somewhat larger for PT users. And also as might be expected, the proportion of PT users stating that they could not travel by PT is very low. The proportions needing assistance is fairly similar for car and PT.

Table 4-10 Are you able to travel by public transport?

	All	Car	PT
Yes, without any assistance	117 (56%)	82 (52%)	35 (73%)
Yes, but I need assistance in getting on and off the vehicle	34 (16%)	27 (17%)	7 (15%)
Yes, but I need assistance (other than with getting on and off the vehicle)	17 (8%)	11 (7%)	6 (13%)
No	43 (21%)	41 (26%)	2 (4%)

The proportion with access to a driving licence is given in Table 4.11. Most respondents have a driving licence and, as would be expected, the proportion is lower for PT users.

Table 4-11 Do you have a driving licence?

	All	Car	PT
Yes	159 (77%)	134 (84%)	25 (52%)
No	48 (23%)	25 (16%)	23 (48%)

Table 4.12 reports the numbers having access to a car, although not specifically for the journey covered in the SP exercises. As expected, a large proportion of car users have access to a car whenever they want but with much lower figures for PT users. Indeed, almost half of PT users had no access to a car.

Table 4-12 Do you have access to a car?

	All	Car	PT
Yes, whenever I want	119 (58%)	106 (67%)	13 (27%)
Yes, but shared with other drivers	19 (9%)	17 (11%)	2 (4%)
Yes, but someone else needs to drive	38 (18%)	29 (18%)	9 (19%)
No	31 (15%)	7 (4%)	24 (50%)

As for providing assistance during a trip, friends and family are, as expected, by far the largest proportion. The proportions for the other óprovidersô are also quite large.

Table 4-13 Who Usually provides the required assistance during a trip?

	All	Car	PT
Friends and family	146 (71%)	118 (74%)	28 (58%)
Neighbours	6 (3%)	5 (3%)	1 (2%)
Staff at shops, train and bus stations, etc.	18 (9%)	10 (6%)	8 (17%)
My PA or carer	17 (8%)	10 (6%)	7 (15%)
Other (please specify)	39 (19%)	31 (20%)	8 (17%)

Regarding the frequency of making different types of trips, Table 4.14 reports the distribution of trips for different purposes across four broad categories of use. Trips for work, education and shopping are those made frequently, with visiting nearby friends and family also relatively frequent. Shopping out of town occurs occasionally as does visiting friends and family out of town but generally most types of trip are made very infrequently.

Table 4-14 And how often do you make this type of trip?

	1	2	3	4
To work/education/shopping/health	67 (32%)	61 (30%)	5 (2%)	74 (36%)
Visit nearby friends/family or other local trips	25 (12%)	122 (59%)	23 (11%)	37 (18%)
To work out of town	6 (3%)	6 (3%)	7 (3%)	188 (91%)
To shop out of town	2 (1%)	62 (30%)	26 (13%)	117 (57%)
To an out of town health appointment	3 (1%)	31 (15%)	57 (28%)	116 (56%)
To go on a short break or holiday	0 (0%)	7 (3%)	107 (52%)	93 (45%)
Visit friends/ family out of town or other non-local trips	0 (0%)	50 (24%)	81 (39%)	76 (37%)

Note: 1 = frequently (5 per week), 2 = occasionally (5 per month), 3 = rarely (5 per year), 4 = none made.

Table 4.15 indicates that most use the internet in connection with their travel and the degree of use is greater for PT users.

Table 4-15 Do you make use of the internet in connection with your travel?

	All	Car	PT
Yes, sometimes	121 (59%)	86 (54%)	35 (73%)
Yes, always	28 (14%)	22 (14%)	6 (13%)
No	58 (28%)	51 (32%)	7 (15%)

The vast majority of respondents have a mobile phone as might be expected and is apparent from Table 4.16. The sample is evenly split between whether it is a smart phone or not.

Table 4-16 Do you have a mobile phone?

	All	Car	PT
Yes, but it is not a smart phone	100 (48%)	78 (49%)	22 (46%)
Yes, and it is a smart phone	102 (49%)	76 (48%)	26 (54%)
No	5 (2%)	5 (3%)	0 (0%)

Table 4.17 indicates the extent to which the mobile phone is used to assist with travel. Around a half of the sample, including both car and PT users, do not use their mobile phone to assist with travel. The proportion with specific apps for assistance is particularly low. Car users are more inclined to use the mobile phone to speak to people whereas PT users are equally likely to use it for speaking to people and accessing the internet.

Table 4-17 Do you use your mobile phone to assist with your travel?

	All	Car	PT
Yes, in order to speak to people	75 (37%)	61 (40%)	14 (29%)
Yes, in order to access the internet	47 (23%)	32 (21%)	15 (31%)
Yes, I have specific apps on my phone which assist me	15 (7%)	13 (8%)	2 (4%)
No	104 (52%)	81 (53%)	23 (48%)

As mentioned above, the SP exercise was based around people who occasionally or rarely made medium- or long-distance trips. Table 4.18 indicates that most trips were made to visit friends or relatives, followed by holiday and then, perhaps surprisingly, health and medical purposes. Shopping forms a fairly small proportion whilst travelling to or in the course of work is rare. Table 4.18 presents responses on journey distance, and shows that the largest proportions are for trips of less than 30 miles although there are sufficient numbers in the other two categories.

Table 4-18 Journey purpose of medium/long distance trips occasionally or rarely made

	All	Car	PT
Travel to work	4 (2%)	2 (1%)	2 (4%)
Travel in the course of work	2 (1%)	2 (1%)	0 (0%)
Health/medical	50 (24%)	42 (26%)	8 (17%)
Shopping	20 (10%)	15 (9%)	5 (10%)
Visiting friends/relatives	69 (33%)	53 (33%)	16 (33%)
Holiday	48 (23%)	36 (23%)	12 (25%)
Other	14 (7%)	9 (6%)	5 (10%)

Table 4-19 Journey distance

	All	Car	PT
10-30 miles	86 (42%)	67 (42%)	19 (40%)
31-100 miles	63 (30%)	51 (32%)	12 (25%)
Over 100 miles	58 (28%)	41 (26%)	17 (35%)

There is a good spread across different journey time bands, as Table 4.20 demonstrates. This provides a good basis for exploring whether the willingness to pay for apps depends upon the length of the journey.

Table 4-20 Journey time

	All	Car	PT
Less than half an hour	24 (12%)	19 (12%)	5 (10%)
Half an Hour to One hour	59 (29%)	53 (33%)	6 (13%)
One to Two Hours	55 (27%)	38 (24%)	17 (35%)
Two to Four Hours	36 (17%)	25 (16%)	11 (23%)
Over Four Hours	33 (16%)	24 (15%)	9 (19%)

As far as mode is concerned, car users are almost equally split between drivers and passengers, with a few taxi users included. There are three times as many train as bus users in our sample.

Table 4-21 Mode

	All	Car	PT
Car Driver	74 (36%)	74 (47%)	0 (0%)
Car Passenger	76 (37%)	76 (48%)	0 (0%)
Train	36 (17%)	0 (0%)	36 (75%)
Bus	12 (6%)	0 (0%)	12 (25%)
Taxi	9 (4%)	9 (6%)	0 (0%)

Table 4.22 indicates the assistance used. In general around a third of people used assistance, with getting into and out of vehicles the most used. However, the use of information about the accessibility of facilities was also quite popular as was the use of satellite navigation amongst car users. Significant numbers specified ‘other’ forms of assistance.

Table 4-22 What was the assistance used?

	All	Car	PT
Getting into/onto the vehicle	69 (33%)	50 (31%)	19 (40%)
Getting out of/off the vehicle	77 (37%)	59 (37%)	18 (38%)
Information about the accessibility of facilities (e.g. services stations, parking, railway stations etc.)	63 (30%)	44 (28%)	19 (40%)
Satellite navigation	47 (23%)	46 (29%)	1 (2%)
Other	57 (28%)	42 (26%)	15 (31%)

Finally, the survey respondents reported on how easy it would have been to make the journey without any apps. The vast majority felt it would be easy or neither easy nor difficult. This would seem to suggest that apps are not highly valued. Very small proportions would find the journey very difficult without the apps. This is perhaps a result of us having asked them to consider a trip that they had already made. Although we focused on a trip which they make either rarely or occasionally, deliberately aiming to capture trips that were likely to be more difficult, the fact that they had made the trip before necessarily means that they had been able to do it.

Table 4-23 How easy would you find it to make this journey without the use of any apps?

	All	Car	PT
Very Easy	46 (22%)	39 (25%)	7 (15%)
Easy	47 (23%)	37 (23%)	10 (21%)
Neither Easy nor Difficult	87 (42%)	66 (42%)	21 (44%)
Difficult	23 (11%)	14 (9%)	9 (19%)
Very Difficult	4 (2%)	3 (2%)	1 (2%)

The SP exercise was completed by 259 car users and 48 PT users, therefore yielding 1590 and 480 observations respectively (10 choice observations per respondent).

Car User models for Options 1, 2 and 3 (choose one or other app, or no app)

We discuss the car user models first. Option 1 is chosen 362 (23%) times, option 2 is chosen 303 (19%) times whilst the app is not purchased on 925 (58%) occasions (Table 4.24).

Logit models have been estimated to the discrete choice SP responses, to relate the probability of choosing an alternative to the utility of each alternative. In turn, the utility of each alternative is a function of the attributes used to characterise it in the SP exercise.

These models specify dummy variables to represent the categorical variables relating to accessibility information, pre-booking options, real time app, route information, assist me request and subscription type. If there are n categories, then n-1 dummy variables are entered and their coefficients represent their effects on utility relative to the arbitrarily omitted category. Given that there are three alternatives, it is possible to specify two alternative specific constants (ASCs). Continuous variables, such as cost and efficiency gain in time, are entered in linear-additive form. Thus monetary valuations are obtained as the ratio of the relevant coefficient and the time coefficient.

Different cost terms are estimated for the permanent licence, the annual subscription and pay as you go, on the grounds that the behavioural response to each will vary, in part depending on frequency of trip making. A model with dummy variables was estimated specifically for the purchase model but they were both far from significant. These were therefore removed on the grounds that attitudes towards the specific purchase model are being discerned by the separate cost terms specified for each.

The first model reported (NL) is a nested logit model, combining the two app options in a single nest. It achieves a good fit to the data, although the t ratios associated with the coefficient estimates are generally disappointing. The scale parameter implies a logsum parameter of 0.25, which lies between 0 and 1 as required. This will have the effect of considerably reducing the cross elasticity between the purchase and non-purchase options compared to the cross elasticity between the two app options.

Nonetheless, the second model is a multinomial logit model (MNL) and despite the worse fit overall it does lead to some distinct improvements in t ratios. Given this, and that the t ratio of the scale in the NL model was only just significantly different from a value of one at which the NL model collapses to MNL, the MNL model has been used.

The second MNL model removed the ASC relating to the non-purchase option (ASC3) since not only was it not significant but it was highly correlated with other variables. ASC1 was also removed as insignificant and because there is no reason to expect a preference for app option 1 over app option 2 with all else being equal. This leads to some further increases in t ratios. However, MNL2 still contains some insignificant coefficients and indeed some wrong sign yet significant ones.

The three terms relating to accessibility information are all negative and indeed the coefficient for assistance availability at service stations along the route and point of arrival is significant. It would also be expected for these coefficients to be positive, if anything, given that they can be expected to be preferred to the base category of just a map of the arrival area. MNL removes these three coefficients and also the others that were not significant at the 5% level of significance. The latter are a further seven terms. As for the assist me request terms, there was no preference for such a facility for car parks or at service stations. A contributory factor here could be that the respondent might not use service stations and might not park in a car park, or that there were insufficient numbers of respondents who required assistance with these stages of their trip. However, there was a positive value in the context of road breakdown services, and it seems plausible that this is the strongest effect.

There was a significant value associated with being able to pre-book a disabled parking spot but the ability to pre-book assistance at the car park was not significant. Perhaps the presence of other travellers reduces the need for the latter, or again there may have been insufficient numbers of respondents who specifically required this type of assistance. Nor was there a significant benefit from the presence of a real-time app. As for route information, car users did place a significant value on directions during the trip, and this is the largest effect in the model, but they did not value disruption information and rerouting, perhaps because they perceive this to be such a rare occurrence.

Surprisingly, the efficiency gain in time was not significant. It may be that respondents did not believe that the app could credibly achieve such time efficiencies, or it may be related to the trip under consideration being viewed as non-time critical.

The three cost coefficients are all highly significant. Those for licence and subscription are so much smaller since the fees are much higher to cover the longer periods. The licence coefficient would be equivalent to the pay-as-you-go coefficient for eight trips whilst the subscription coefficient would be equivalent to the pay-as-you-go coefficient for just over four trips. These numbers seem sensible.

The easiest way to obtain willingness to pay values is to use the pay-as-you-go go coefficient since it will yield a value per trip. For the three significant coefficients we obtain the following values:

- £0.69 per trip for the road breakdown assistance;
- £1.50 per trip for the pre-book disabled parking slot;
- £1.60 per trip for directions during the trip.

These valuations seem plausible. To place them in context, the official value of travel time savings in the UK is around £0.08 per minute, so the largest value above is equivalent to 20 minutes on a round trip.

Table 4-24 Overall SP models for car users

	NL	MNL1	MNL2	MNL3
Alternative Specific Constant (Option 1)	0.025 (0.7)	0.103 (1.0)	-	-
Alternative Specific Constant (Option 2)	-	-	-	-
Alternative Specific Constant (Option 3)	0.163 (0.7)	0.048 (0.1)	-	-
Map of arrival area (Base)	-	-	-	-
Location and number of disabled parking spots	-0.054 (0.5)	-0.185 (1.0)	-0.199 (1.2)	-
Distance from (disabled) parking to destination	-0.078 (0.7)	-0.241 (1.5)	-0.215 (1.7)	-
Assistance availability at service stations along the route and point of arrival	-0.232 (2.1)	-0.626 (3.0)	-0.624 (4.3)	-
No Assist Me Request (Base)	-	-		-
At Service Station	0.124 (1.5)	-0.010 (0.1)	-0.007 (0.0)	-
Road Break Down Services	0.237 (2.2)	0.274 (1.4)	0.289 (1.6)	0.168 (2.5)
At Car Park	0.088 (0.8)	0.054 (0.3)	0.060 (0.3)	-
No Pre-booking options	-	-	-	-
Pre-book disabled parking spot	0.242 (2.7)	0.484 (3.5)	0.515 (3.9)	0.365 (3.2)
Pre-book assistance at car park	0.033 (0.4)	0.113 (0.8)	0.160 (1.3)	-
No Real Time APP (Base)	-	-	-	-
Real Time APP	-0.059 (0.5)	-0.061 (0.2)	-0.107 (0.6)	-
No Route Information (Base)	-	-	-	-
Directions during trip	0.139 (1.6)	0.353 (1.9)	0.418 (2.5)	0.390 (3.5)
Disruption information and Rerouting	0.020 (0.3)	-0.051 (0.3)	-0.038 (0.2)	-
Both	0.125 (1.4)	-0.011 (0.1)	0.039 (0.2)	-
Efficiency Gain in Time (%)	-0.0001 (0.0)	0.006 (0.5)	0.0053 (0.6)	-
Cost Licence	-0.0091 (2.6)	-0.0298 (11.4)	-0.0298 (11.7)	-0.0318 (15.8)
Cost Pay as You Go	-0.0981 (1.4)	-0.2210 (2.2)	-0.2310 (4.1)	-0.2431 (6.5)
Cost Subscription	-0.0249 (3.0)	-0.0513 (7.2)	-0.0514 (9.6)	-0.0568 (14.8)
Scale	4.01 (2.1)[a]	-	-	-
Log-Likelihood	-1332.9	-1342.9	-1343.5	-1356.1
Adjusted ρ^2	0.226	0.221	0.222	0.220

Note: [a] t ratio with respect to one

Public Transport User models for Options 1, 2 and 3 (choose one or other app, or no app)

Turning to the public transport users, option 1 is chosen 153 (32%) times, option 2 is chosen 130 (27%) times whilst the app is not purchased on 197 (41%) occasions. Thus public transport users have a somewhat greater interest in purchasing the app. The same models were estimated as for car users and these are reported in Table 4.25.

Although the levels can be different for train and bus users, such as the level 2 accessibilities of distance between platforms for train and accessible walking route to stop and destination for bus, there are so few observations for public transport that it would be futile to try and distinguish between them.

The scale parameter in the NL model is not significantly different from one and hence the MNL is justified on empirical grounds. MNL1 contains the full set of attributes. It can be seen that a lot of the coefficients are not significant at the 5% level, although the limited sample size will not have helped here. Following the same procedure as for car users, we removed the ASCs, both of which were far from significant. This had little effect on the t ratios of the other coefficient estimates.

The coefficients were then removed step by step, starting with those with the lowest t ratios until MNL3 was arrived at. Coefficients with t ratios greater than one were retained, through a more generous process than might otherwise have been given the relatively small data set, although only two coefficient estimates in MNL3 are not significant at the 95% level.

As with car users, none of the coefficients for the accessibility information are retained, although this is because they all had t ratios less than one. It may be that respondents have a reasonably good idea about the distances in the first two levels or and they might have presumed that there would be staff available on trains anyway.

Surprisingly, neither of the assist me request terms were significant, perhaps due to the concept of being able to request assistance on-route being unfamiliar to respondents.

The pre-booking options were both significant, with the taxi being more important than staff assistance at the station. As with car users, there was no value for a real time app and again the efficiency gain in time was far from significant.

The three information terms were all significant with fairly similar coefficients. Again, the cost coefficients for licence and subscription are somewhat smaller than for the pay-as-you-go option.

The preference is to use the pay-as-you-go cost coefficient as the numeraire in calculating money values. A slight concern here is that the coefficient is not quite significant. In this case, the licence coefficient would be equivalent to the pay-as-you-go coefficient for 4.7 trips (as opposed to 8 for car users) whilst the subscription coefficient would be equivalent to the pay as you go coefficient for 2.3 trips (as opposed to 4.3 for car users). Thus these ratios in the range of 50-60% of the previous ratios, and this might be due to the relatively low precision of the pay as you go cost coefficient. Given this, and the much greater precision with which the licence and subscription coefficients are estimated, there is a case for basing values on a corrected pay as you go coefficient which is 55% larger. Values are presented below for the original pay-as-you-go cost coefficient and the revised one (in brackets based on a cost coefficient 80% larger). These are:

- Pre-booking staff assistance at station £1.81 (£1.01) per trip
- Pre-booking accessible taxi £2.92 (£1.62) per trip
- Information on next station/stop and arrival time £5.32 (£2.96) per trip
- Up to date connection information £4.60 (£2.56) per trip
- Accessibility information of arriving train or bus is £6.01 (£3.34) per trip

On balance the amended values are preferred as being more credible.

At the official value of time, the amended values range from 12.6 minutes per round trip for pre-booking staff assistance at stations to 41.8 minutes for accessibility information per round trip.

It seems that the values of the features of an app and the propensity to buy one are somewhat larger for public transport than car users. This seems quite plausible, given that the consequences of poor accessibility information and support are likely to be more problematic when travelling via public transport than via car.

Table 4-25 Overall SP models for public transport users

	NL	MNL1	MNL2	MNL3
Alternative Specific Constant (Option 1)	-0.024 (0.1)	-0.062 (0.4)	-	-
Alternative Specific Constant (Option 2)	-	-	-	-
Alternative Specific Constant (Option 3)	-0.080 (0.2)	-0.018 (0.1)	-	-
Station/local map (Base)	-	-	-	
Distance between/accessibility platforms **Accessible walking route to stop and destination**	0.198 (0.5)	0.223 (0.8)	0.214 (0.9)	-
Distance between and accessibility of connecting services	0.191 (0.3)	0.285 (1.0)	0.276 (1.2)	-
Staff availability on station and in train	0.052 (0.2)	0.056 (0.2)	0.040 (0.2)	-
No Assist Me Request (Base)	-	-	-	-
On board assistance **Assistance at main bus station**	-0.320 (0.4)	-0.428 (2.2)	-0.398 (1.5)	-
Platform assistance **Warn bus driver on access and egress stops**	0.123 (0.1)	0.273 (1.1)	0.256 (0.9)	-
No Pre-booking options	-	-	-	-
Pre-book staff assistance at station	0.212 (0.5)	0.252 (1.0)	0.252 (1.1)	0.236 (1.1)
Pre-book accessible taxi	0.237 (0.2)	0.415 (1.9)	0.393 (2.1)	0.380 (2.2)
No Real Time APP (Base)	-	-	-	-
Real Time APP	0.294 (0.9)	0.260 (0.8)	0.246 (0.8)	-
No Route Information (Base)	-	-	-	-
Info on next station/stop and estimated arrival time	0.387 (0.3)	0.548 (1.6)	0.552 (1.9)	0.692 (3.3)
Up to date connection info at interchange	0.307 (0.3)	0.443 (1.5)	0.434 (1.6)	0.598 (3.1)
Accessibility info of arriving train **Accessibility info and seat availability of arriving bus**	0.368 (0.4)	0.497 (1.6)	0.449 (1.7)	0.781 (3.7)
Efficiency Gain in Time (%)	-0.003 (0.1)	0.000 (0.0)	0.000 (0.0)	-
Cost Licence	-0.0195 (0.3)	-0.0306 (7.2)	-0.0304 (7.1)	-0.0276 (7.7)
Cost PAYG	-0.0772 (0.1)	-0.1471 (1.0)	-0.149 (1.4)	-0.1300 (1.7)
Cost Subscription	-0.0521 (0.4)	-0.0709 (5.5)	-0.070 (6.0)	-0.0561 (6.1)
Scale	1.59 (0.32)[a]	-	-	-
Log-Likelihood	-448.5	-448.7	-448.7	-452.6
Adjusted ρ^2	0.113	0.115	0.119	0.125

Note: [a] t ratio with respect to one.

4.3 Assessment of the Solution - Accessibility Applications for Disabled People

4.3.1 Assessment of Applicability

Investment costs

Costs to users of these apps varies. Some, such as Jaccede, are free, whilst others, such as Navigon, are approximately ú 50 to purchase.

Operation and maintenance costs

Once the user has purchased, there is not usually any ongoing cost. However, for the developers, there are costs to ensuring that the information underpinning the app is updated and kept reliable.

Financial viability

Most apps are provided either on a commercial basis or are provided by no for profit organisations, drawing on financial contributions (e.g. charitable donations) to their organisation.

Technical feasibility

Some of the apps are technically challenging, but their implementation is taken as proof that they are feasible and that, in general, technical barriers are being overcome.

Organisational feasibility

None known

Administrative burden

None known

Legal feasibility

No issues known of.

User acceptance

Our survey serves to inform on this topic, and our forecasts will provide further input here. At present, we can say that user acceptance, as indicated by take-up, is relatively low at present.

Public acceptance

The wider public is not concerned with these apps.

4.3.2 Assessment of Interest for Travellers

Door to door travel time

Some of these apps will help reduce travel time.

Door to door travel costs

The apps to not affect travel costs.

Comfort and convenience

No direct impact.

Safety

No direct impact.

Security

No direct impact.

Accessibility for mobility impaired passengers

This is the criterion of most relevance here. As mentioned above, the potential benefits would seem to be extensive, though realisation of these as yet is, apparently, modest.

4.3.3 Assessment of Modal Change

Car usage

This will emerge in the next phase of work, when forecasts are generated.

Bus and coach usage

This will emerge in the next phase of work, when forecasts are generated.

Rail usage

This will emerge in the next phase of work, when forecasts are generated.

Ferry usage

No known impact

Aeroplane usage

No known impact

4.3.4 Assessment of Other Impacts

Increased mobility

This will emerge in the next phase of work, when forecasts are generated.

Congestion

No expected impact

CO2 emissions

No expected impact

Contribution to user pays principle

No expected impact

European economic progress

No expected impact

Territorial cohesion

No expected impact

4.3.5 Assessment against Main Criteria – Summary

Table 4-26 Accessibility applications for disabled people - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	0
Financial viability	✓
Technical feasibility	✓
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	0
Public acceptance	0
D2D travel time	✓
D2D travel costs	0
Comfort and convenience	0
Safety	✓
Security	✓
Accessibility for mobility impaired passengers	✓
Car usage	0
Bus and coach usage	0
Rail usage	+
Ferry usage	0
Aeroplane usage	0
Mobility	✓
Congestion in overcrowded corridors	0
CO2 emissions	0
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

5 CASE STUDY 4 - ITS SOLUTIONS FOR BARCELONA'S LOCAL BUS NETWORK

5.1 EXECUTIVE SUMMARY OF THE CASE STUDY

In order to improve the efficiency of Barcelona bus network, TMB (Barcelona Bus Operator) is carrying out a series of improvements in their operations and in the services provided. The current Barcelona local bus network has existed for almost 100 years. The network is difficult to understand for less frequent users: the bus lines overlap and itineraries are difficult to understand. Additionally, the bus network is radial (thus not serving trips not passing through the city centre) and bus commercial speed has been reduced from 12 Km/hr to 11.2 km/hr. The Barcelona local bus network has been losing users and Barcelona City Council has approved an ambitious plan to boost public bus services.

The main initiative is to transform the current network to an orthogonal network following the structure of the urban area. The orthogonal network forms a network of horizontal and vertical lines, equally spaced out in a grid structure, for all parts of the municipality.

For an easier transition, TMB has introduced several initiatives in order to improve the customer relationship and rationalise deficit services such as neighbourhood buses. The technical solutions introduced and presented in this case study are the following:

- Smart phone Applications: the bus operator (TMB) has developed several smart applications (TMB for mobile phones, TMB Virtual and TMB Maps) in order to provide updated and real-time information to users. In addition to already existing apps, this case study surveyed the potential interest in additional user information applications.
- Smart bus stops: these are the new bus stops installed on the orthogonal Barcelona bus renewal network. The smart bus stops are fully equipped technologically. They provide real-time information about the time of arrival of the buses, updated every 30 seconds. They provide information about services (delays, relevant information to users). Bus stops are equipped with audio systems for blind people. Smart bus stops also provide static information about bus itineraries and relevant information about the surrounding area.
- DRT Smart applications for mountain neighbourhoods: the case study surveyed the potential interest of implementing DRT systems between the city of Barcelona and its ómountainô areas, and between relevant metropolitan metro and commuter rail stations and the these areas. DRT systems could increase the demand of currently exiting bus services in low density neighbourhoods of Barcelona.

5.2 THE BACKGROUND OF THE CASE STUDY

5.2.1 Motivation for this Case Study

The aim of COMPASS Case Study 4 *ITS Solutions for Barcelona's local bus network* is to explain the ITS solutions for bus services introduced by TMB (the Barcelona bus services operator) in order to improve the costumer relationship and to rationalise neighbourhoods bus services.

The current Barcelona local bus network has existed for almost 100 years. The network is difficult to understand for less frequent users: the bus lines overlap and itineraries are difficult to understand. The Barcelona local bus network has been losing users and Barcelona City Council has approved an ambitious plan to boost the bus public service.

Technologic solutions presented in this case study are:

- Smart phone applications;
- Smart bus stops;
- DRT in mountain neighbourhoods.

5.2.2 General Description of the Region

Barcelona is the second largest city in Spain. It is located in the Mediterranean coast and it is the capital of the Region of Catalonia (7 million inhabitants).

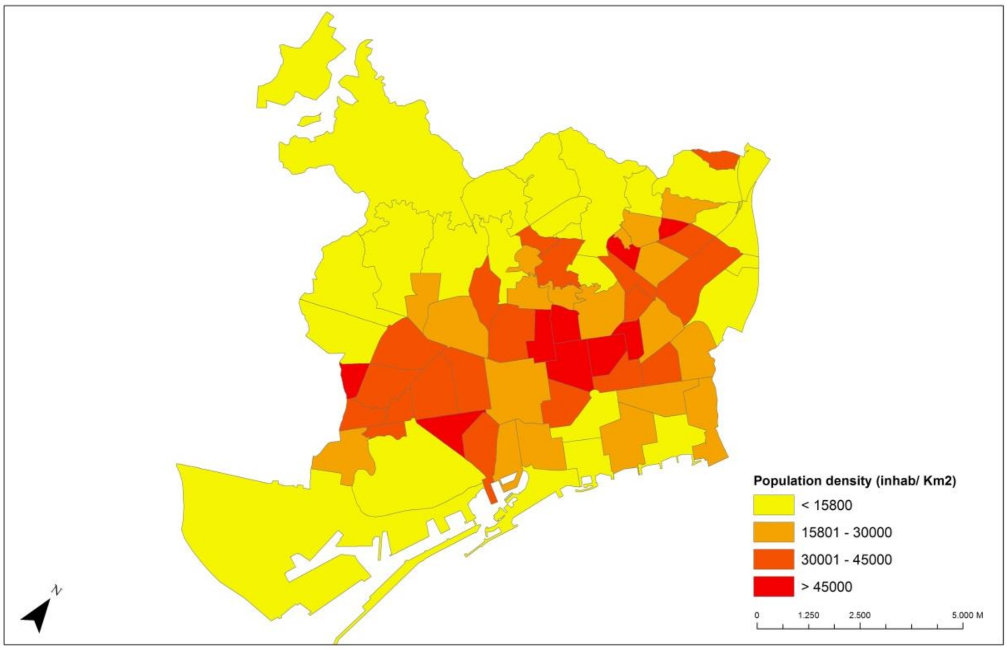
The Metropolitan Region of Barcelona comprises 36 municipalities and has a total area, of 636 km^2 and a population of over three million (2011). The municipality of Barcelona comprises 101 km^2 and a population of 1.6 million.

Figure 5-1 Barcelona location map

Barcelona is one of the most densely populated cities in Europe, with 15,813 inhabitants per km^2. To the west the city borders Tibidabo MOUNTAIN, to the east it borders Mediterranean Sea, to the north it borders the Besos River and to the south it borders the Llobregat River, as shown in Figure 5-2.

Figure 5-2 Limits of Barcelona

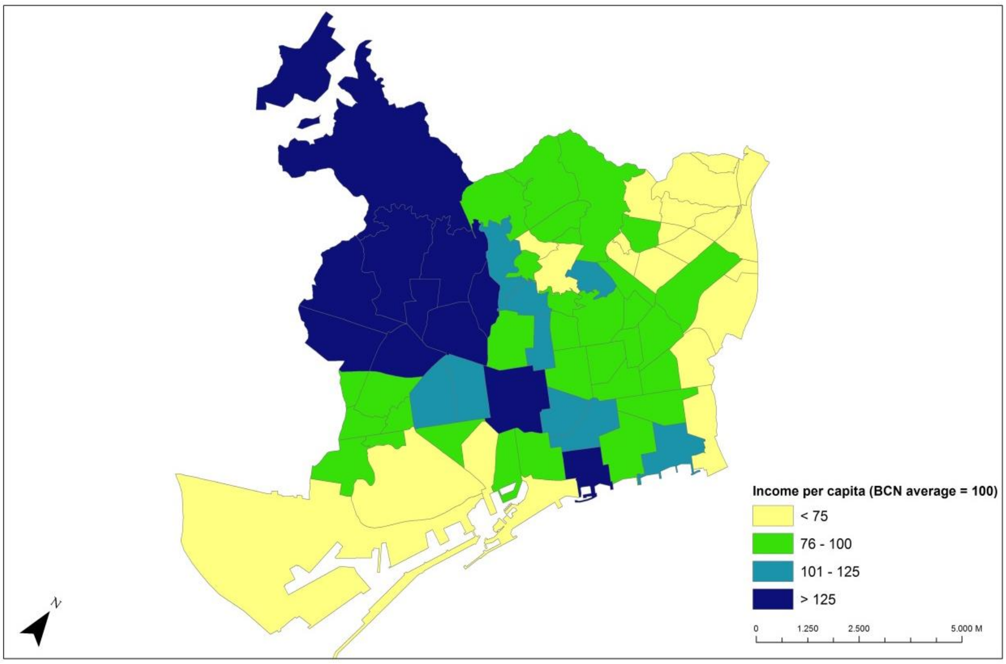
The population distribution within Barcelona is extremely uneven. Half of the municipality (50km^2) contains less than 10% of the Barcelona population (Zona Franca industrial area and Montjuic Park). The city's highest density is found around the neighbourhoods of Sagrada Familia, Sants and Gracia, with a population density above 50,000 inhabitants per km^2. Mountain neighbourhoods within the city are characterised by having difficult topographic conditions and relatively low population densities (15,500 inhabitants per km^2).



Source: Barcelona City Council, 2013

Figure 5-3 Barcelona population density by neighbourhoods, 2011

In Barcelona city, the level of wealth varies among neighbourhoods. Whereas western areas rank among the wealthiest of Barcelona, eastern areas are clearly under the municipal average.



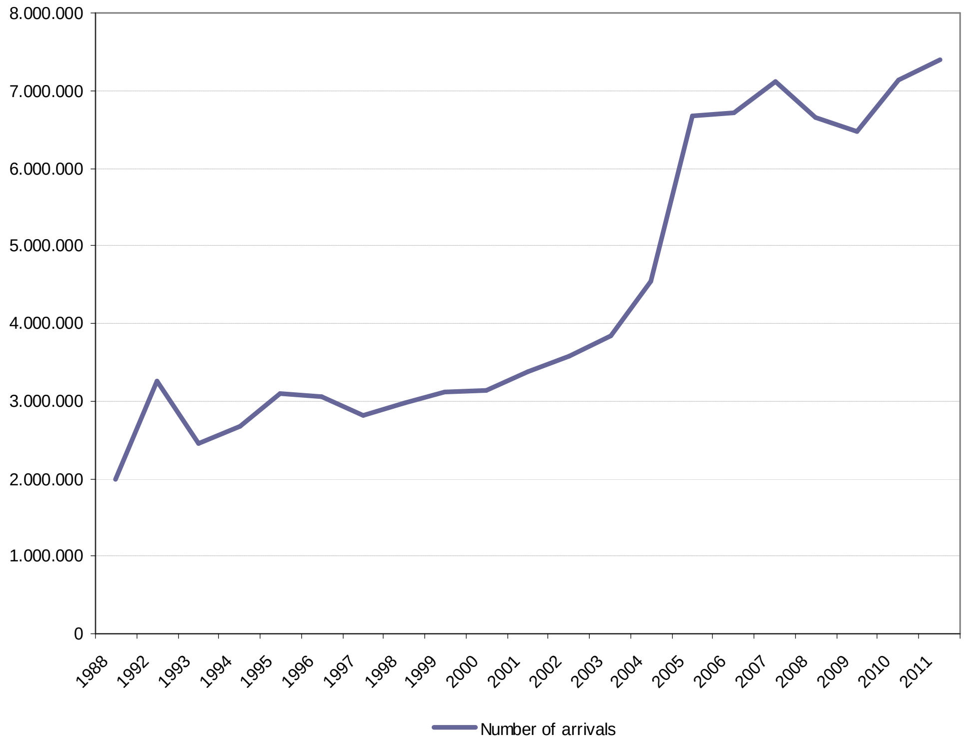
Source: Barcelona City Council, 2013

Figure 5-4 Available family income in mountain neighbourhoods (Barcelona average =100), 2011

Barcelona is a transport hub at the European level with the following :

- First port of cruise activity in the Mediterranean, with more than 2 million passengers;
- Barcelona international airport, which handles over 35 million passengers per year is the second-largest airport in Spain and the largest on the Mediterranean coast;
- Extensive motorway network which links Barcelona with France;
- High-speed rail network which links Spain with France and the rest of Europe.

Barcelona is the 20th most visited city in the world and the fourth most visited in Europe after Paris, London, and Rome, with more than 7 million tourists in 2011 (Source: Euromonitor, 2011). Tourist activity represents 10% of Barcelona's GDP and it supports more than 100,000 jobs. In 1990, approximately 1.7 million tourists visited Barcelona. The Olympic Games in 1992 triggered a tourism explosion in the city and since then the number of tourist arrivals has grown, with approximately 7.3 million visitors staying overnight in hotels in the city in 2011. The expected trend is that tourist activity in Barcelona will continue to grow in coming years.



Source: Barcelona Tourism Office, 2013

Figure 5-5 Tourist arrivals in Barcelona 1988-2011

5.2.3 Stakeholders Involved

Transports Metropolitans de Barcelona (TMB)

Transports Metropolitans de Barcelona (TMB) is the collective name of the companies Ferrocarril Metropolità de Barcelona, SA, and Transports de Barcelona, SA, which manage the metro and bus networks respectively on behalf of Àrea Metropolitana de Barcelona (AMB).

Transport de Barcelona SA

Transport de Barcelona SA is a public enterprise which manages Barcelona bus services. The Barcelona bus network has a fleet of over thousand vehicles, all of which are wheelchair adapted, and with more than 100 lines the bus network covers 936 km between Barcelona and the ten municipalities in the metropolitan area.

Number of lines*		106
Length of the network*		935,95
Number of stops*		2.615
	with bus shelter	1.358
	with bus stop pole	1.257
km of bus lane		131,96

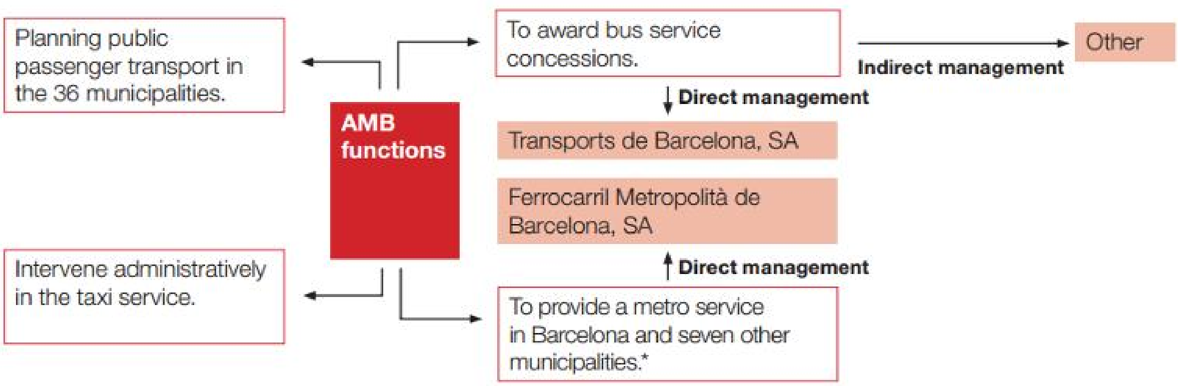
(*) Not including Barcelona Bus Turístic lines or Tramvia Blau or numbers 80, 81, 82 and 83 (contracted out to Sagalés).

Source: TMB, 2011

Figure 5-6 Barcelona bus network

The Barcelona Metropolitan Area (AMB)

The Barcelona Metropolitan Area (AMB) is a supra-municipal administration that comprises 36 municipalities and has authority in the following areas: territory and urbanism, transport and mobility, environment, economic promotion and strategic planning. AMB owns 100% of TMB shares and has the following functions in matters of transport:



* Badalona, Cornellà de Llobregat, Esplugues de Llobregat, l'Hospitalet de Llobregat, Sant Adrià de Besòs, Santa Coloma de Gramanet and Montcada i Reixac.

Source: TMB, 2011

Figure 5-7 Barcelona Metropolitan Area functions

Barcelona Metropolitan Transport Authority (ATM)

Barcelona Metropolitan Transport Authority (ATM) has the following functions: planning infrastructures and services, coordinating the relations with public transport operators, setting the tariff of public transport and managing the integrated ticketing system in the Barcelona metropolitan area.

5.2.4 Methodology of the Case Study

The methodology followed for this case study is the following:

- Literature research and review of the press
  - Review of some previous studies available and developed by Agència d'Ecologia de Barcelona (AEB): *Bases per a la implantació d'una nova xarxa de BUS per Barcelona en el marc d'un nou model de mobilitat* (TMB and AEB).
- Analysis of public data available :
  - Transports Metropolitans de Barcelona website (www.tmb.cat);
  - Xarxa de Bus Ortogonal website (http://www.novaxarxabus.bcn.cat/).
- Survey of mountain neighbourhoods about on-going restructuration of the Barcelona urban bus network and awareness of TMB smart phones applications.

Survey of mountain neighbourhoods

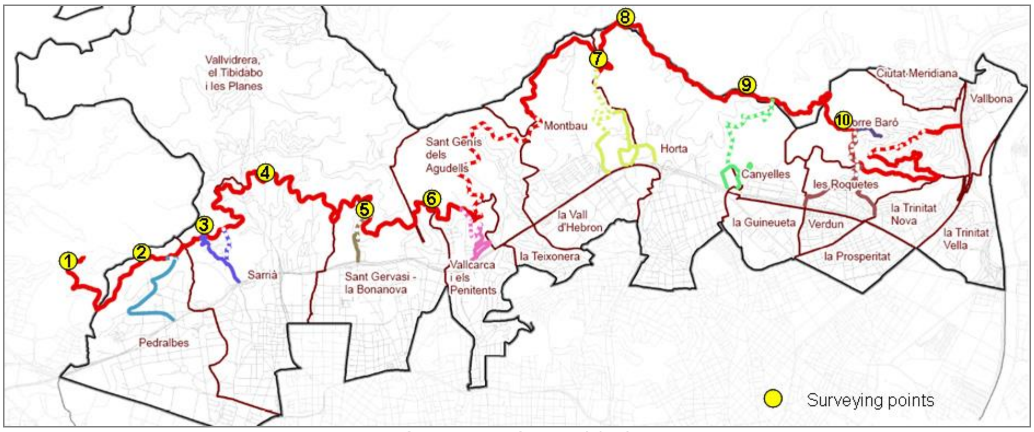
The survey of mountain neighbourhoods was carried out at different access points of “Passeig de les Aigües de Barcelona” on the 3rd of February of 2013, from 8am until 5pm (9 hours in total). A total number of 533 surveys were obtained, 240 from cyclists and 329 from pedestrians.

“Passeig de les Aigües de Barcelona” is located in the Tibidabo hills of Barcelona. It is a recreational path for cyclists and hikers overlooking the city of Barcelona. The access to the “Passeig de les Aigües” is through the mountain neighbourhoods of Barcelona, a set of districts characterised as having difficult topographic conditions and relatively low population densities (which do not allow for regular bus services to be used) and also as having an increasingly old population, and with some localised areas of poverty, which makes the provision of public transport service a matter of general interest.

This case study explores, among other aims, the possibility to increase the use of existing bus services in the mountain neighbourhoods of Barcelona with users that access “Passeig de les Aigües” for recreational purposes, eventually increasing ridership figures of these ad-hoc designed services.

The survey was conducted in the Passeig de les Aigües, in the Barcelona Tibidabo hills. The main characteristics of the survey were as follows:

- The survey took place on the 3rd of February 2013 (winter time), a sunny day, from 8am until 5pm;
- Surveys were carried out at 10 points along Passeig de les Aigües;
- Surveys were carried out in person by 10 interviewers;
- The survey had 26 questions. 14 questions were common for cyclists and pedestrians, 12 questions were specially adjusted depending if the respondent was a cyclist or a pedestrian (only minor changes);
- Estimated response time was 3 to 5 minutes.



Source: MCRIT, 2013

Figure 5-8 Surveying points along Passeig de les Aigües, Barcelona

The contents of the survey were as follows:

- Gender, age and neighbourhood (or municipality if outside Barcelona) where respondent lives (3 questions);
- Characteristics of the trip required to access the area of Passeig de les Aigües (11 questions):
  - Access point used to get to Passeig de les Aigües;
  - Trip purpose (walking, sports …);
  - Size of the group accompanying the surveyed person;
  - Frequency of the trip, average trip length (in time), approximate schedule of the trip;

- Mode of transport used to access Passeig de les Aigües;
- Questions related to parking for users accessing with private car .

➢ Level of awareness of existing initiatives and services by TMB for a more efficient and user friendly bus transport in Barcelona (7 questions):

- Ongoing restructuration of the Barcelona urban bus network (2 questions);
- TMB smart phone application providing real-time service information (3 questions);
- Existing public transport services to mountain neighbourhoods (2 questions).

➢ Potential acceptance of new applications for smart phones, related to the following topics (5 questions):

- Security and guidance;
- DRT services from Barcelona to Passeig de les Aigües;
- DRT from other areas of Tibidabo hills to major metropolitan transport stations (metro, suburban rail);
- Mountain bike sharing services;
- Parking booking applications.

The most relevant questions are listed below:

➢ Do you know the smart phone app by Barcelona Metropolitan Transport (TMB) that provides real-time information?

➢ Would you pay ú 0.80 for a smart phone app providing information about the Tibidabo mountain and user assistance in case of emergency?

➢ Would you be willing to pay for a dedicated transport system for bikes (and passengers) from Barcelona to ῥpasseig de les Aigüesò(with demand-responsive pick up points)?

➢ Would you be willing to pay for a demand-responsive pick up service from different areas of the Tibidabo mountain to the closest rail or metro station?

➢ Would you be willing to use a mountain bike sharing system?

➢ Would you be willing to pay to book a parking space using a smart phone app?

5.3 Specific Characteristics of the Case Study

5.3.1 General Description of the Case Study

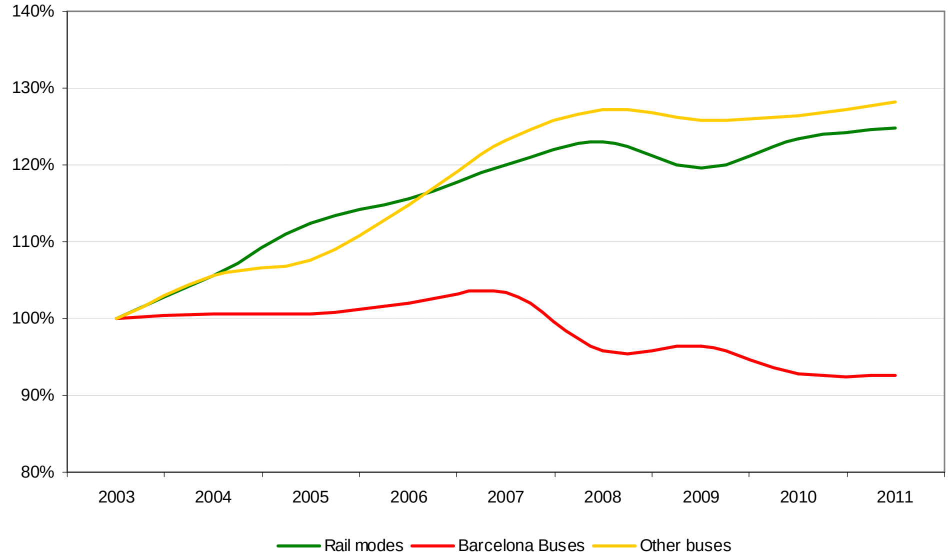
Declining rider ship in TMB Buses

TMB has invested in extensions of the bus network and improvements in the Barcelona local bus transport service. In 2001 Barcelona had around 800 km of network length and by 2011 the network had expanded to 936 km.

Source: Barcelona Metropolitan Transport Authority, 2013

Figure 5-9 Changes in bus network length (km) and million vehicles per km (2001 – 2011)

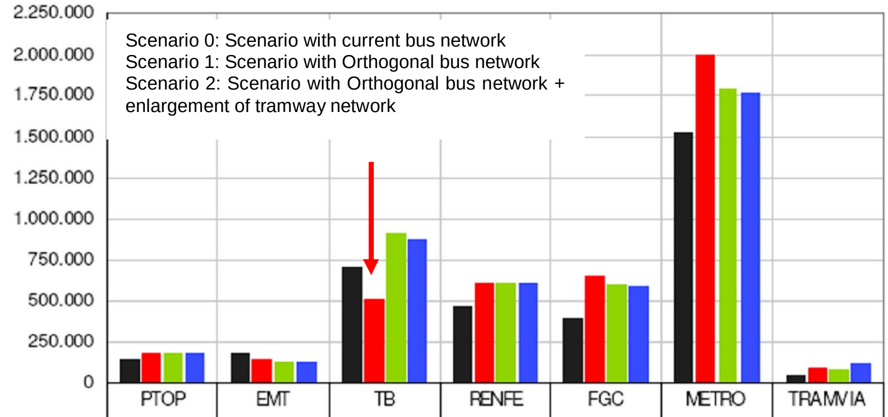
Local bus services transport 190 millions of passengers annually. In the last 10 years all Barcelona public transport services have gained 180 millions of passengers (+24%). During the same period of time, despite increased investment the bus local service, the Barcelona local bus network has lost more than 22 million passengers.



Source: ATM, 2003 ï 2011

Figure 5-10 Changes in demand of public transport: rail modes (local train and metro), Barcelona local bus and metropolitan buses

If the Infrastructure Master Plan (PDI), developed by the Metropolitan Transport Authority (ATM), is implemented and the bus network is not reorganised, it is expected that bus service demand will be reduced by30% (200,000 users every day).



	PTOP	EMT	TB	RENFE	FGC	METRO	TRAMVIA
Escenari actual (2006)	147.171	178.934	699.105	467.291	395.426	1.528.336	54.511
Escenari 0	184.516	141.615	509.978	610.140	649.537	1.992.095	93.719
Escenari 1	184.230	135.032	903.299	609.091	604.393	1.787.336	80.207
Escenari 2	184.229	135.220	879.087	608.347	591.141	1.763.560	125.724

Source: Agència Ecologia de Barcelona and Mcrit, 2013

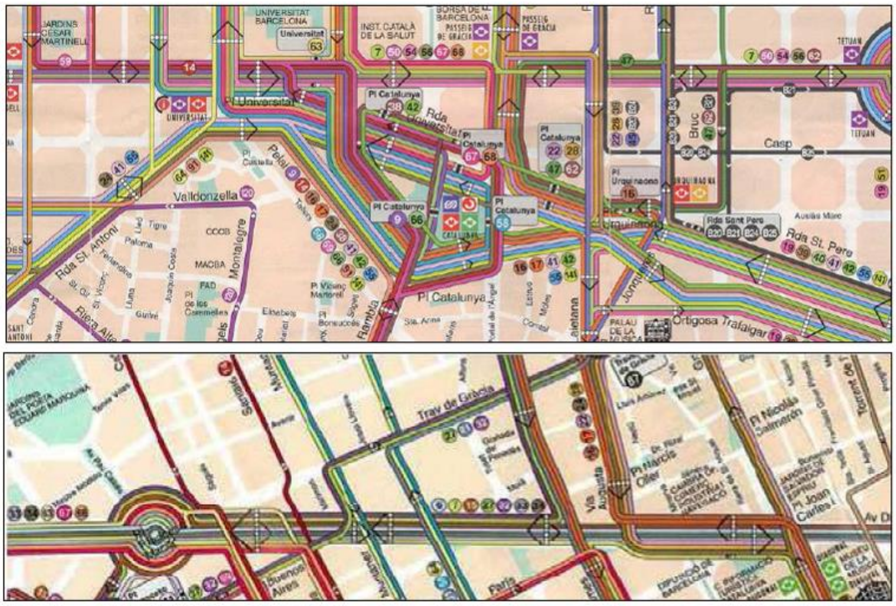
Figure 5-11 Public transport demand in 2006 and estimated transport public demand in 2020 under the Infrastructure Master Plan

To increase the efficiency of buses in Barcelona, the public bus operator and the municipality are considering a full redesign of the local bus network. Many routes currently operating have now been in place for almost 100 years, with modifications and extensions over time in the light of new needs, resulting today in a very complex network

Main issues for loss of bus attractiveness

According to Barcelona City Council and TMB, the loss of competitiveness of the bus network is due to the factors outlined below:

- **Bus itineraries are difficult to understand for non-frequent users.** Overlapping of bus lines creates traffic congestion at bus stops.



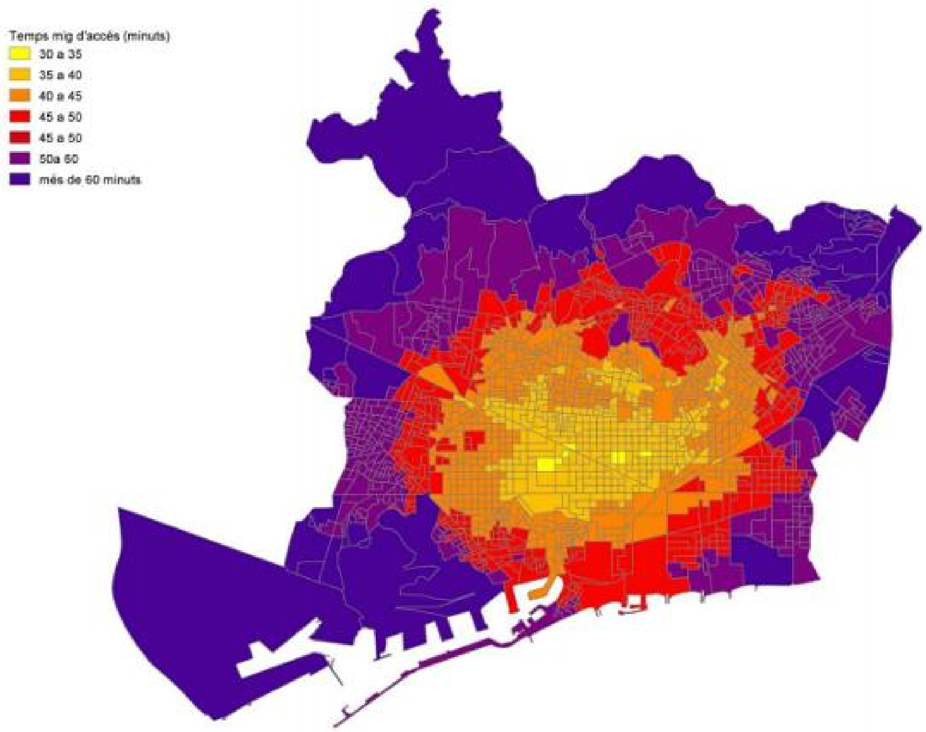
Source: TMB, 2013

Figure 5-12 View of current Barcelona bus network

Source: www.mapametrobarcelona.net

Figure 5-13 Overview of Barcelona bus network

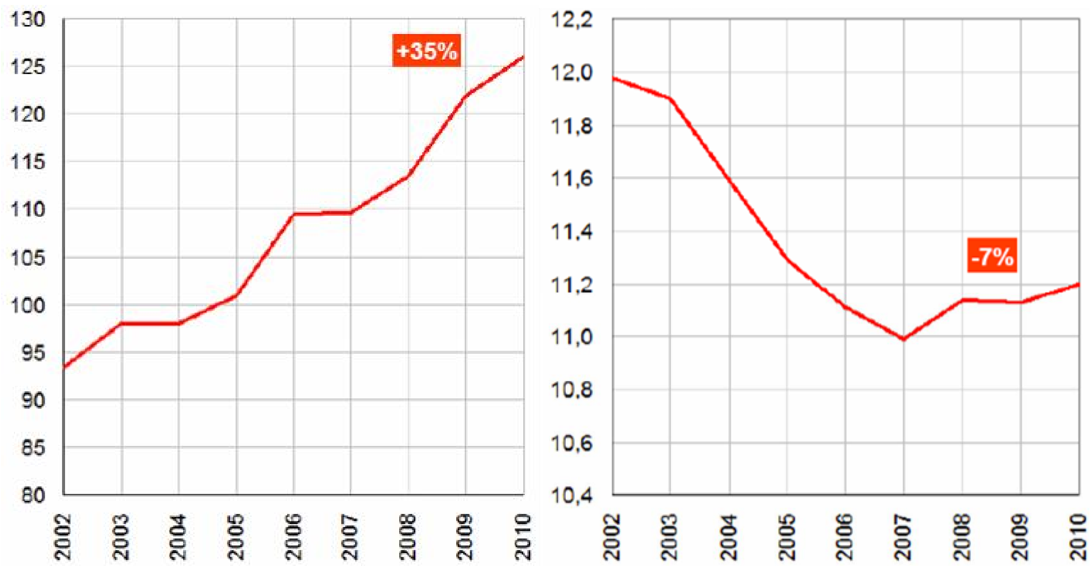
- **The bus network is radial.** The network links Barcelona centre with peripheral neighbourhoods (Sarrià, Horta, Sants …) efficiently, but it doesn't serve trips between peripheral neighbourhoods. Some new focal points of activity are not covered by the current bus network.



Source: Agència d'Ecologia de Barcelona, 2004

Figure 5-14 Access time from a point of the territory to all the others (minutes)

- **Reduction of bus commercial speed from 12 km per hour (2002) to km per hour (2010).** Although the length of bus lanes has increased by 35% since 2002, the commercial speed of bus services has reduced 7% during the same period of time.



Source: Barcelona Council, 2013

Figure 5-15 Length of bus lanes in Barcelona (km) and commercial speed of buses (km/ h)

- **Current bus stops are not comfortable for users.** Bus stops only provide static information about bus lines. Real-time information is not provided. For non-frequent users it is difficult to understand the bus itineraries and information provided. It is not possible to buy tickets at the bus stops; passengers must buy tickets in the metro.

Source: TMB, 2013

Figure 5-16 View of Barcelona bus stop

The Orthogonal bus network

Barcelona City Council and the transport operator (TMB) have designed an orthogonal bus network following the structure of the urban area. This forms a network of horizontal and vertical lines, equally spaced out in a grid structure, for all parts of the municipality. The network comprises a set of 28lines:

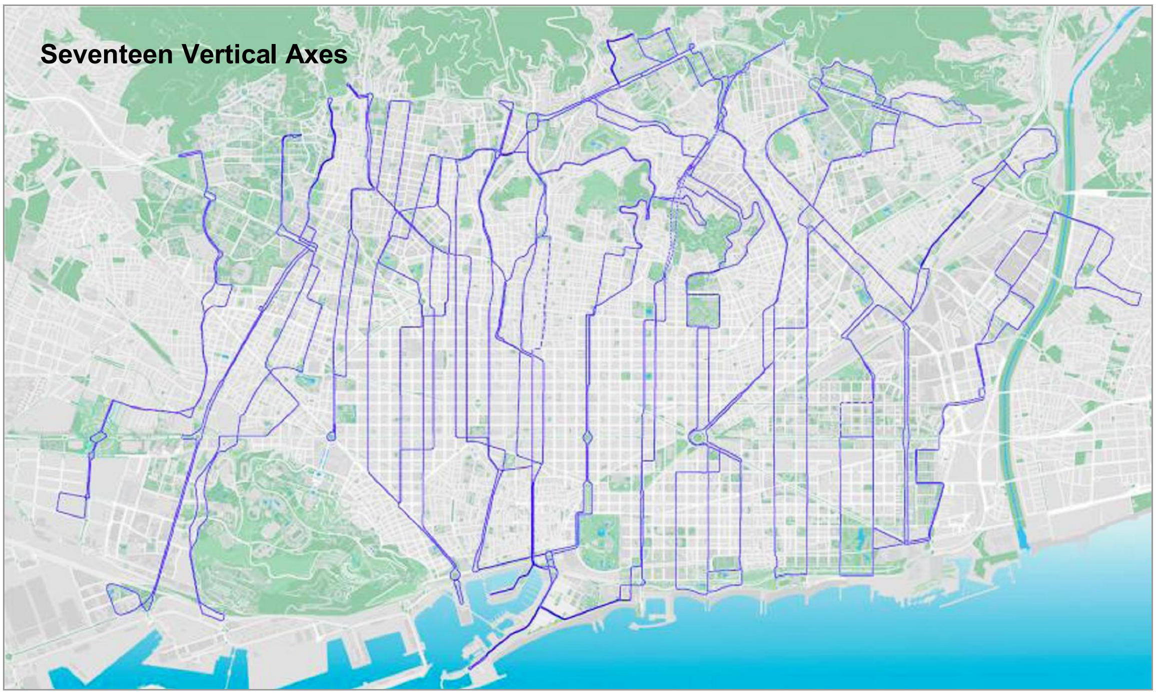
- 16 bus lines will cross the city vertically, from the mountain neighbourhoods to the maritime neighbourhoods;
- 8 bus lines will cross the city horizontally (Besòs ï Llobregat axis);
- 3 bus lines will cross the city diagonally, following the axes of Diagonal, Meridiana and Parallel.

Aims of the Orthogonal Bus Network

The aims of the proposed network are outlined below:

- Provide a comprehensible network for regular and no regular users.
- Improve the geographical coverage of the bus network. 1.87 million inhabitants will be less than 300 meters from a bus stop. The current geographical coverage will be increased by 30,000 inhabitants.
- Better frequency and improve of commercial speed. Current bus frequency is around 12 minutes from 7am until 9pm. Renewal of the network is expected to provide a frequency of 5 ï 8 minutes during the same period. It is expected to improve commercial speed around by 10% - 15%.
- Saving time. Users are expected to save 10 million hours of annual trips.
- Proximity; currently only15% of inhabitants can reach any part of the municipality within 40 minutes. With renewal of the network it is expected that 50% of inhabitants will be able to reach any part of the municipality within 40 minutes.
- Higher capacity: the new network will have more overall capacity because routes have been designed to respond effectively to demand and vehicles will maintain frequency.

- Better connectivity by improving the connectivity between bus services and other public transport services (metropolitan bus, metro, train): 89% of metro stations will have a bus stop within 200 meters.



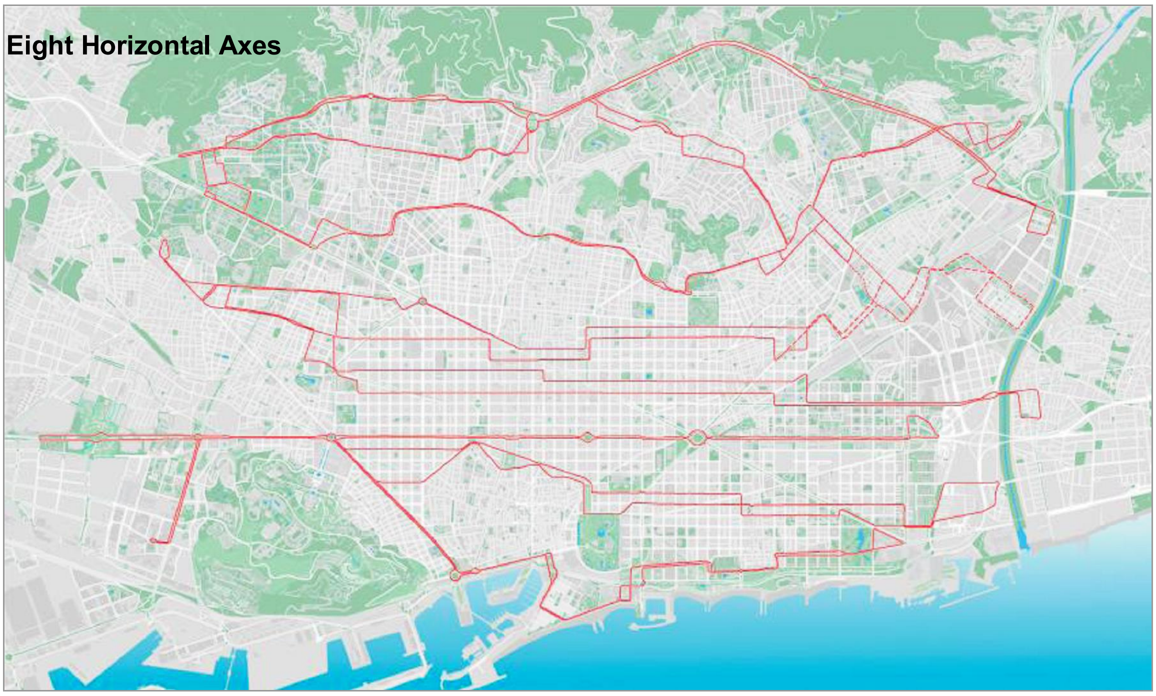


Figure 5-17 The proposed orthogonal bus network in Barcelona

The orthogonal bus network will be complemented by some of the current bus lines and neighbourhood bus lines.

Table 5-1 Current network features and orthogonal network features

	Current Network	Orthogonal Network
Bus lines	102	63
Network length (km)	1690	1150
Commercial speed (Km/h)	11,5	13,6
Vehicles (number)	923	841
Unimodal trip (%)	86%	65%

Source: TMB and Agència dÉcologia de Barcelona, 2012

Five lines of the orthogonal network were implemented in October 2012: two horizontal lines, two vertical lines and one diagonal line, together forming 88.8 kilometres. According to TMB, these new bus routes have been carrying 70,000 people a day, almost 10% more than the old routes. The remaining phases of implementation will take place gradually; in October 2013 five bus lines will be implemented and final implementation will be carried out gradually over the coming years.

According to a survey conducted within the framework of this COMPASS case study 59% of respondents were aware about the ongoing restructuring of the bus network and improvements at bus stops. Among respondents who are regular public transport users, 72% were aware of the new orthogonal network.

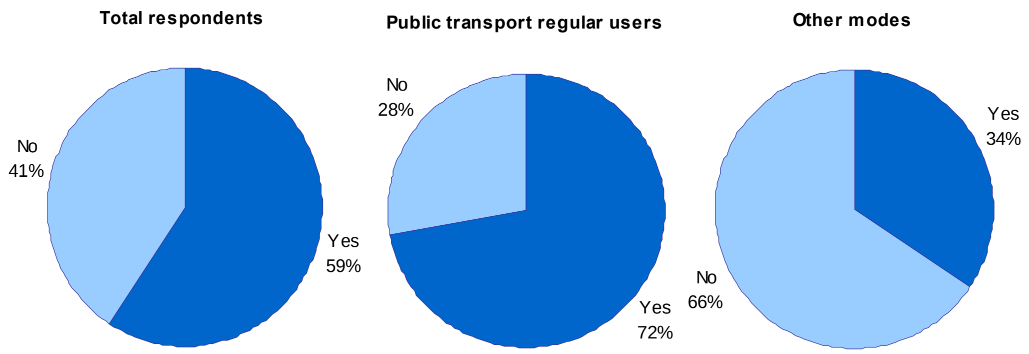


Figure 5-18 Awareness of bus network and bus stop improvements

To allow for an easier transition, TMB has introduced several initiatives in order to improve the information provided to users:

- Smart phone applications (see chapter 4.4). The bus operator (TMB) has developed several smart applications (TMB on your mobile phone, TMB Virtual and TMB Maps) to provide updated and real-time information to users. In addition to already existing apps, the case study surveyed the potential interest in additional user information applications.
- Smart bus stops (see chapter 4.5). These are new bus stops installed on the orthogonal Barcelona bus renewal network. The smart bus stops are fully equipped technologically. They provide real-time information about the time of arrival of buses, updated every 30 seconds. They provide information about operator services (delays, relevant information to users). Bus stops are equipped with audio systems for blind people. Smart bus stops also provide static information about bus itineraries and relevant information about the surrounding area.
- DRT systems could increase the demand of currently exiting bus services in low density neighbourhoods of Barcelona. This case study surveyed the potential interest of implementing DRT systems between the city of Barcelona and its ómountainô areas, and between relevant metropolitan metro and commuter rail stations and the these areas (see chapter 4.6).

5.4 ASSESSMENT OF THE SOLUTION - SMART PHONE APPLICATIONS

5.4.1 Specific Description of the Solution

TMB has developed since 2010 several applications (TMB on your mobile phone, TMB Virtual and TMB Maps) for smart phones and other technological devices in order to provide real time information to the users. Applications are available for Android and IOS. Developed applications are presented below.

TMB on your mobile

TMB on your mobile is the official app of TMB which contents the main search functions:

- *Where am I?* It provides transport services around the user's GPS location.
- *Going to:* It provides TMBõs travel planner, which combines bus and metro networks. The users can plan their trip with updated information.

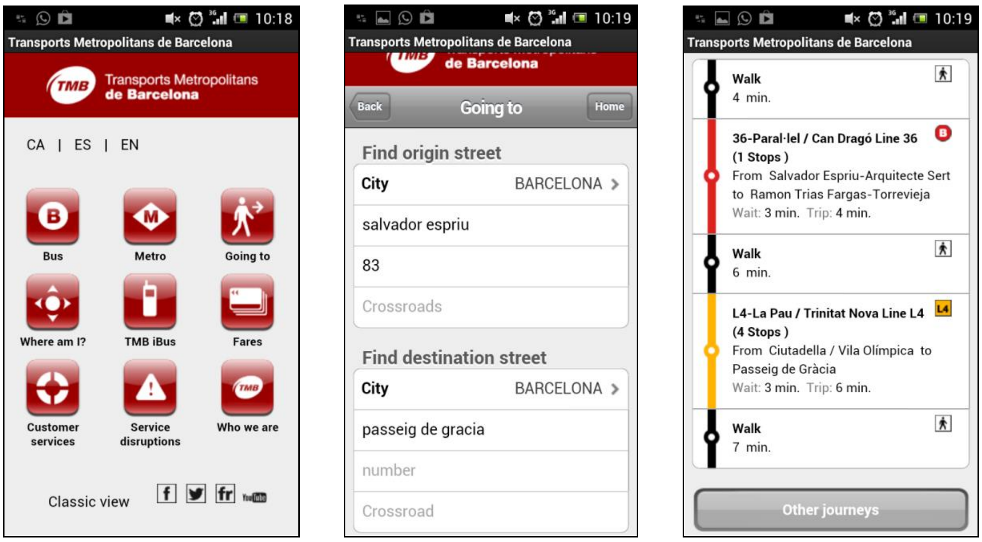


Figure 5-19 View of TMB *Going to* function

- *TMB iBus:* It is a free service that provides real time information about waiting time at bus stops. The users enter bus stop code provided at bus stop or the number of line bus.

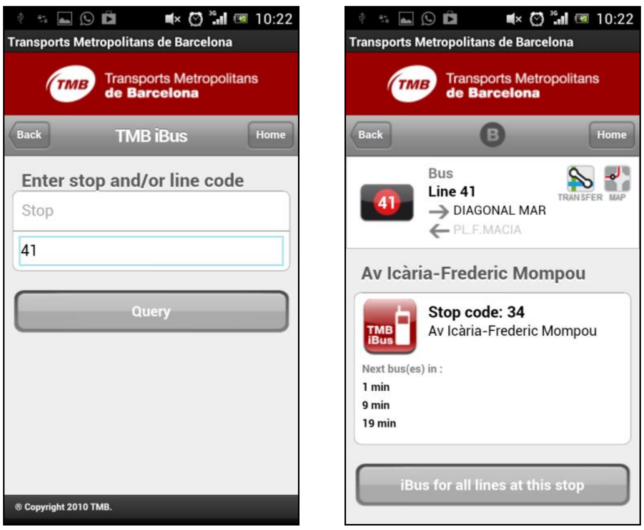


Figure 5-20 View of TMB *iBus* function

➢ *Bus:* it provides information about itineraries, frequency, and timetable of each bus line. A map for each bus line in pdf is also provided. If the users click on a bus stop, real waiting time at bus stop is provided.

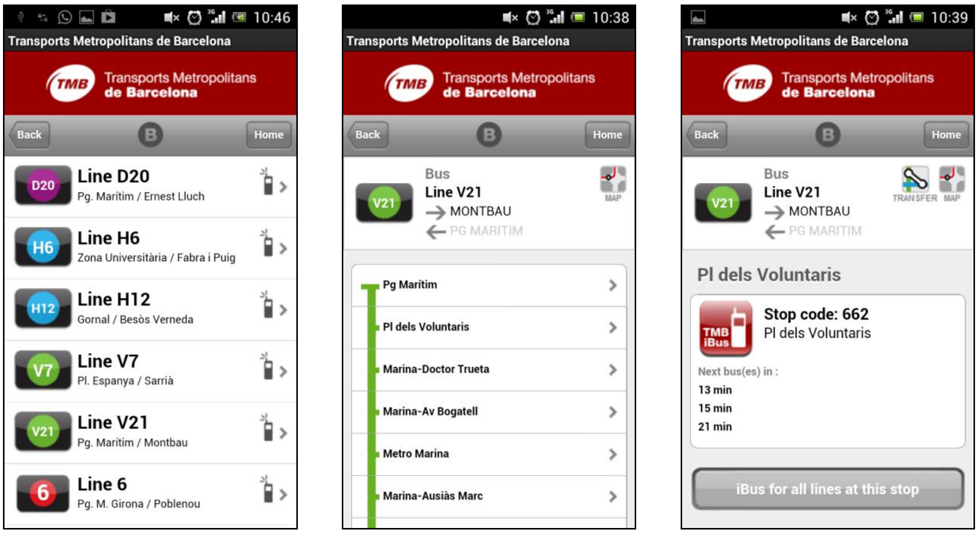


Figure 5-21 View of TMB *Bus* function

➢ *Metro:* it provides information about timetable of the metro service and a map in pdf. For each metro station information about links with other public transport service is also provided.

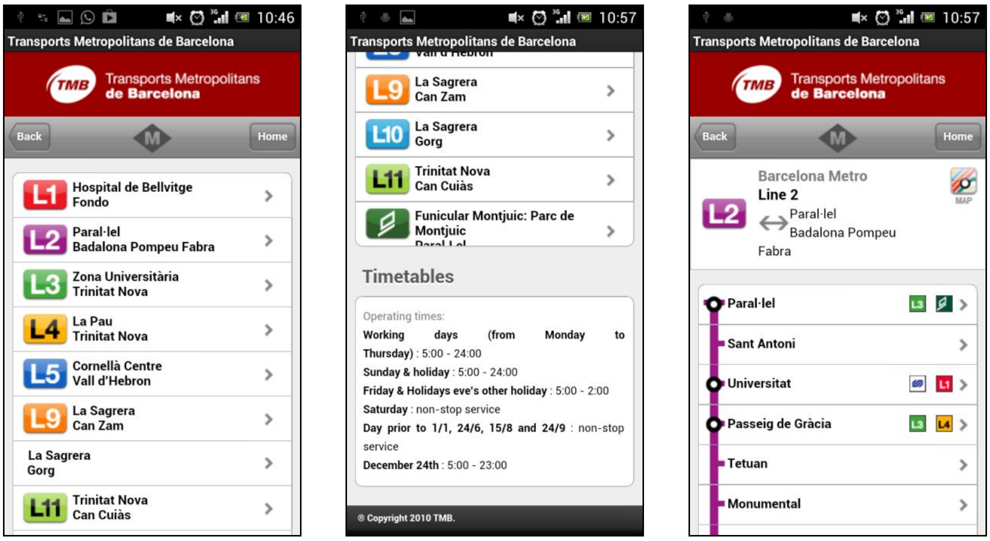


Figure 5-22 View of TMB *Metro* function

- *Fares:* it provides fares information according to type of users: frequent users, sporadic users, tourist tickets or other tickets.

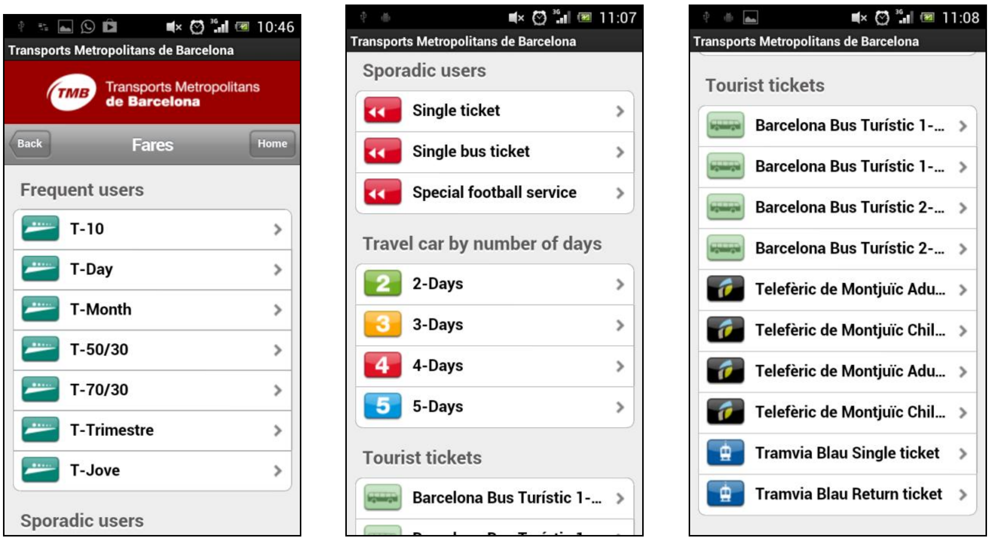


Figure 5-23 View of TMB *fare* function

- *Costumer services:* It provides location and timetable of the Costumer Services Offices.
- *Service disruptions:* It provides real time information about incidents on bus and metro services.

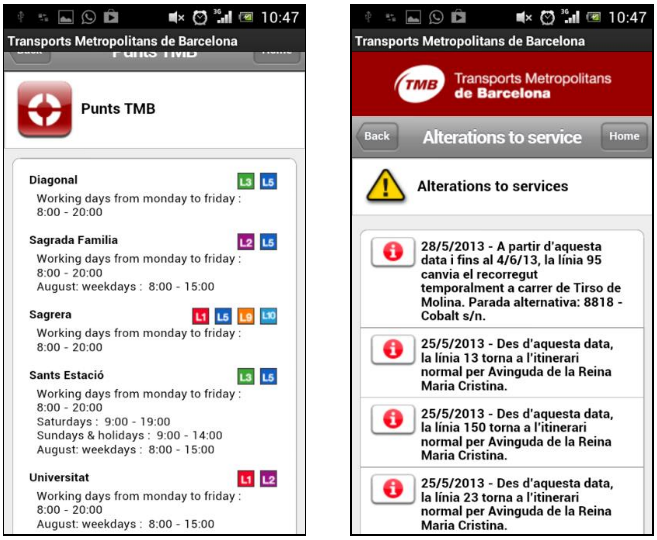


Figure 5-24 View of TMB *Costumer services and Service disruptions* functions

TMB Virtual app

TMB Virtual app is the augmented reality TMB application for smart phone and electronic devices (tablesé). This application locates the nearest bus stops and metro stations with augmented reality. Just point the phone's camera in any direction and bus stop signs, lines and the distance to them in metres will appear on the screen, superimposed on real-world images. If user turns its phone sideways, it becomes a compass and each stop is shown as an arrow pointing in the direction to take. In the horizontal position the arrows lead you to selected spot. It provides additional applications as *Where I am?, Going to and TMB iBus*.

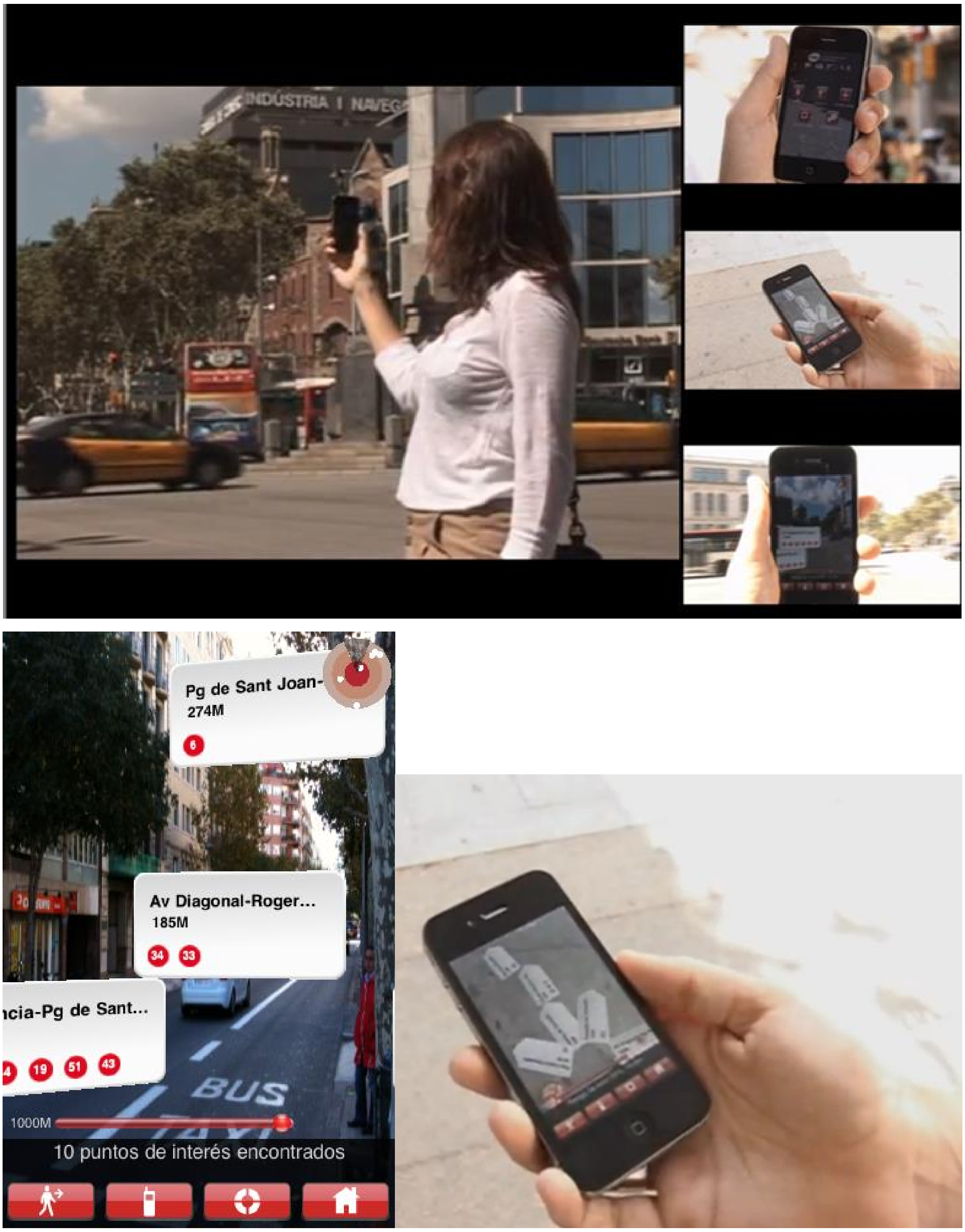


Figure 5-25 View of TMB virtual applications for smart phones

TMB has developed a version for the Barcelona Tourist Bus. The tourist bus augmented reality application offers the following functions:

- Information on the three Barcelona Bus tourist service lines, with a description of each stop and all the points of interest along each of the route;
- Find out where customer service points are located;
- Completely updated information on changes to the service.

Users can find out in which direction and distance important sights are located. If the user puts the mobile phone in a horizontal position arrows will show the direction to the sights.

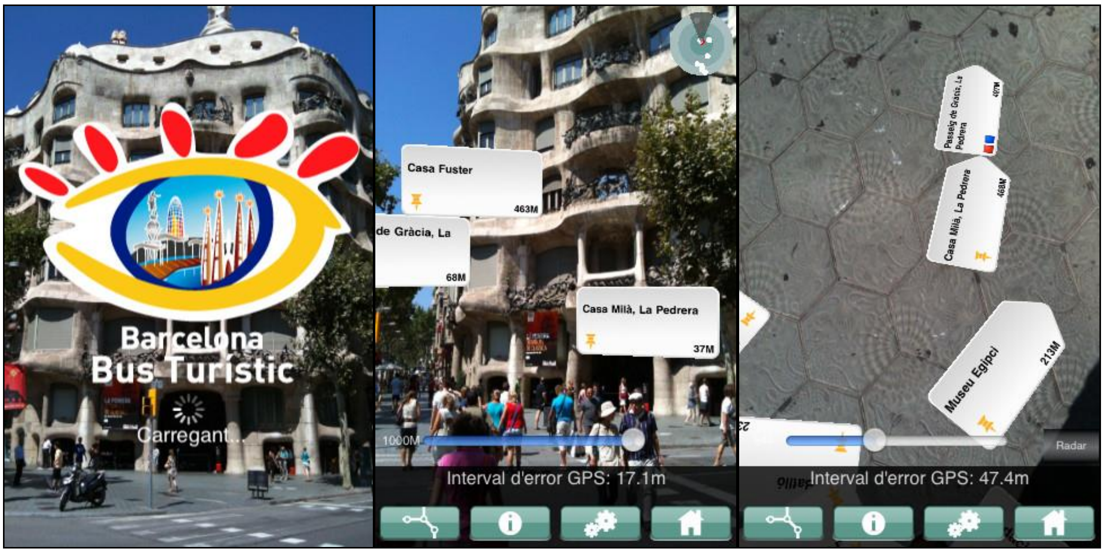


Figure 5-26 View of TMB Tourist Bus augmented reality application

TMB Maps application

TMB Maps application is an interactive app for iPad that TMB has developed to help planning journeys on public transport in Barcelona and its metropolitan area easier, with information in real time. The application locates metro stations and bus stops in the immediate vicinity, with information on each and the lines that stop there. Users can choose between map, satellite or hybrid views. Information on the public transport network is downloaded to local storage to speed up communications. TMB Maps also offers the following functions: shown as an arrow pointing in the direction to take. It provides additional applications as *Where I am?, Going to, TMB iBus*.

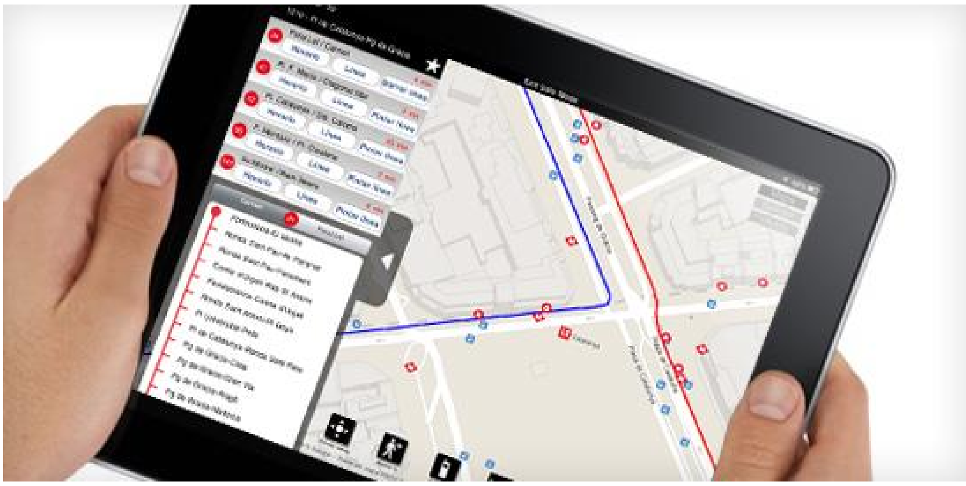


Figure 5-27 View of TMB Maps Application for tablets

5.4.2 Assessment of Applicability

Investment costs

In order to improve TMB customer service, several initiatives have been developed:

- Update TMB website
- TMB in social network (Facebook, Twitter, Youtube)
- Smart phone applications development

The cost is estimated at ú 1.72 million in 2010.

Operation and maintenance costs

No data is available on operation and maintenance costs, but since most of the updates are being done automatically the operation and maintenance are thought to be low.

Financial viability

Financial viability is not expected to be barrier to develop smart phone applications.

Technical feasibility

No technical barriers are expected to develop TMB smart phone applications.

Organisational feasibility

There are not organisational obstacles to this application.

Administrative burden

There are not administrative obstacles to this application.

Legal feasibility

There are no legal issues.

User acceptance

According to Survey conducted on the framework of COMPASS Case Study ñITS Solutions for Barcelona Bus Networkò, 55% of respondents were aware about TMB smart phone applications that provide information at real time. Of those who know the app, just over half actually use it, and that is more or less the same for cyclists and pedestrians.

Do you know the smart phone App by Barcelona Metropolitan Transport (TMB) that provides real-time information?

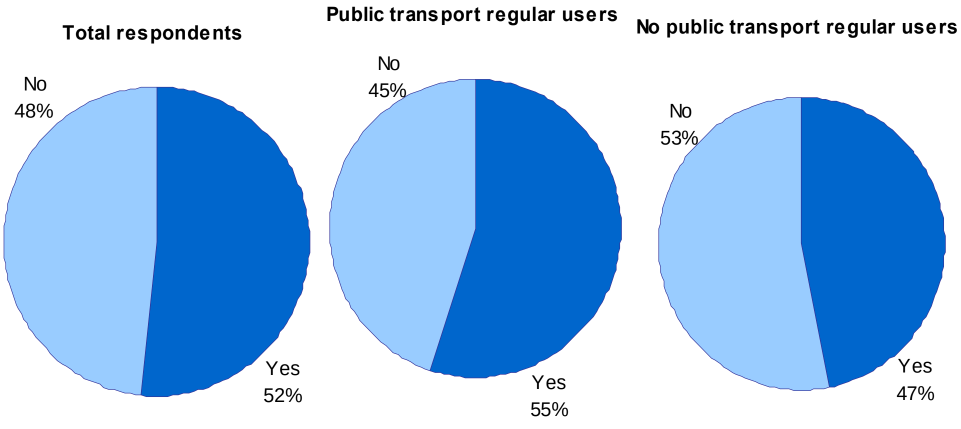


Figure 5-28 Respondents who know smart phone applications by TMB that provides real time information by type of user: total respondents (left), public transport regular user (middle), no public transport regular users (right)

Do you use it regularly?

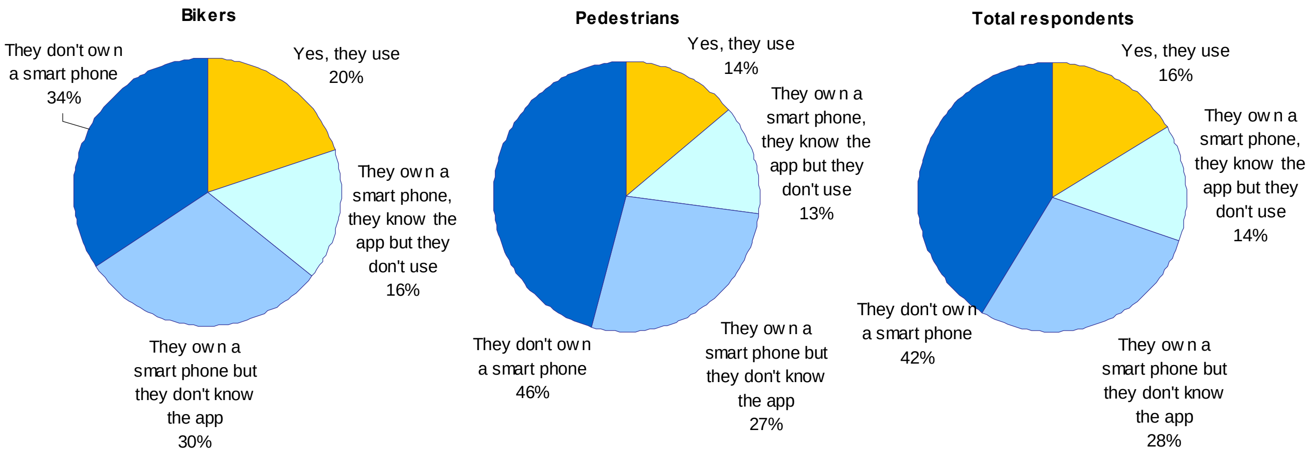


Figure 5-29 Respondents who uses regularly the TMB smart phone application by type of respondent: cyclists (left), pedestrians (middle) and total respondents (right)

Public acceptance

Acceptance by the general public who are not aware of the app is not an issue.

5.4.3 Assessment of Interest for Travellers

Door to door travel time

It is expected that door to door travel time will be reduced due to improved quality information provided to user. Additionally, the user can access to bus stop few minutes before bus arrives and reduce the waiting time by around 5 to 10 minutes.

Door to door travel costs

There is no direct impact on travel costs.

Comfort and convenience

Better knowledge of the bus network and precise knowledge about bus arrival time makes bus travel much more convenient.

Safety

No impact is expected.

Security

No impact is expected.

Accessibility for mobility impaired passengers

No particular impact is expected.

5.4.4 Assessment of Modal Change

Car usage

If the use of public transport service becomes more attractive it is possible to induce a modal shift from the private car to public transport.

Bus and coach usage

Smart phone applications impact on the quality of information provided to users, reducing uncertainty and therefore making the bus mode more attractive.

Rail usage

No impact expected.

Ferry usage

No impact expected.

Aeroplane usage

No impact expected.

5.4.5 Assessment of Other Impacts

Increased mobility

No impact expected.

Congestion

Increased usage of public transport and decreased car travel will help reduce urban congestion.

CO2 emissions

The modal expected modal shift will directly reduce CO2 emissions, and the reduction in congestion will make an additional contribution.

Contribution to user pays principle

No impact expected.

European economic progress

No impact expected.

Territorial cohesion

No impact expected.

5.4.6 Assessment against Main Criteria – Summary

Table 5-2 Barcelona Bus smart phone applications - Point score for the criteria

	Score
Investment costs	€€
Operation and maintenance costs	€
Financial viability	*0*
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	*0*
Legal feasibility	*0*
User acceptance	✓
Public acceptance	*0*
D2D travel time	✓
D2D travel costs	0
Comfort and convenience	✓✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	-
Bus and coach usage	+
Rail usage	-
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	0
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

5.5 Assessment of the Solution - Smart Bus Stops

5.5.1 Specific Description of the Solution

Smart bus stops are the new bus stops which will be installed on the renewed Barcelona bus network. It is expected that all bus stops will be equipped with smart information system in order to provide real-time information to the users.

Source: TMB, 2012

Figure 5-30 Real-time information provided by Smart Bus Stops

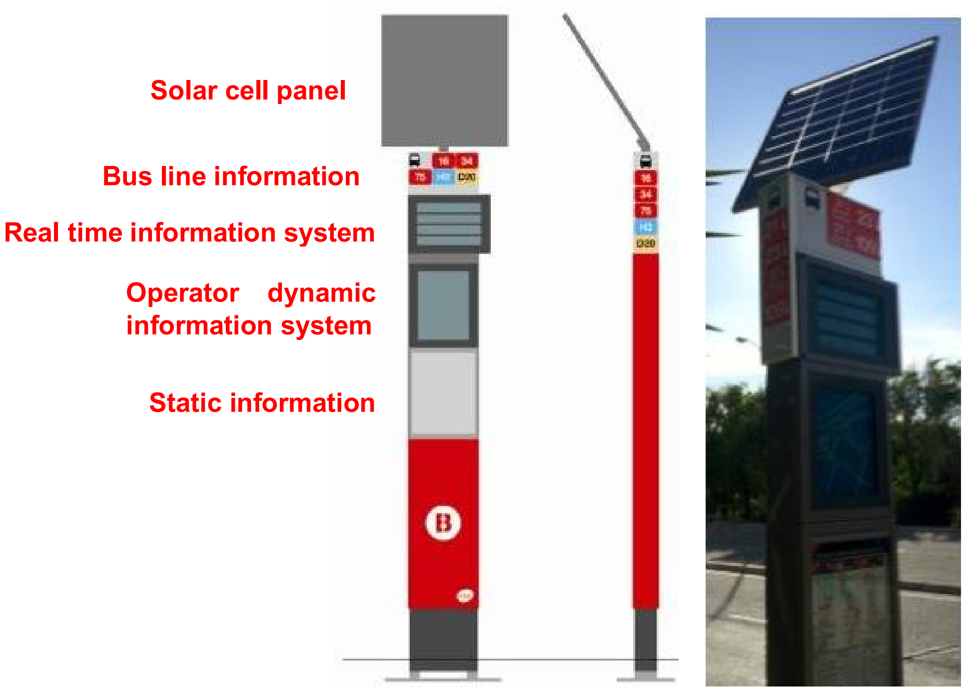
Smart bus Stops will increase the quality of the service, since the user, upon arriving at the stop, will be punctually informed of the time of arrival of the buses of the different lines. The information will be updated every 30 seconds and will also offer other information of interest for the user. Bus stops will be equipped by an audio system for visually impaired people.

Smart bus stops are designed to provide dynamic and static information:

- Dynamic Information: the bus stops are equipped with User Information Screens which provides real time information.
    - Bus dynamic information system: screen which provides real-time information about the time of arrival of the bus lines in minutes. For each line, the screen shows the number the line, the direction and the waiting times.
    - Operatorõs dynamic information system which provides information about incidents on the network.
- Static Information
    - Static bus line information: this panel provides the name of the bus lines which stop on it
    - Static information: this panel provides information about bus itineraries and relevant information about surrounding area.

Smart bus stops are equipped with solar cell panel systems.

The Barcelona bus network has 2,500 bus stops. In 2012, 250 bus stops had been equipped.



Source: TMB, 2012

Figure 5-31 Design of smart bus stop

Additionally, two central bus stops (Plaça Universitat and Plaça Espanya) are equipped with big (42 inch) touch screens. The Barcelona public transport travel planner is available there and users can plan their trip or they can have real-time information about the public transport service network. It includes real-time information about the bus and metro network.

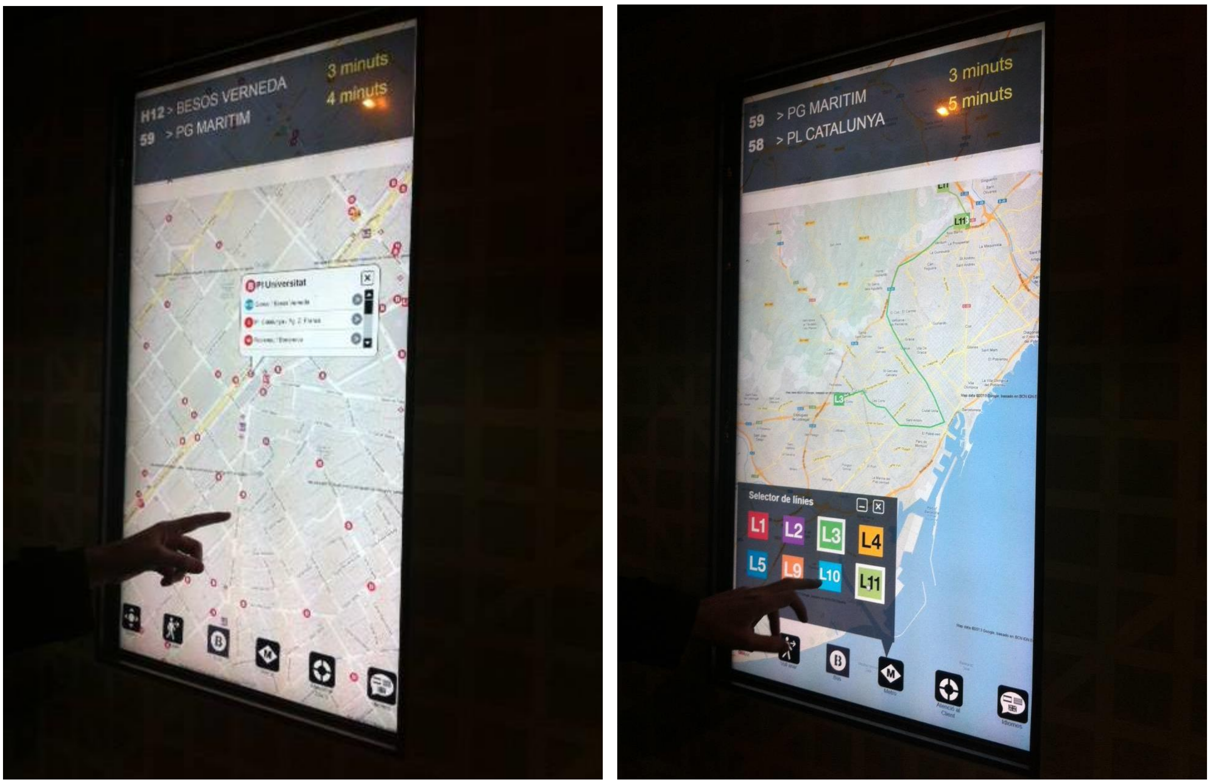
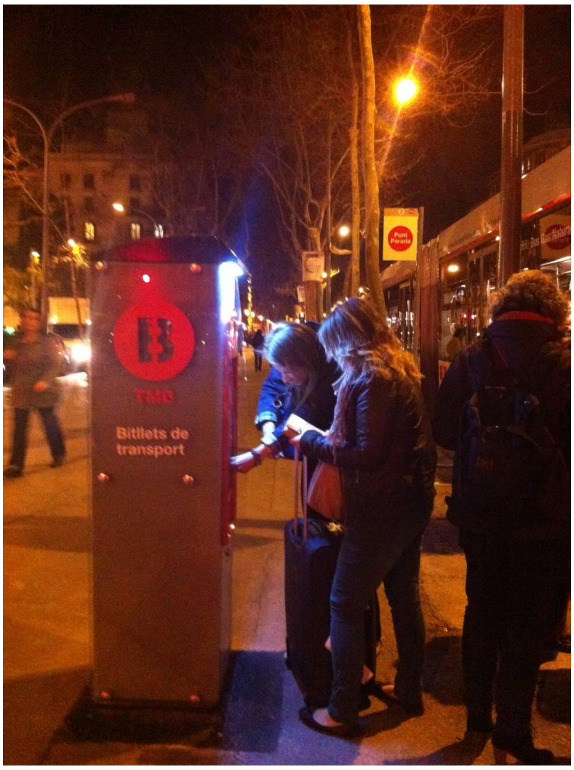


Figure 5-32 View of travel planner and ticket vending machine

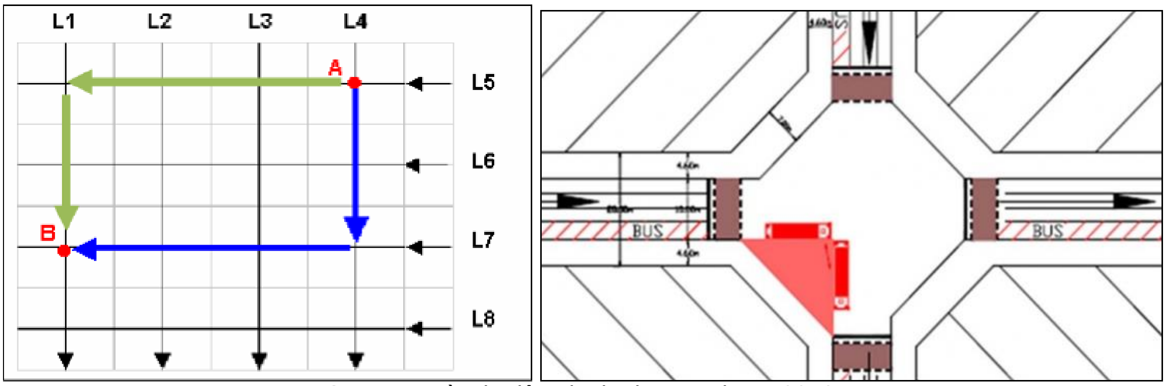
These pilot bus stops are also equipped with ticket vending machines. Up to now, the users have to go to metro stations to buy bus tickets.



Source: TMB, 2012

Figure 5-33 View of ticket vending machines at Universitat Square (Barcelona city centre)

The renewed bus network is designed as a grid and the bus itineraries intersect at different point of the grid, named transfer points. They promote the interconnectivity between bus and other services of public transport (train, tramway, sharing bike services or metro).



Source: Agència d'Ecologia de Barcelona, 2013

Figure 5-34 Placement of bus stops

It is expected that once the renewal process will be finalised, all bus stops located at transfer points, will provide real time information about the service and will be equipped with travel planners and ticket vending machines.
In addition, smart bus stops and their surroundings located at the transfer points will be designed especially to provide information to users with the aim of shortening the transfer time: signs of transfer on the pavement have been installed.

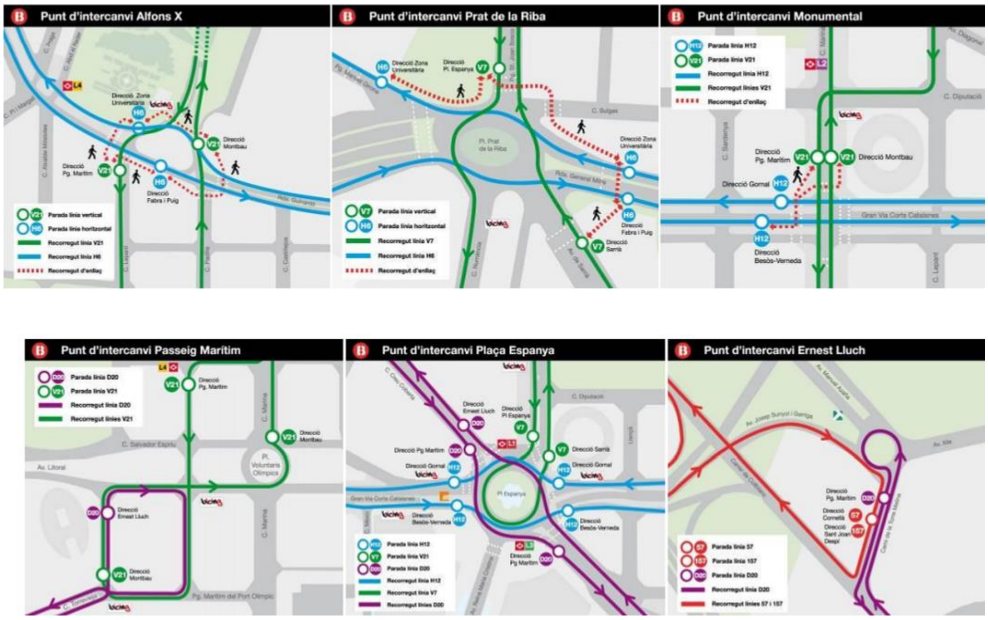
Source: Barcelona Council

Figure 5-35 Signs of transfer on the pavement and smart stops

Six transfer points are equipped with this is far:

- *Alfons X* transfer point: it links V21 bus line, H6 bus line and L4 metro line.
- *Prat de la Riba* transfer point: it links V7 bus line, H6 bus line and L9 metro line.
- *Monumental* transfer point: it links V21 bus line, H12 bus line and L2 metro line.
- *Passeig Marítim* transfer point: it links V21 bus line, D20 bus line
- *Plaça Espanya* transfer point: it links V7, H12 and D20 bus lines and L1 metro line.

- *Ernest Lluch* transfer point: it links D20 bus line 57 conventional bus line and tramway.



Source: TMB, 2012

Figure 5-36 Transfer points in service

5.5.2 Assessment of Applicability

Investment costs

The unitary cost of installing similar stops at Barcelona Tramway equipped with ticket vending machines and screens with real time information was around ú 12,000 tramway stop. According to data provided, the cost of installing a Smart Bus Stop is estimated in ú 70,000.

Operation and maintenance costs

Data about operation and maintenance costs on smart bus stops at Barcelona Bus Network are not available. However, the unitary cost of maintenance at Barcelona Tramway (it includes cleaning service, vandalism and ticketing service) was around 10% of installation cost.

Financial viability

The cost of renovation bus stops is expected to be large. The economic crisis and reducing public budgets may slow down the process of renovation. The level of payback through increased customer numbers is uncertain.

Technical feasibility

There are no technical barriers.

Organisational feasibility

There are no organisational obstacles to this application.

Administrative burden

There are no administrative obstacles to this application.

Legal feasibility

There are no legal issues.

User acceptance

The acceptance of smart bus stops is high because they are more comfortable for bus users and provide real time information.

Public acceptance

Even for those who do not use public transport and only passing by the stop, the smart stops will improve the image of public transport in Barcelona and even the image of the city itself.

5.5.3 Assessment of Interest for Travellers

Door to door travel time

It is expected that door to door travel time will be reduced due to improved quality information provided to the user.

Door to door travel costs

Door to door travel costs will not change.

Comfort and convenience

The convenience of bus use is expected to increase because of smart bus stops provide real time information and their surroundings are designed to reduce transfer time. Additionally, the smart bus stops are equipped with tickets vending machines, while up to now, it was not possible to buy tickets at bus stops.

Safety

No particular impact is expected.

Security

No particular impact is expected.

Accessibility for mobility impaired passengers

Smart bus stops are expected to improve the service for visually impaired people because they provide audio information.

5.5.4 Assessment of Modal Change

Car usage

If public transport services become more attractive it is possible to induce a modal shift from private cars to public transport.

Bus and coach usage

It is expected that bus use will increase.

Rail usage

No impact expected.

Ferry usage

No impact expected.

Aeroplane usage

No impact expected.

5.5.5 Assessment of Other Impacts

Increased mobility

No impact is expected.

Congestion

Increased usage of public transport and decreased car travel will help reduce urban congestion.

CO2 emissions

The modal expected modal shift will directly reduce CO2 emissions, and the reduction in congestion will make an additional contribution.

Contribution to user pays principle

No impact expected.

European economic progress

No impact expected.

Territorial cohesion

No impact expected.

5.5.6 Assessment against Main Criteria – Summary

Table 5-3 Barcelona smart bus stops - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	úú
Financial viability	*0*
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	*0*
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	(✓)
D2D travel costs	0
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	✓
Car usage	-
Bus and coach usage	+
Rail usage	-
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

5.6 Assessment of the Solution - DRT Smart Application for Mountain Neighbourhoods

5.6.1 Specific Description of the Solution

Characteristics of Barcelona's Mountain Neighbourhoods

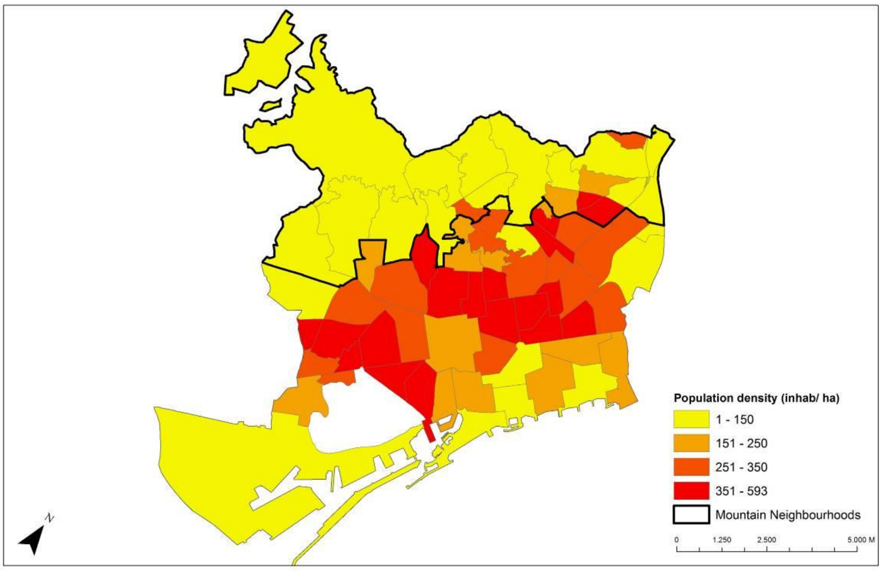
Mountain neighbourhoods differ from the other Barcelona neighbourhoods as follows:

- Slopes are very important in most streets, and the street width is often too narrow to allow the passage for a conventional 12 meter-long buses.3

Source: Google Street View, 2013

Figure 5-37 View of a Canyelles neighbourhood in Barcelona, and bus stop in the mountain neighbourhoods of Barcelona

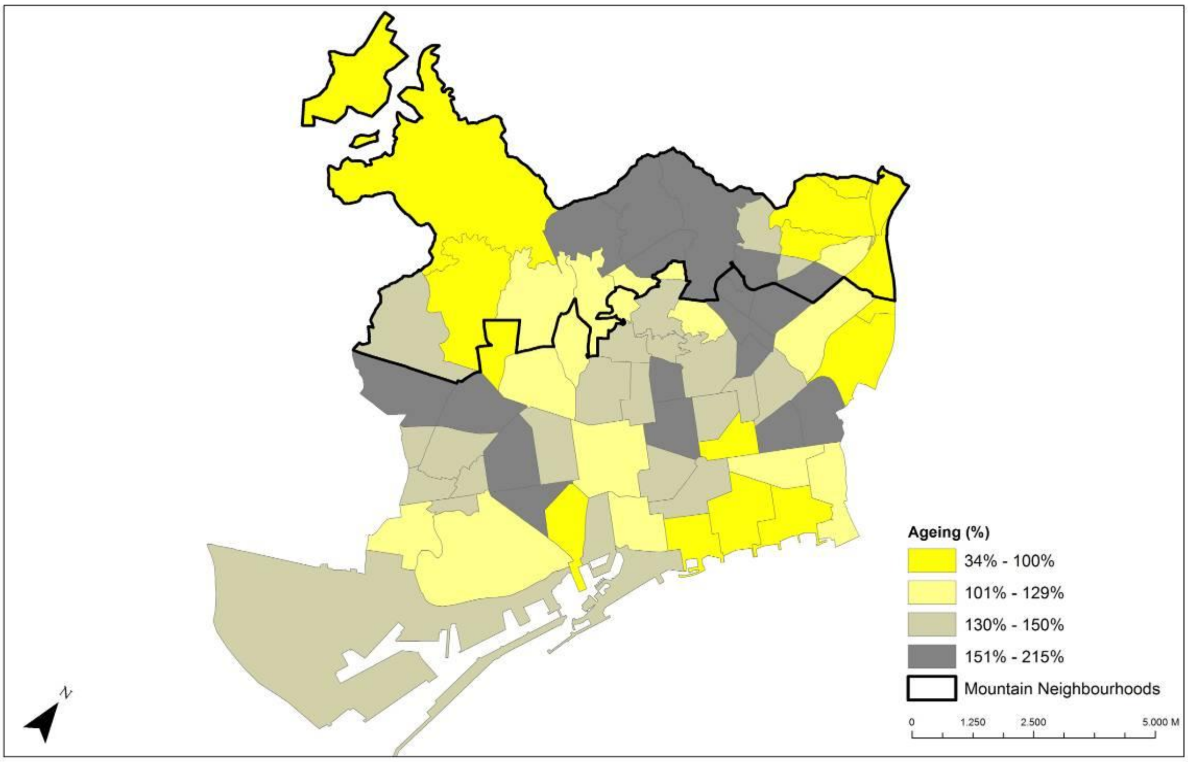
- Low population densities compared to other zones of the city. The average density of mountain neighbourhoods is 155 inhabitants per hectare, compared to 250 in average in the rest of the city. This reduces the margin of profit for public transport services in this area.



Source: Barcelona City Council, 2013

Figure 5-38 Barcelona population densities by neighbourhoods 2011

- Residents of mountain neighbourhoods are relatively older compared to the rest of the city. Older residents have fare discounts to purchase public transport tickets.



Source: Barcelona City Council, 2013

Figure 5-39 Ageing at Barcelona neighbourhoods, 2009

Mountain Neighbourhoods are linked between them and the city through Barcelona's ring road (*Ronda de Dalt*). It is the main road to access all these areas with motorised modes. However, at some points, the ring road is a physical barrier to access by non-motorised modes.

Public transport in mountain neighbourhoods

TMB offers a dedicated service called neighbourhood bus (*Bus de Barri*) based on micro-buses that internally tour these neighbourhoods, linking their many areas with the closest metro stations and stops to larger bus lines. The neighbourhood bus loses money because of lack of ridership. In 2012, TMB and Barcelona City Council decided to cancel the service at the weekends.

With the aim to provide a public quality service, TMB is testing strategies that change the pattern of the service offered until now. In this context, demand responsive transport applications become an alternative to neighbourhood buses.

DRT smart phone applications for mountain neighbourhoods

In the framework of COMPASS, a survey was conducted in Passeig de les Aigües located in the Tibidabo Hills of Barcelona. It is a recreational path for cyclists and hikers overlooking the city of Barcelona. The access to the "Passeig de les Aigües" is through the mountain neighbourhoods. The survey was carried out at different access points of "Passeig de les Aigües de Barcelona" on 3rd February 2013, from 8:00 am until 5:00 pm (9 hours in total). A total number of 533 responses were obtained, 240 of which from cyclists and 329 from pedestrians.

The survey was focused on the potential acceptance of smart phone pay applications that provide demand responsive transport services.

Additionally, potential acceptance of new applications for smart phones, related to information and security at Tibidabo Hills, parking booking and rural bike sharing system were investigated.

In the following are the results from survey showing that, in general, contestants were not willing to pay for DRT services and smart phone applications.

Demand Responsive Transport (DRT) service from and to Barcelona or closest metro/ train station

Would you be willing to pay for a demand responsive pick up service from different areas of the Tibidabo Mountain to the closest rail or metro station?

- 70% of respondents would not be willing to pay for a demand responsive transport service from Barcelona to Passeig de les Aigües. Bikersôrespondents (78%) would be less willing to pay than pedestrian respondents (65%).
- 14% of cyclist respondents and 22% of pedestrians respondents would be willing to pay ú 1.00 per trip, from a pick up point to the closest rail or metro station to Passeig de les Aigües.
- 12% of pedestriansôrespondents and 7% of cyclistsôrespondents would be willing to pay up to ú 2.00 per trip.
- Only 1% of total respondents would be willing to pay up to ú 5.00 per trip.

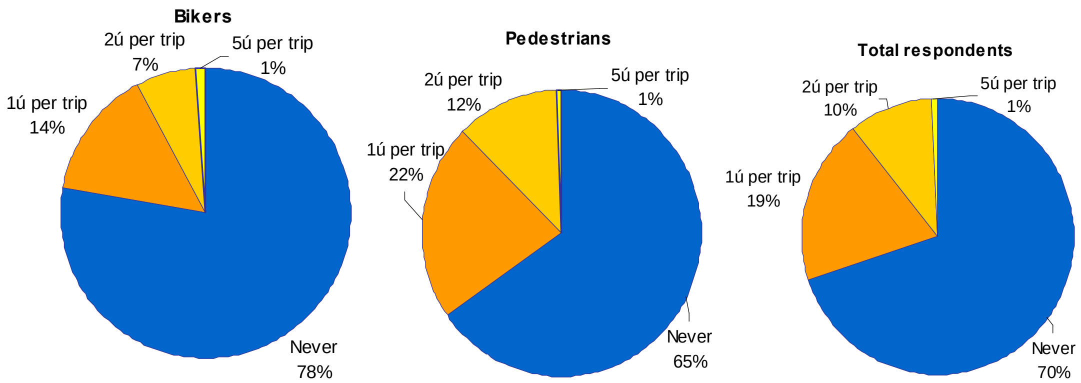


Figure 5-40 Willingness to pay for a demand responsive transport service from different areas of the Tibidabo Mountain to the closest rail or metro station: cyclists (left), pedestrians (middle) and total respondents (right)

Would you be willing to pay for a dedicated transport system for bikes (and passengers) from Barcelona to "passeig de les Aigües" (with demand-responsive pick up points)?

- 68% of respondents would not be willing to pay for a demand responsive transport service from Barcelona to Passeig de les Aigües. Bikersôrespondents (79%) would be less willing to pay than pedestrian respondents (62%).
- 12% of cyclist respondents and 7% of pedestrians respondents would be willing to pay ú 1.00 per trip, from a pick up point in Barcelona to Passeig de les Aigües.
- 21% of pedestrians respondents would be willing to pay ú 2.00 per trip and 10% of pedestriansô respondents would be willing to pay up to ú 5.00 per trip.
- 8% of cyclists respondents would be willing to pay ú 2.00 per trip and only 1% of cyclistsô respondents will be willing to pay up to ú 5.00 per trip.

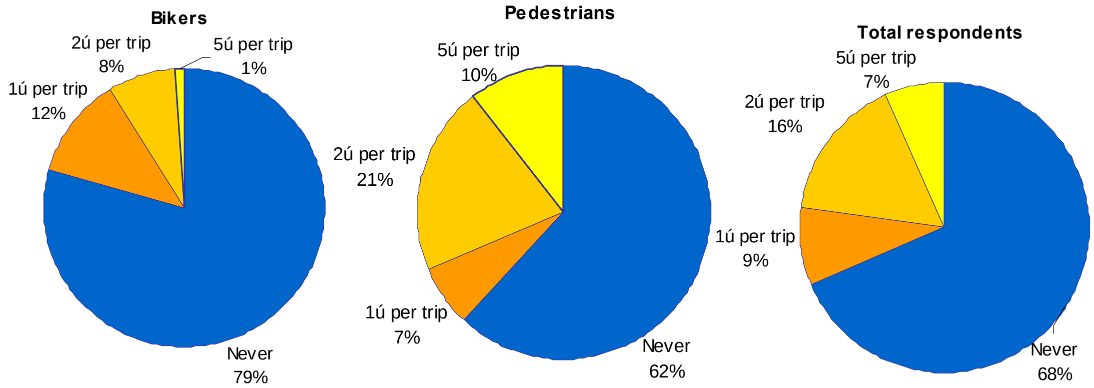


Figure 5-41 Willingness to pay for a demand responsive transport service from Barcelona to Passeig de les Aigües: cyclists (left), pedestrians (middle) and total respondents (right)

Information and security application

Would you pay € 80 cents for a smart phone App providing information about the Tibidabo mountain and user assistance in case of emergency?

- 50% of respondents were willing to pay 80 cents for applications that could provide information about the Tibidabo Mountain and user assistance in case of emergency. Cyclist respondents would be more willing to pay in case of emergency than pedestrians (47%)

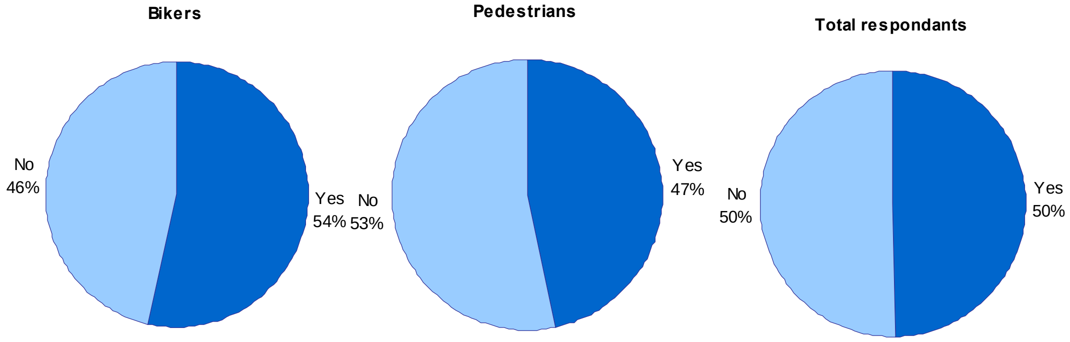


Figure 5-42 Willingness to pay information and security application: cyclists respondents (left), pedestrians respondents (middle) and total respondents (right)

Parking Booking Applications

Would you be willing to pay to book a parking space using a smart phone app?

- 82% of total respondents would not be willing to pay to book a parking area using a smart phone. 11% of respondents would be willing to pay up to ú 1.00 to, 6% of respondents would be willing to pay up to ú 2.00 per book. Only 1% of respondents would be willing to pay up to ú 3.00 per service.

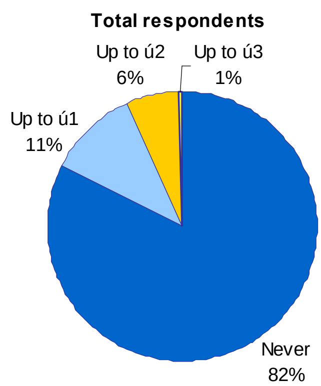


Figure 5-43 Willingness to pay to book a parking space using smart phone application

Rural bike sharing service

Would you be willing to use a mountain bike sharing system?

- 76 % of cyclist respondents would not be willing to use bike sharing system for rural areas.

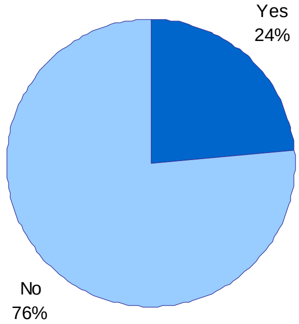


Figure 5-44 Would you be willing to use a mountain bike sharing system?

5.6.2 Assessment of Applicability

Investment costs

No data about investment costs is available. However, the DDS MobiRouter system suggests that the set up cost of a DRT service with a mid-size fleet is around ú 70,000 for 30 vehicles.

Operation and maintenance costs

No data about operation costs is available. However, the DDS MobiRouter system suggests that the operation cost of a DRT service is around ú 15,000 for 30 vehicles.

Financial viability

DRT services are generally not making any profit, and have to be subsidised by the public sector which makes this investment with a view to the social returns of such a system.

Technical feasibility

Based on other experience, the main concern in technical barriers is match service complexity to market demand. An authority seeking to replace fixed route services with DRT will also need to inform and educate users of the differences in service engagement, booking requirement and use.

Organisational feasibility

No problems expected.

Administrative burden

No impacts expected.

Legal feasibility

There are no legal issues.

User and public acceptance

In this case all of the public are potential users. According to the survey results 30% of those interviewed would be willing to pay for a DRT service and 37% of these even more than ú 1 per trip, showing a high level of public and potential acceptance.

5.6.3 Assessment of Interest for Travellers

Door to door travel time

It is expected that door to door travel time would improve, in particular through the fact that the buses arrive on demand and passengers do not have to wait for infrequent buses in low density areas.

Door to door travel costs

No decisions have been made about any future fare level, so it is impossible to say now whether the process would be higher than for the existing neighbourhood bus service.

Comfort and convenience

It is expected that DRT service would increase the convenience of bus users. The neighbourhood bus is not available at the weekends and it is difficult for residents in the mountain area to get to other areas of the city by public transport.

Safety

No particular impact is expected.

Security

No particular impact is expected.

Accessibility for mobility impaired passengers

It is expected that DRT services would improve the accessibility for mobility impaired passengers.

5.6.4 Assessment of Modal Change

Car usage

If public transport services become more attractive, it is possible to induce modal shift from private cars to public transport.

Bus and coach usage

It is expected that bus use would increase due to improvements on the service provided.

Rail usage

No particular impact expected.

Ferry usage

No impact expected.

Aeroplane usage

No impact expected.

5.6.5 Assessment of Other Impacts

Increased mobility

No impact is expected.

Congestion

No impact is expected.

CO2 emissions

If cyclists or pedestrians call a DRT service, they will increase emissions. Where passengers use them instead of the neighbourhood buses, there will not be much difference. Where people use the bus instead of a car, they will reduce emissions. On balance there should be no significant impact either way

Contribution to user pays principle

No impact is expected.

European economic progress

No impacts expected.

Territorial cohesion

The DRT services will make the more remote, as well as poorer, areas of Barcelona more accessible.

5.6.6 Assessment against Main Criteria – Summary

Table 5-4 DRT Smart Application for Barcelona mountain neighbourhoods - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	*0*
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	*0*
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	✓
Car usage	-
Bus and coach usage	+
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	*0*
CO2 emissions	*0*
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	✓

6 CASE STUDY 5 – FUTURE INTERURBAN PUBLIC TRANSPORT IN WARMINSKO-MAZURSKIE VOIVODSHIP

6.1 EXECUTIVE SUMMARY OF THE CASE STUDY

The objective of this case study was to assess the transferability potential of the six ICT solutions identified within the project in a rural area in underdeveloped region. As a result of the process for the selection of regions for the case studies conducted in COMPASS the Szczytno region located in northeast Poland was selected as an example of an area with low GDP and peripherality problems but also some tourist potential.

The following set of specific ICT solutions have been tested in the selected area:

- Internet-based travel planners;
- Electronic real-time information at bus stops;
- Real-time information on estimated arrival times, stops, route on board of vehicles;
- Ticket purchasing via mobile phones / internet;
- Real-time information on services via mobile phones;
- Demand responsive services - possibility for direct pick-up/delivery of passengers in response to prior demand.

In this case study, which is a test bed, traditional methods of desk-based research have been used, including analysis of official statistics and the Central Statistical Office review of data provided by the service operator. However, the main source of the information and data collection has comes from quantitative and qualitative surveys that have been conducted in the region for this case study. The main stakeholders involved in this case study are transport users and other residents in the region and the main service provider ï the bus transport company PKS. Quantitative surveys covered a group of 300 transport users and non-users. Quantitative analysis was based on three focus groups with in-depth interviews. The groups consist of users and potential users and service provider employees.

Internet-based travel planners

For Internet-based travel planners this case study explores the potential use of internet-based travel planners in specific conditions in the rural area where one transport mode at the local and regional level is mainly used. As shown by the case study results, the potential for internet-based travel planners exists mainly for long-distance trips where interconnection is an important element of the trip and the travel planner can be useful to plan the first/last mile stage of the journey. From a technical perspective there are no transferability barriers, but within this case study some non-technical constraints have been identified, for example there is little usefulness and willingness to pay by older people with limited access to the internet and fear of using any high technology solutions. Another finding was that the increase of distance travelled is accompanied by a higher acceptance level. This solution can significantly influence travel time and that can also be a factor stimulating the interest the solution for travellers. It is especially important in rural areas for planning a long-distance journey where regular bus services for access and egress stages are not frequent.

Electronic real-time information at bus stops

This solution is applicable in the rural context at a medium level (and in some secluded locations it is low) although user acceptance is high and there are no legal or administrative barriers. The most significant barrier is a shortage of resources for such investments. Moreover, there is a high risk of vandalism and a need for frequent replacement of the displays making operations costly. There is high interest among younger users (more ready to accept innovations) but there is no opposition from older users. This measure is important for the local population as well as for tourists and it is very useful both for leisure and daily commuter trips. It increases comfort and convenience but it is still not sufficiently attractive for high income groups to switch from private car. On the other hand operators are not really interested due to financial constraints. The initial cost is high and maintenance costs are also expected to be high. Other considerations do not create barriers (administrative or organisational) but will not outweigh the financial risks.

Real-time information on estimated arrival times, stops, route on board of vehicles

The overall applicability of this solution is medium due to financial constraints creating an applicability barrier but no other important barriers (organisational, social or technical) are noted. The solution in the specific context of this case study could only be assessed in regard to rural (and light urban areas) as well as only to regional ï local or national ï long-distance travel. For users from those areas in general only average transferability is noted. There is a slight difference between the needs of local and long-distance travellers. Real-time information on board vehicles seems to be more appropriate for short-distance users (more frequent use) and less for long-distance users (many of their trips are planned ahead and the need for exact on-board information is reduced). Younger users are especially willing to accept this solution while older users are slightly more reluctant. This represents the general pattern in society that younger people are more likely to accept innovations. Older users are fluent in the use of the existing system so they do not find this innovation necessary. There is higher acceptance among low and medium income users. High income users are not opposed to the solution; they are rather not interested in it due to the fact that they do not use public transport (in the tested rural area). For the same reason the interest expressed by business travellers is low, while it is a very interesting solution for leisure and daily commuter travellers and for tourists. The solution does not have an impact on travel time or travel cost (unless the operator decides to increase ticket prices in exchange for introduction of this new system). It increases the reliability and comfort of travel (the user knows their location and also whether they will be able to make connection/arrive on time).

Ticket purchasing via mobile phones / internet

Ticket purchasing via mobile phones / internet shows good transferability in rural areas but there can be some difficulties due to limited access to the internet and mobile phones. In this case study mobile phones access is not a problem but internet access is very limited. The overall applicability can be assessed as high but it is also highly differentiated. High user acceptance is characteristic for young users travelling for medium and long-distance journeys. For other market segments the acceptance is assessed as much lower. This solution is interesting for the general public - interest is higher for business and leisure long-distance public transport users, while for commuters, students and older people the interest is lower. There are no specific organisational, technical or legal obstacles to implement this solution in a rural area.

Real-time information on services via mobile phones

This solution is applicable easily in technical terms. The only serious problem could be financing. The use of this type of system requires relatively (for rural area transport company) high initial investment. Applicability is higher for local (inside the rural region) travellers than for long-distance travellers, but both groups benefit significantly. For the age differentiation criteria this solution (as results show) attracts more travellers in younger age groups. For older people significant usability barriers exist (they have no knowledge how to use advanced functions of mobile phones/smartphones). It is not expected that business travellers will use this frequently (few business travellers use public buses) and it is not intended for high-income individuals who are reluctant to use public transport regardless of increased quality, but it is met with high interest by low and medium-income users. Travellers are mainly interested due to perceived very high time savings (in rural areas even as much as 20 minutes) resulting from just in time departure from home and reduction of waiting time at bus stops. This solution, if offered, will not have a specific target it will rather be directed at all current and potential users of public transport. This is also directed at private car users as some modal shift to public bus is expected.

Demand responsive services

Generally it can be expected that the applicability of demand responsive services in rural areas is high although this case study shows that some significant barriers to applicability exist. This solution is applicable mainly for short-distance trips but even here there are barrier resulting from low social consciousness and understanding of the solution in less developed rural areas. Costs of the implementation are relatively high and profitability is risky. External financing seems to be possible but difficult to achieve. The willingness to pay for demand responsive services in the studied area is very low. Taking distance travelled as a differentiating factor for medium-distance users the willingness to pay is at the highest level of 26% (still low) while for the long-distance passengers it is only 15%. This tendency can be explained by the interest of people travelling within a voivodship to eventually use these services. For long-distance trips planned in advance demand response services are not considered an attractive solution. Some legal and organisational barriers in rural peripheral areas can be expected, such as classification of bus fleet used, revenues allocation etc. No significant technical barriers exist in regard to equipment. The specific constraints in more remote rural areas concern the low technological development and technological potential of the transport operator that is necessary to implement the solutions efficiently. Additionally there can be limitations in mobile phone coverage in rural and forested areas and these can be a constraint to implementation.

6.2 THE BACKGROUND OF THE CASE STUDY

6.2.1 Motivation for this Case Study

This study has been chosen to represent rural areas in underdeveloped regions of the EU, representing both low GDP level and peripherality issues, including barriers in transport accessibility. On the other hand some tourism potential is an advantage of the region influencing its development.

6.2.2 General Description of the Region

Geographical coverage, characteristic from the COMPASS perspective (differentiated regions), includes:

- Economic potential (wealth and ability to pay, also potential for practical introduction of given solution due to cost barrier);
- Predominant form of settlement (e.g. urbanisation level of the area);
- Accessibility on the European level;
- Specific geographical location and tourism (coastal regions, mountainous regions, border regions, with sub-criteria of existence of cultural and landscape landmarks of significance which impacts migrations and tourism).

The area of the survey is the Szczytno region in the Warminsko-Mazurskie voivodship in northeast Poland, shown in Figure 6-1. This is a rural area with low GDP. It has about 25,000 inhabitants, while the surrounding area of Szczytno (poviat) has a population of around 70,000 for whom Szczytno is the centre of gravity. The survey area is the same as the defined case study area.

Source: maps.google.pl

Figure 6-1 Szczytno Region in northeast Poland

Looking at the map of the Warminsko-Mazurskie voivodship in Figure 6-2, it can be noted that the Szczytno region is located at the relative centre of the voivodship and close to Olsztyn ï the capital of the voivodship, but this does not mean that it is not peripherally located in the map of Poland. The density of population is very low and amounts to 37 persons per 1 km^2 while the average for Poland is 124 persons. The population of the region has systematically decreased and this trend is going to be maintained. That is due to the general negative population growth but also to the migration balance of the region (the balance for 2012 was minus 205 persons).

Source: Targeo, Automapa

Figure 6-2 Szczytno region location in Warminsko-Mazurskie Voivodship

Szczytno poviat consists of the city of Szczytno with 25,000 inhabitants and the small town of Pasym (2,500 inhabitants) and seven gminas with predominated rural gminas (see Figure 6-3 below).

The official urbanisation level is 58%, which means that almost half of the regionõs population lives in the rural area. Other specific features of the regions are:

- High forest cover close to 44% of total area;
- High quality of nature and landscape;
- Large area under legal protection (parks, protected areas).

High unemployment amounting to 25% (as of May 2013) is one of the most important economic problems of the region. The Szczytno poviat is in Polandõs top 15 poviats for high unemployment (the average unemployment rate for the country is 13.5% / May 2013). The structure of employment, shown below, is very traditional but with a surprisingly low percentage in agriculture:

- Agriculture ï 6%,
- Industry ï 30%,
- Education ï 19%,
- Construction and building ï 3%,
- Trade ï 9%,
- Transport ï 9%,
- Other ï 28%.

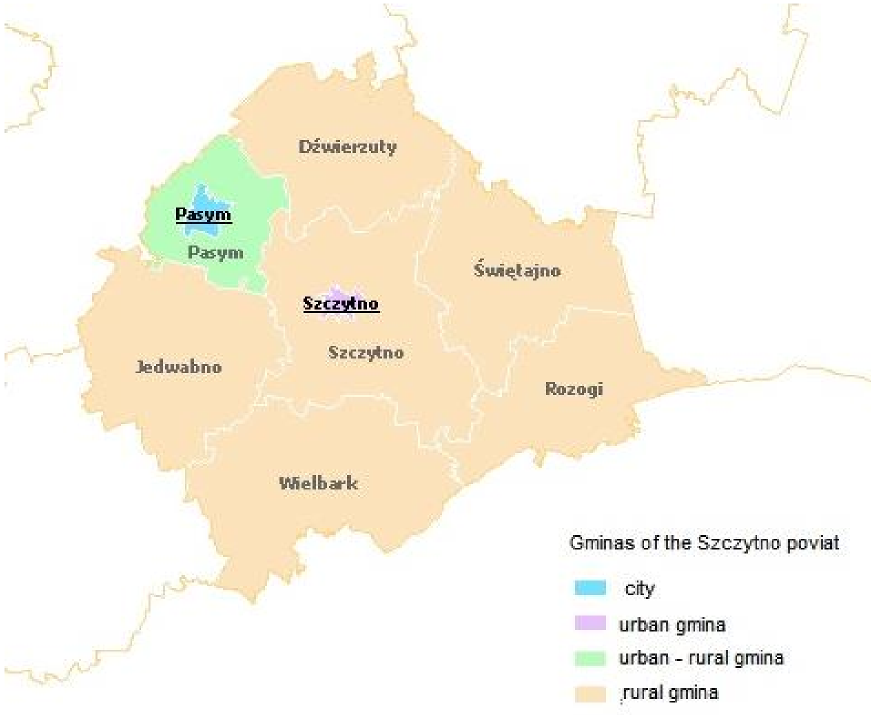


Figure 6-3 Szczytno poviat administrative structure

The external accessibility of the region is poor though there is a quite well developed in-region road network. Overall the transport network at the area is rather underdeveloped. The road network constitutes the three national roads:

- No 53 (Olsztyn-Ostroleka);
- No 57 (Bartoszyce-Pultusk);
- No 58 (Olsztynek-Szczuczyn).

There is also one voivodship level road - no 600 (Szczytno-Mragowo) and few local roads. Poor maintenance of regional and local roads is a significant problem and there are insufficient funds to modernise and develop the network.

There is a railway connection from Szczytno to Olsztyn and Elk (line no 219). Two local lines (no 35 to Ostroleka and no. 262 to Biskupiec) have been disconnected from the network by PKP (Polish State Railways). The role of railways is insignificant.

However an international airport is located in the area ï Szczytno-Szymany which is 7 km from Szczytno but this only serves occasional flights. The closest international airport conducting scheduled flights is in Warsaw located about 160 km from Szczytno. The next closest airport with regular operations is in Gdansk - located 230 km from Szczytno. Regional authorities are not very active in developing programmes for stimulation of entrepreneurship. There are also some organisational barriers for European Union funds to be used, mainly due to administration staff skills and low involvement of non-governmental organisations.

The tourist potential of the region can be assessed as high but existing attractions need investment and promotion. The most important tourist attractions besides the 120 lakes in the region, are Nidzicka Forest (a wildlife reserve of wolves, wild boars, deer and moose as well as birds: grouse and capercaillie), the ruins of the Teutonic Castle in Szczytno, and the Hindenburg Line - a German defensive position from World War I.

The natural environment and tourist attractiveness are the biggest economic potential of the region. It is important to reduce emissions from transport road vehicles which are the main emission source in the region.

6.2.3 Stakeholders Involved

The main stakeholders involved in this case study are public transport users in the region and the main service provider ï the bus transport company PKS. Additionally some non-transport users have been involved in focus group surveys conducted for the case study.

6.2.4 Methodology of the Case Study

This case study takes the form of a test-bed analysing the potential for, and the conditions and barriers of implementation for six specific solutions in the rural area of Szczytno in Poland. This case study has been realised through desk work, consultation with the transport operator and surveys (quantitative surveys among transport users and qualitative focus groups among transport users and bus drivers). Additional information comes from interviews carried out with management staff of the bus company.

6.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

6.3.1 General Description of the Case Study

The subject of this case study is to gain knowledge about the applicability of ICT solutions in low GDP, poor, peripheral regions (the region of minimal potential - negative extreme in the COMPASS scale of regions). The research should answer the following:

- Is it possible to introduce complex ICT solutions in such regions?
- Are ICT solution accepted on social/organisational/legal/political levels in rural settings?
- What is the society knowledge of ICTs and what are society expectations in regard to their use in rural areas?
- Are the transport providers capable of introducing often technically advanced ICT solutions into their daily operations?
- Is it cost efficient to introduce ICTs in rural settings?
- What barriers exist to prevent introduction of ICTĝs in regions with all those negative characteristics?
- Are those barriers removable in any other way than improving basic region features (increasing GDP, wealth etc.*)?*
- Are there any barriers preventing users benefitting from ICTs when already introduced?

The set of specific ICT solutions considered in this test encompasses:

- Internet based travel planners;
- Electronic real time information at bus stops;
- Ticket purchasing via mobile phones / internet;
- Real time information on services via mobile phones;
- Real time information on estimated arrival times, stops, route on board of vehicles;
- Demand responsive services - possibility for direct pick-up/delivery of passengers in response to prior demand.

6.3.2 Data Used

The data used in this study comes from the following sources:

- General information about region features (GUS – databases, GUS – Glowny Urząd Statystyczny / Central Statistical Office). This data is used only in few instances and the general background of the case study is based on it (e.g. population density, flows etc.).
- Quantitative survey conducted in the Szczytno area with a group of 300 users and non-users. The sample is representative in regard to gender, occupation, age and different travel routes researched.
- Quantitative analysis based on three focus groups in-depth interviews. The groups consisted of users and potential users and service provider employees.
- Interviews with service provider management.

Full and detailed descriptions of the survey results have been provided in COMPASS milestone MS 11.

Results of the specific survey

Questionnaire research used in this survey provides data on:

- User acceptance of all tested solutions (for each solution separately) in regard to distance travelled;
- User acceptance of all tested solutions (for each solution separately) in regard to user age;
- User willingness to pay for the introduction of particular ICT solutions among different distance travellers;
- User willingness to pay for the introduction of particular ICT solutions among different age groups;
- For users willing to pay there is in-depth analysis of price elasticity and data allows to answer how much the users expressing will to pay are ready to pay for each of the proposed ICT's (both in division into age groups and different distances);
- Potential for modal shift caused by each of the proposed ICT solutions in regard to different distances;
- Potential for modal shift caused by each of the proposed ICT solutions in regard to different age groups;
- Perceived time savings expected by users resulting from introduction of each of the ICT solutions.

Focus groups provide insight into:

- User preferences of ICT solutions and reasons for high/low acceptance;
- User views on actual and ideal transport system and possibility of ICT solutions to breach the gap existing between them;
- Barriers as perceived by users preventing introduction of proposed ICT solutions;
- Barriers as perceived by service providers preventing introduction of proposed ICT solutions;
- Most likely effects of introduction of ICT solutions on user behaviour;
- Most likely impacts of introduction of ICT solutions on service provider's conduct of business;

In addition, the Interviews with service provider management give insights to operational and financial barriers in introduction of ICT solutions.

Information received from other surveys for this case study

No information from other surveys was used.

6.4 Assessment of the Solution - INTERNET-Based Travel planners

6.4.1 Specific Description of the Solution

Travel planners are already well known instruments allowing users to integrate information concerning their trip. They can cover regional, national or international transport connections and different transport modes. This case study explores the potential of the use of internet based travel planners in the specific conditions of the rural area where mainly one transport mode at the local and regional level is used. Here potential for internet based travel planners exists mainly for long-distance trips where interconnection is an important element of the trip and travel planners can be useful to plan the so-called first/last mile stage of the journey (element corresponding to the access and egress stages to the long-distance legs). From the technical perspective there are no transferability barriers, but within this case study some non-technical constraints have been identified.

6.4.2 Assessment of Applicability

Investment costs

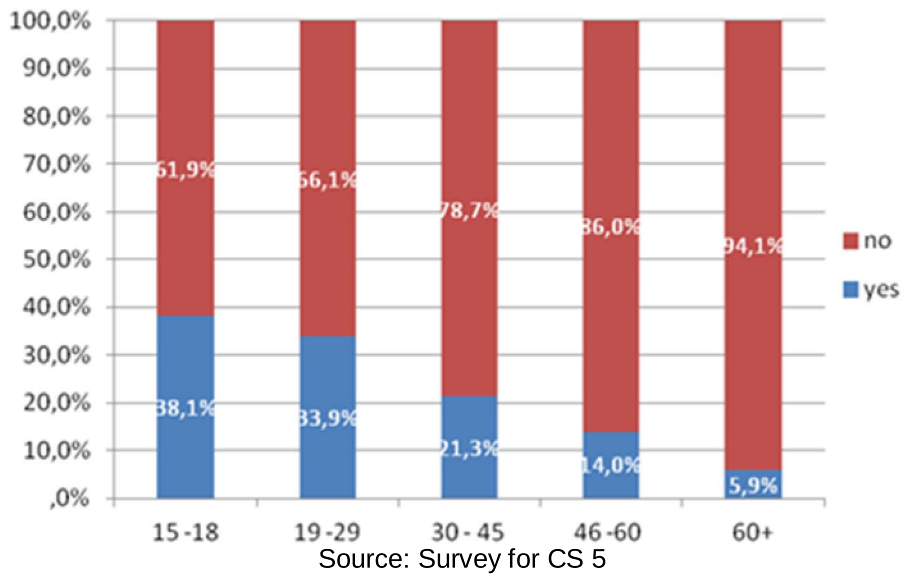
The costs for setting up travel planners are high. They involve setting up the website with the user interface, the software platform for the trip planning and the data input from potentially a wide range of data sources. In this case, it made much easier because there is only data from the one bus operator needed and the main issues is setting up the automatic feed of new bus schedules into the travel planner to avoid the high maintenance costs quote for the travel planner in the Marche region.

Operation and maintenance costs

If the feed of new schedules into the travel planner is automated, then the costs for operation and maintenance should be low.

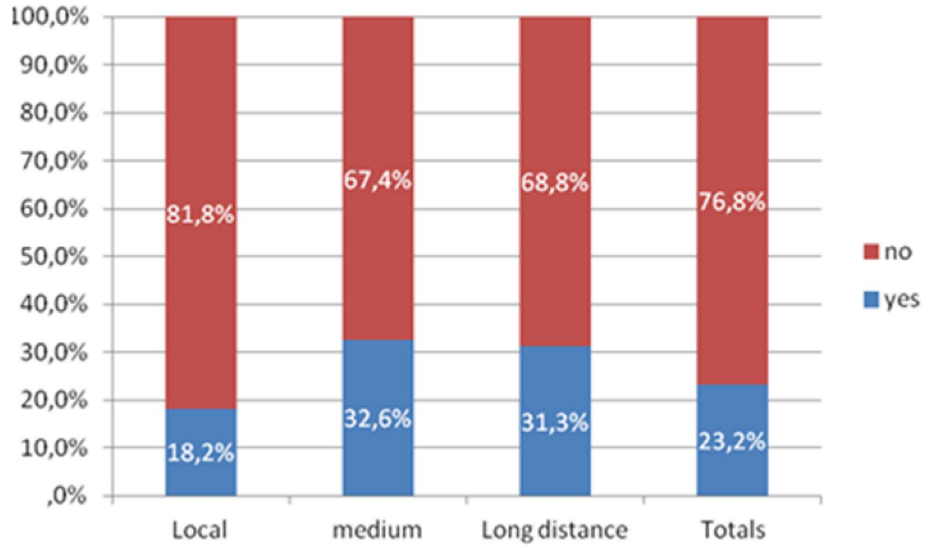
Financial viability

The willingness to pay for the introduction of an internet based travel planner in the study area is rather low. Figures 6-4 and 6-5 below show the user willingness to pay among different user age groups and among those travelling different distances. The highest acceptance (38%) is noted for the youngest group of users (15-18 years old). With increasing age the willingness to pay decreases. For the long-distance travellers the acceptability to pay is higher than for those travelling short distance. Also for medium distance trips (within voivodship) the willingness is at a similar level as for long-distance, which is a positive factor since this segment is very important in the total trips.



Source: Survey for CS 5

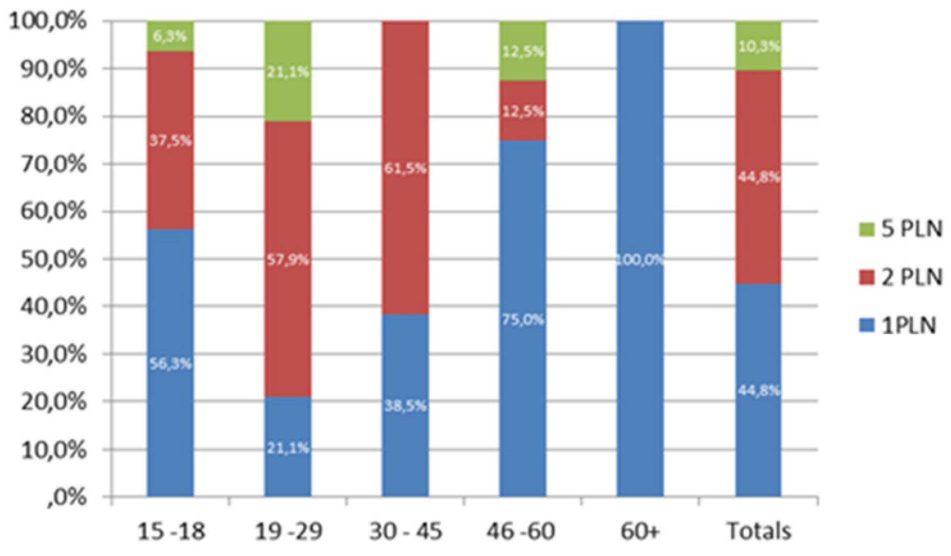
Figure 6-4 Willingness to pay for internet based travel planners among different age groups



Source: Survey for CS 5

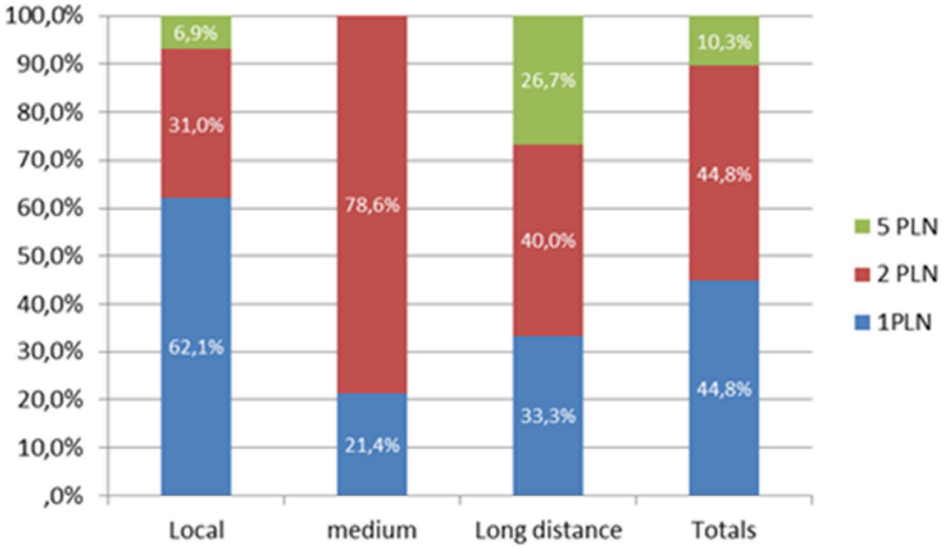
Figure 6-5 Willingness to pay for internet based travel planners among different distance travellers

Figures 6-6 and 6-7 present which increase of ticket price is acceptable to the users (among those who are willing to pay). The majority of respondents accepts amount of PLN 1 or 2 (ca. ú 0.25 to ú 0.5). Taking age of travellers into consideration it can be noted that 60% of people between 19 and 45 years old accept a price increase of PLN 2 , while for other age segments the share is much lower. If looking for segmentation by distance travelled, for most local users only a minimal price increase is acceptable, while medium distance travellers who are willing to pay show a somewhat higher tolerance for the increase in ticket price.



Source: Survey for CS 5

Figure 6-6 User acceptance of ticket price increase in exchange for introduction of internet based travel planners among different age groups



Source: Survey for CS 5

Figure 6-7 User acceptance of ticket price increase in exchange for introduction of internet based travel planners among different distance travellers

Overall over half of those respondents, who would be willing to pay for a travel planner, 45% would accept an increase of PLN 2 and 10% of PLN 5, which translates into 10% respectively 2% of all persons surveyed. So even if the price were to be set at PLN 1, it seems unlikely that the 23% of people that would then use the planner would create an income that would be greater than the amortisation of the investment and the operational costs, and any further price increase would create an even lower income. The travel planner would therefore have to be subsidised by the regional authority and/or the bus operator, and then the likely increase in bus passenger numbers (see further below), and the additional income through their fares, as well as the wider social benefit of the planner through achieving the modal shift would have to be taken into account.

Technical feasibility

No significant technical barriers exist. The technology is available.

Organisational feasibility

The implementation of the solutions requires efficient cooperation with transport operators and managers in the region. This is crucial for providing and updating data which means that some necessary skills of the operatorὂs staff and the openness to the idea of cooperation is needed. In the first stage of introducing this solution it could be significant barrier.

Administrative burden

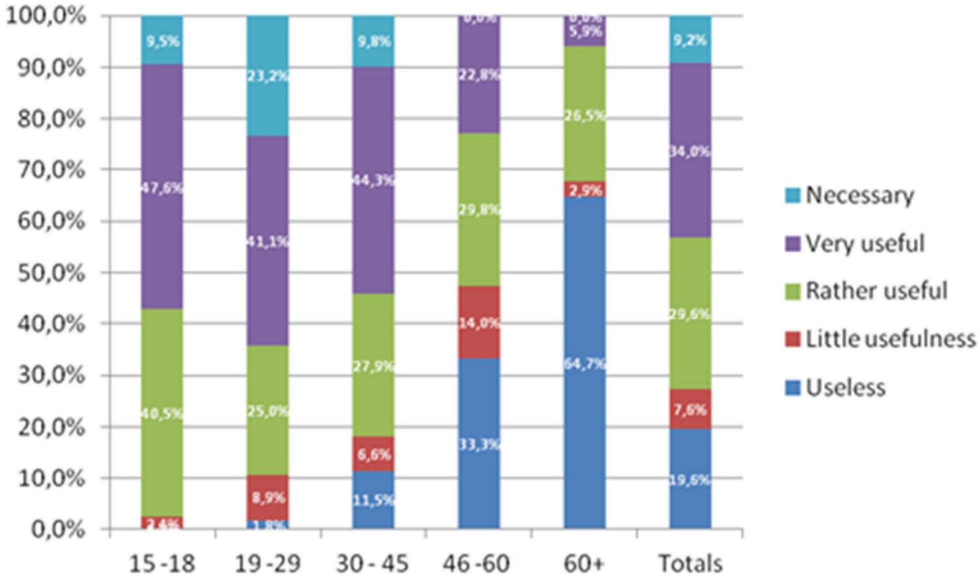
There are several institutions which can be interested in the implementation of the internet based travel planner in rural area, e.g. local authorities, tourism organisations and tourism agencies. Depending on specific local context some barriers can exist at the level of contract arrangements for travel planner operation and copyright issues as well as the financial settlements.

Legal feasibility

There are no legal barriers.

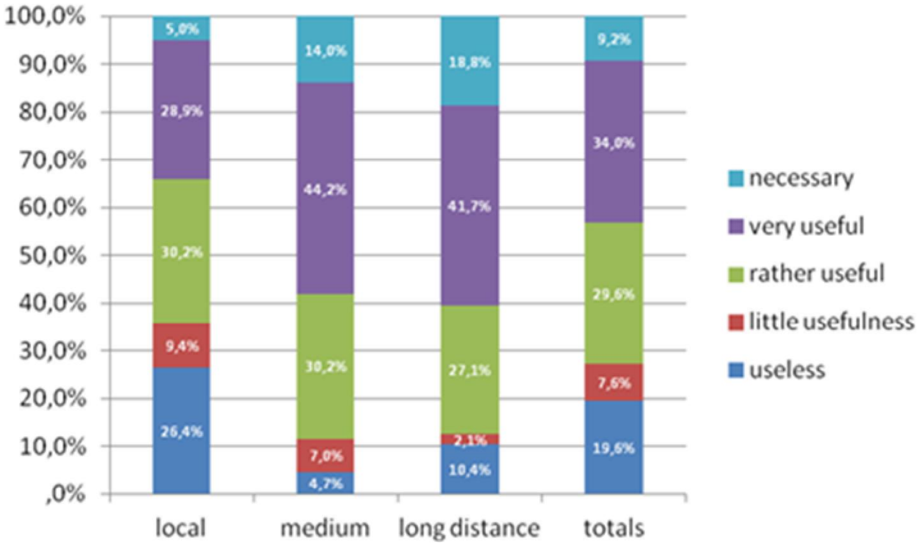
User and public acceptance

Public acceptance, which equates in this case to potential user acceptance, is generally high. Internet based travel planners are considered necessary by 9.2% of users, very useful by 34% and useful by 30%. On the other hand almost 20% of users assess the solution as useless which was surprisingly very high figure. The reason for that is the high share of older people (65% of those above 60 years old) expressing low acceptance of the solution (Figure 6-8). Older people in rural areas have mainly limited access to internet and fear of using any high technology solutions. Figure 6-9 presents the characteristics of the relationship between travel distance and acceptance of travel planners. With the increase in distance travelled the acceptance level increases too.



Source: Survey for CS 5

Figure 6-8 User acceptance of internet based travel planners among different age groups.



Source: Survey for CS 5

Figure 6-9 User acceptance of internet based travel planners among different distance travellers.

There are however certain additional considerations regarding rural areas. As it has been identified by the interviews conducted in focus groups, necessary access to the internet and skills can be a barrier especially for older users.

6.4.3 Assessment of Interest for Travellers

Door to door travel time

The planner can have significant impact on travel time. Efficient and advanced planning of the trip especially for long-distance journeys in the rural area, where the regular bus services for access and egress stages are rare, would shorten waiting time.

Door to door travel costs

No impact on travel cost.

Comfort and convenience

Significant impact on comfort and convenience. Internet based travel planner can provide quick access to the information and a good spectrum of information what enables optimisation of travel plan especially for medium and long-distance users in rural areas. Itʹs also possible to enrich the available information by road works information, type of bus data, etc.

Safety

Not impact.

Security

Not impact.

Accessibility for mobility impaired passengers

There would be a likely positive impact on access by people with reduced mobility. These passengers may potentially be able to plan the trip ahead taking into consideration their impairments better.

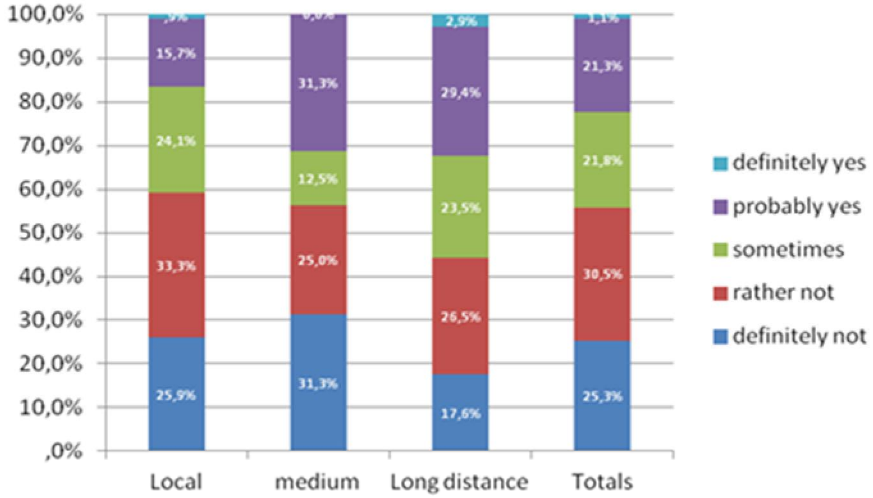
6.4.4 Assessment of Modal Change

Car usage

There is some potential impact on modal shift. In this area only the serious competitor to bus transport is use of the personal car. Introduction of internet based travel planners increases bus usage and reduce the usage of personal cars as shown below.

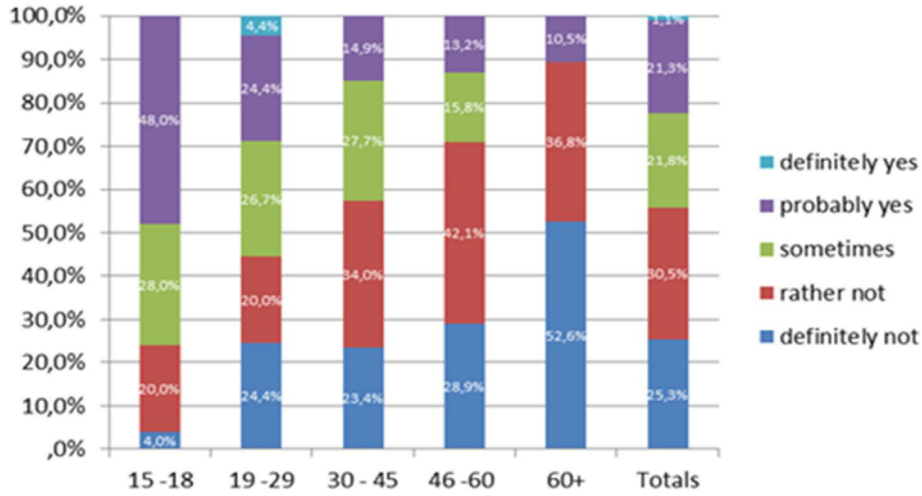
Bus and coach usage

From those bus users who have the possibility to use a car only 1% will certainly switch to bus if travel planners become available, but more than 40% state that they will do it very likely or likely (Figure 6-10). However, more than 55% are not willing to use a bus (definitely not or rather not answers). Travel planner can have the biggest impact on modal shift in long-distance trip (here 55% state they would be going to switch to a bus frequently). As it is presented in Figure 6-11 below quite big differences exist between age groups. About ¾ of young passengers using a car state that they are willing to switch to buses (probably yes and definitely yes) while for older users that is only 10% of the total.



Source: Survey for CS 5

Figure 6-10 Modal shift in response to the introduction of internet based travel planners among different distance travellers



Source: Survey for CS 5

Figure 6-11 Modal shift in response to the introduction of internet based travel planners among different age groups

Rail usage

No significant impact on rail usage due to very limited rail network and sporadic service in the area.

Ferry usage

Not applicable

Aeroplane usage

Not applicable

6.4.5 Assessment of Other Impacts

Increased mobility

It is not predicted that implementation of internet based travel planner will significantly change the mobility in rural areas. A slight increase can result from the stimulating mobility of young transport users who can go more often to visit friends, for shopping etc. from rural locations that are difficult to access.

Congestion

This is a rural setting where congestion is not significant factor in transport system.

CO2 emissions

Small positive effect on CO_2 emissions due to the probable modal shift from cars.

Contribution to user pays principle

No impact.

European economic progress

No direct impact.

Territorial cohesion

No direct impact.

6.4.6 Assessment against Main Criteria – Summary

Table 6-1 Internet-based travel planners - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	*0*
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	*0*
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	✓
Car usage	-
Bus and coach usage	+
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	✓
Congestion in overcrowded corridors	*0*
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

6.5 Assessment of the Solution - Electronic Real-time information at Bus Stops

6.5.1 Specific Description of the Solution

This solution provides real time information to the passengers awaiting bus arrival at the bus stop. It show the actual position of the bus and/or the real arrival time. This solution application in rural settings eliminates uncertainty as to the question whether a bus has already departed or not. On rural routes delays are frequent and passengers waiting for the bus might wonder whether the bus has already departed (running a few minutes early) or not. Sometimes due to traffic conditions or weather conditions delay could be significant thus exact information about bus position eliminates uncertainty. This type of instrument has been pioneered in many cities.

6.5.2 Assessment of Applicability

Investment costs

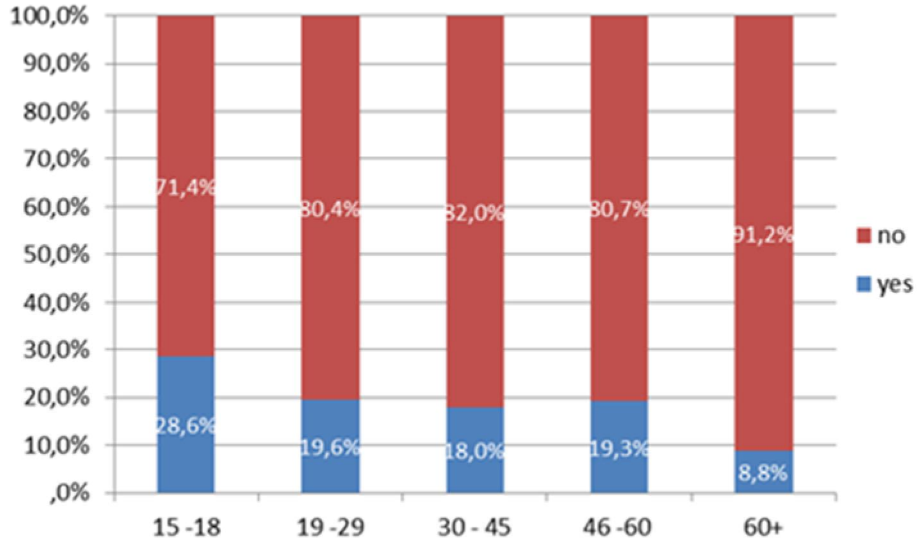
For similar systems installed in cities costs are: ú 0.7 million for 167 displays in Rybnik ï although it has to be noted that not all displays are working in real time. In Radom electronic information system for 100 bus stops together with electronic ticket will cost about ú 2 million. A similar system (but without electronic ticket component) for 41 bus stops in Gdansk was around ú 0.7 million. In Poznan 7 electronic boards installed in crucial interchanges will cost approx. ú 0.4 million.

Operation and maintenance costs

No precise figures are available, but the interviews with transport operator provide some insights. The system maintenance is not perceived as very expensive under usual conditions but it might become very expensive due to vandalism. The electronic displays on bus stops are subject to damage and if the pattern with current paper timetables displays is maintained it would mean at least 1-2 replacements per bus stop each year, which operators believe to be a prohibitive cost. One must remember that rural settings are more prone to vandalism acts because of the seclusion of bus stops, while in urban areas there are more people moving around which prevents acts of vandalism.

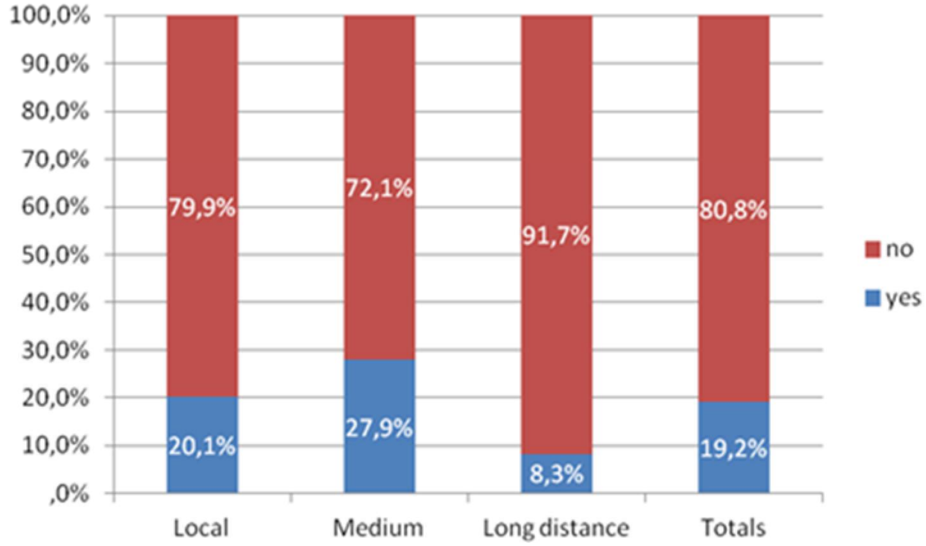
Financial viability

The introduction of this system is not efficient in rural setting due to high initial expenditure and potentially high maintenance costs. This becomes even more obvious when the costs are confronted with usersô unwillingness to pay for this service. Figures 6-12 and 6-13 below show the user willingness to pay among different user age groups and in case of users willing to pay the maximum accepted amount. Little willingness to pay extra for availability of information could be noted across all user groups. Only 19.2% of users are willing to pay and from those as many as 72.9% no more than PLN 1. Only 18.9% is willing to pay up to PLN 2 and just 6.3% of users up to PLN 5 with slightly more than 2% - more than that amount. Highest willingness to pay is represented by youngest users (15-18 years of age) and middle aged users (30-45 years). This could be explained by the fact that youngest people are those raised in economic conditions of competition (born after country transition to market economy and for this reason have higher acceptance for the concept that everything comes with a cost), while the middle aged are those who are currently employed and have comparatively more financial resources than other groups.



Source: Survey for CS 5

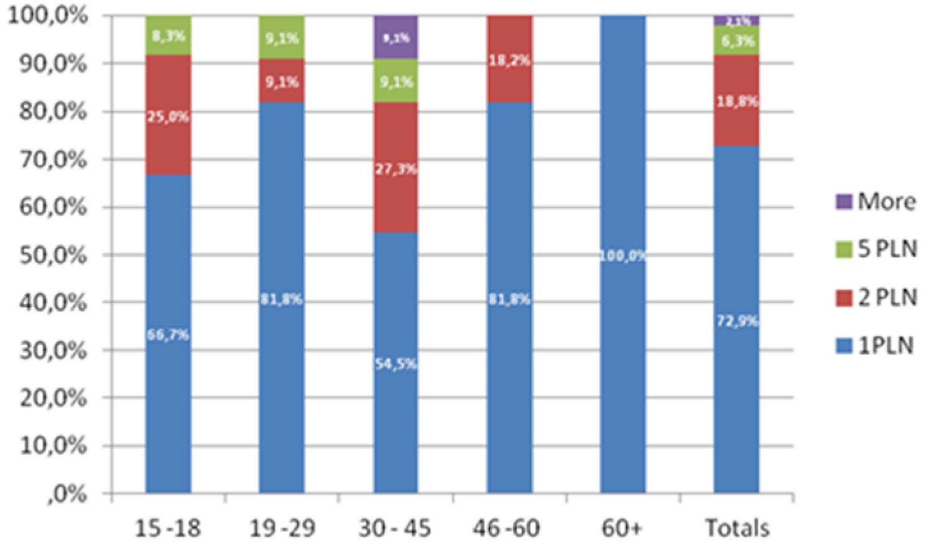
Figure 6-12 Willingness to pay for electronic information at bus stops among different age groups



Source: Survey for CS 5

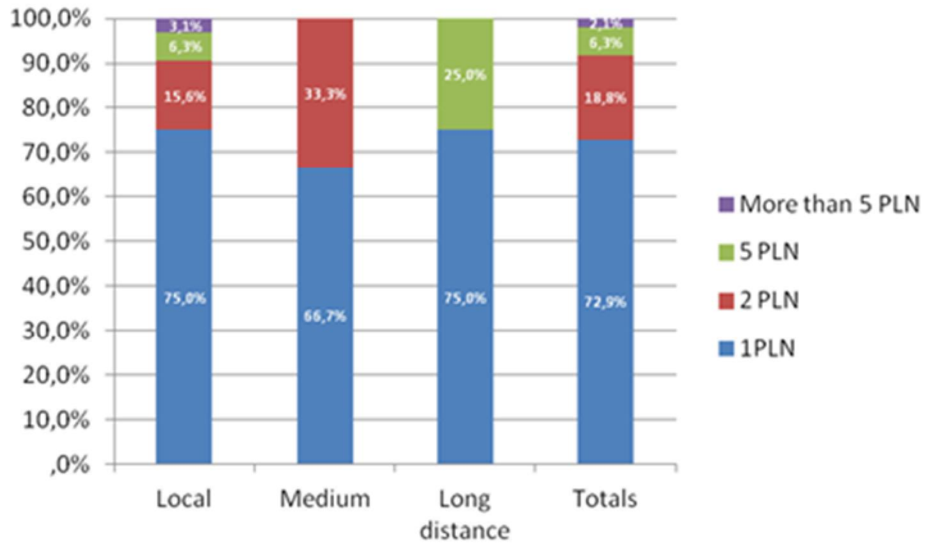
Figure 6-13 Willingness to pay for electronic information at bus stops among different distance travellers

Even among those who are willing to pay the maximum accepted amount is not higher than PLN 1 (around ú 0.25).



Source: Survey for CS 5

Figure 6-14 User acceptance of ticket price increase in exchange for introduction of electronic information at bus stops among different age groups



Source: Survey for CS 5

Figure 6-15 User acceptance of ticket price increase in exchange for introduction of electronic information at bus stops among different distance travellers

Technical feasibility

No significant technical barriers exist. The technology is available. There are however certain additional considerations. Firstly the fleet of buses available to rural operator is in large share composed of old vehicles. Installing modern based on satellite navigation systems in them although technically viable could create additional problems. It is also questionable whether the investment should not be first made in a new fleet rather than equipping an old fleet with modern technologies. In addition the maintenance of the IT system which will channel data from satellite navigation receivers into user readable format and transmit it to appropriate facilities at many remote bus stops is a challenge.

Organisational feasibility

There is organisational complexity involved.

Administrative burden

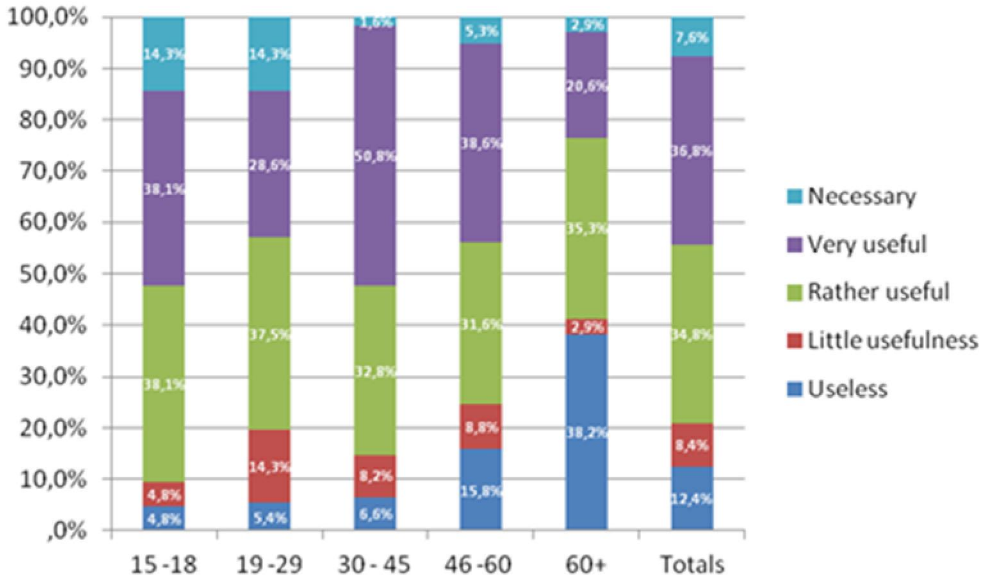
Introduction of real time bus ï stop information requires significant organisational change. IT department or data processing centre has to be created. In addition new employees dedicated to system maintenance have to be attracted to the company. This is economically questionable given the current price of tickets in this rural area..

Legal feasibility

There are no legal barriers.

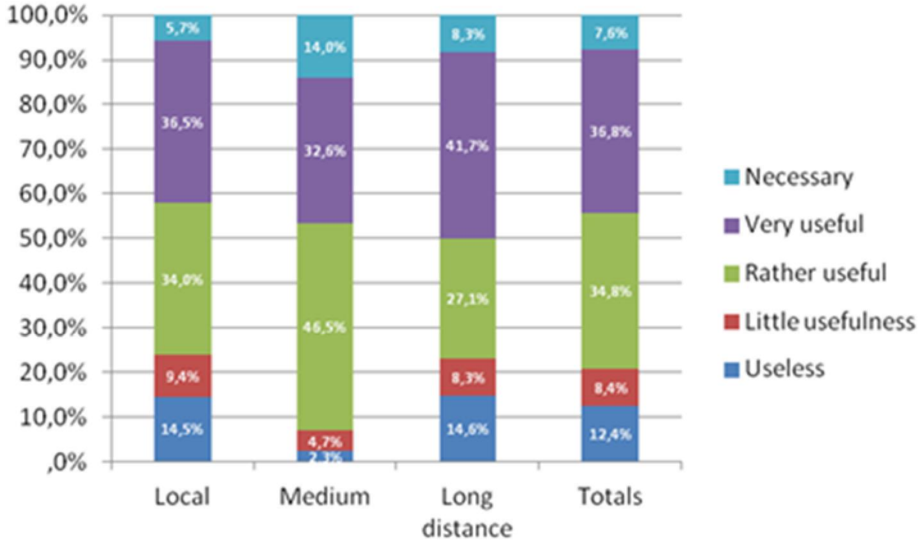
User and public acceptance

Public acceptance, which is this case is the same as the potential user acceptance, is generally high. Electronic real time information at bus stops is considered necessary by 7.6% of users, very useful by 36.8%, useful by 34.8%, of little use by 8.4% and of no use at all by 12.4%. This picture differs if various distances are considered. Usually with all on-the bus-stop information it is expected that they are most beneficial to the short distance travellers. It is not a case here. The solution is considered most useful by middle distance travellers. 14% of them deem it necessary, 32.6% very useful and 46.5% useful. For the short distance travels the numbers are: necessary ï 5.7%, very useful ï 36.5%, useful ï 34%. Similar acceptance is found in long distance travellers group. In that case 8.5% of them consider solution necessity, 41.7% treat it as very useful improvement and 27.1% as useful.
The highest acceptance is associated with young age. In the age group 15-18 there are 14.3% respondents considering proposed measure as necessary, 38,1% as very useful, 38.1% as useful and only 4.8% say it was of little use with the same number treating it as unnecessary. Similar situation could be noticed in segment of 19-29 year olds with 14.3% finding it necessary, 28.6% - very useful, 37.55 ï useful, 14.3% of little use and 5.4%- not useful at all. Age group 30-45 differs in regard to exact percentages but general picture holds: 1.6% answered that proposed solution was necessary, 50.8% that it was very useful, 32.8% ï useful and 8.2 % found it of little use with 6.6% considering proposal not useful. A clear border could be established when switching to people over 45 years. For those aged 46-60, 38.6% consider solution very useful and 31.6% useful while 8.8% of little use and 15.8% of no use at all. This trend is strengthened in age group of over 60 years old users ï where solution is considered very useful by only 20.6%, useful by 35.3% of little use by 2.9% but of no use by as many as 38.2% of all users.



Source: Survey for CS 5

Figure 6-16 User acceptance of electronic information at bus stops among different age groups



Source: Survey for CS 5

Figure 6-17 User acceptance of electronic information at bus stops among different distance travellers

6.5.3 Assessment of Interest for Travellers

Door to door travel time

The system does not have any direct impact on travel time, but users can use the time before the arrival of the on activities offered locally near the bus stop (e.g. shopping), if they know that the bus will only arrive 10 or 20 minutes later.

Door to door travel costs

No impact on travel costs.

Comfort and convenience

The impact on comfort and convenience as perceived by interviewed passengers is high. The system eliminates uncertainty as to the bus arrival/departure time and fear of missing the bus. This is especially important on remote bus stops where services are not frequent (e.g. at some bus stops in analysis it could be as little as 2 or 3 times per day).

Safety

Does not have impact on safety.

Security

Does not have impact on personal security

Accessibility for mobility impaired passengers

No impact on access by people with reduced mobility

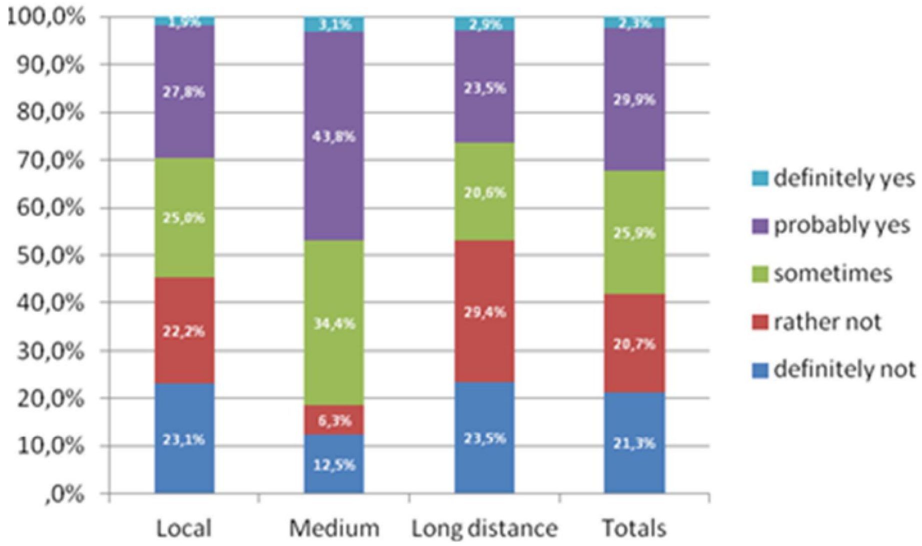
6.5.4 Assessment of Modal Change

Car usage

There is some potential impact on modal shift. In this area the only serious competitor of bus transport is use of the private car. Introduction of electronic information on bus stops may reduce usage of private cars (see below).

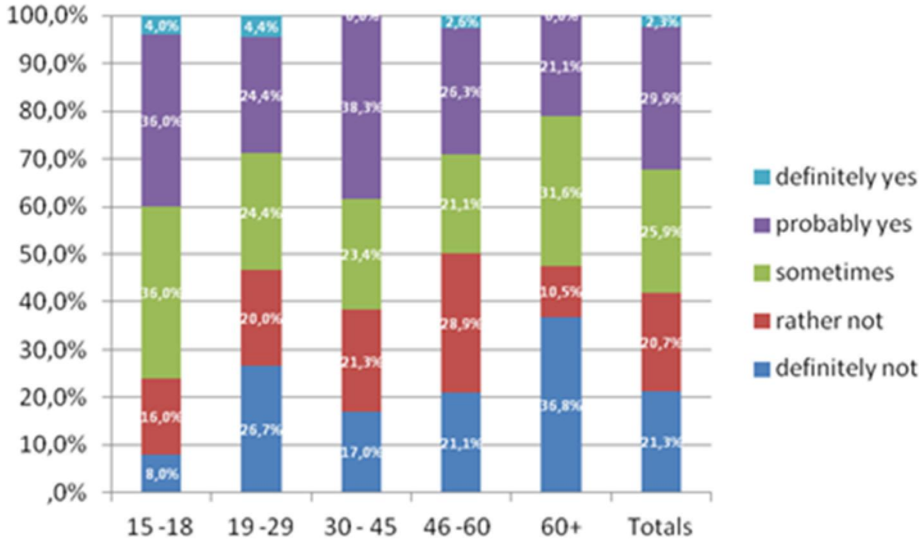
Bus and coach usage

From those bus users who have possibility to use a car 2.3% state that they will certainly switch to bus, if this improvement is introduced, with further 29.9% saying this is very likely and 25.9% likely to do this on some occasions.



Source: Survey for CS 5

Figure 6-18 Modal shift in response to the introduction of electronic information at bus stops among different distance travellers



Source: Survey for CS 5

Figure 6-19 Modal shift in response to the introduction of electronic information at bus stops among different age groups

Rail usage

No significant impact on rail usage due to very limited rail network in the area and sporadic service.

Ferry usage

Not applicable.

Aeroplane usage

Not applicable.

6.5.5 Assessment of Other Impacts

Increased mobility

Psychological effects of certainty as to the bus arrival/departure times associated with this solution have some impact on mobility. Users may travel more by bus if they are offered ICTs which increase service quality, but any increase should not be significant and the main effect should be the modal shift.

Congestion

This is a rural setting where congestion is not significant factor in the transport system.

CO2 emissions

Some reduction of CO2 emissions should result from the probable modal shift from private cars. A compounding factors is the fact that in rural settings the number of electric/hybrid cars will be lower than in cities (mainly due to lower GDP/wealth of inhabitants levels) Furthermore, in those areas there is significantly larger share of old cars producing more emissions in operation and their elimination from overall trip volumes contributes more.

Contribution to user pays principle

No impact.

European economic progress

No impact on economic progress on a large scale. Some local impacts (better mobility of workforce locally) could occur.

Territorial cohesion

No significant impact.

6.5.6 Assessment against Main Criteria – Summary

Table 6-2 Real-time information at bus stops - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	úú
Financial viability	XX
Technical feasibility	0
Organisational feasibility	0
Administrative burden	X
Legal feasibility	1
User acceptance	✓
Public acceptance	✓
D2D travel time	0
D2D travel costs	0
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	0
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

6.6 Assessment of the Solution - Real-time Information on-board the Vehicle

6.6.1 Specific Description of the Solution

This solution provides real time information about the actual position of the bus to the people travelling in this bus. An extended version provides also information as to the position of other buses and possible delays/connections.

6.6.2 Assessment of Applicability

Investment costs

This solution does not exist in the described rural setting. Comparisons could be made with existing city operators. In Lublin the cost of one electronic board in the bus is about ú 2,000. The total cost will depend on the size of the fleet. If the fleet size is 50 buses, the cost will be approx. ú 100,000. This does not include cost of data processing centre which transmits all information to the buses, the cost of which might be as high as ú 250,000 to ú 500,000.

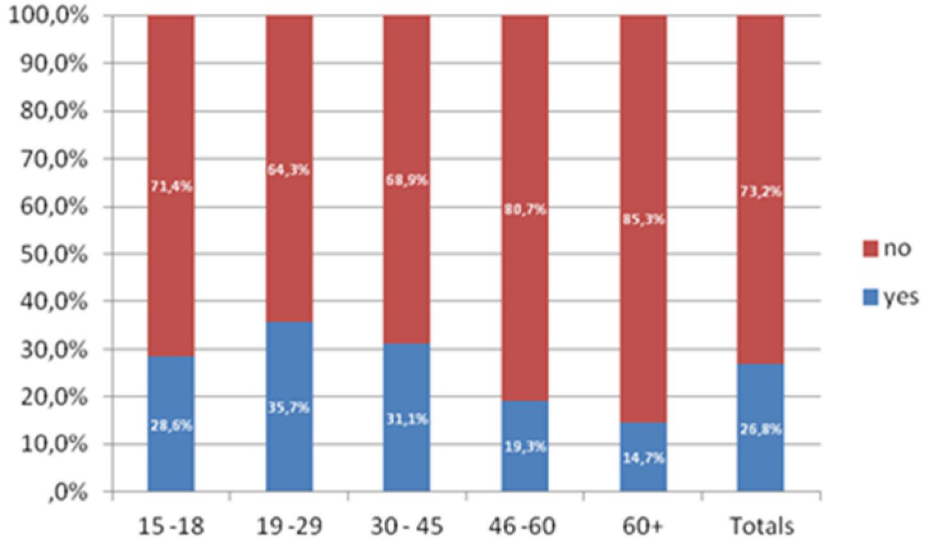
Operation and maintenance costs

Annual operation and maintenance costs are considered as low.

Financial viability

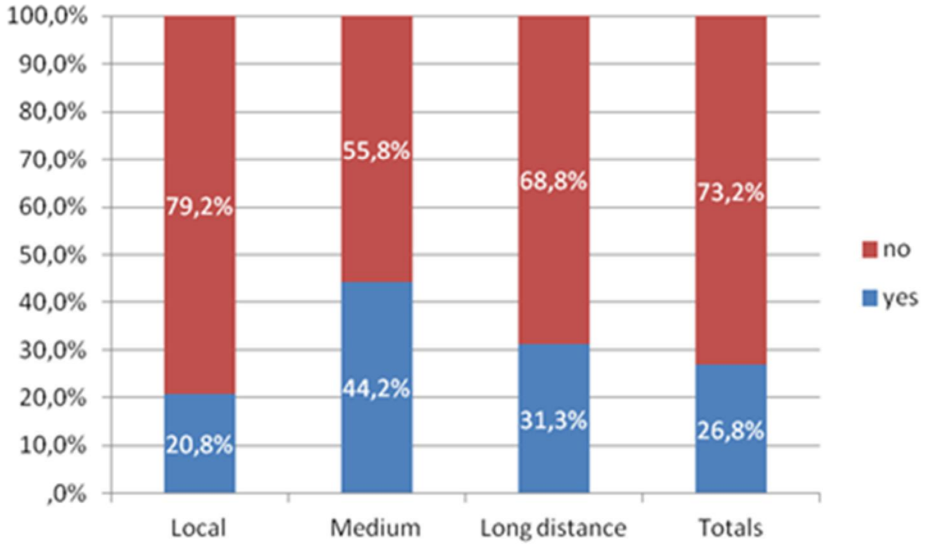
Financial viability is questionable, especially given considering user reluctance to pay additional fees for this improvement, and it therefore also having to be regarded as not particularly socially beneficial..

User willingness to pay is low and from all ICTs tested within this rural setting this particular solution has the highest willingness to pay. Yet it is too still low to be sufficient from the operatorsôview, with as many as 73.2% of users refusing to pay for this improvement.



Source: Survey for CS 5

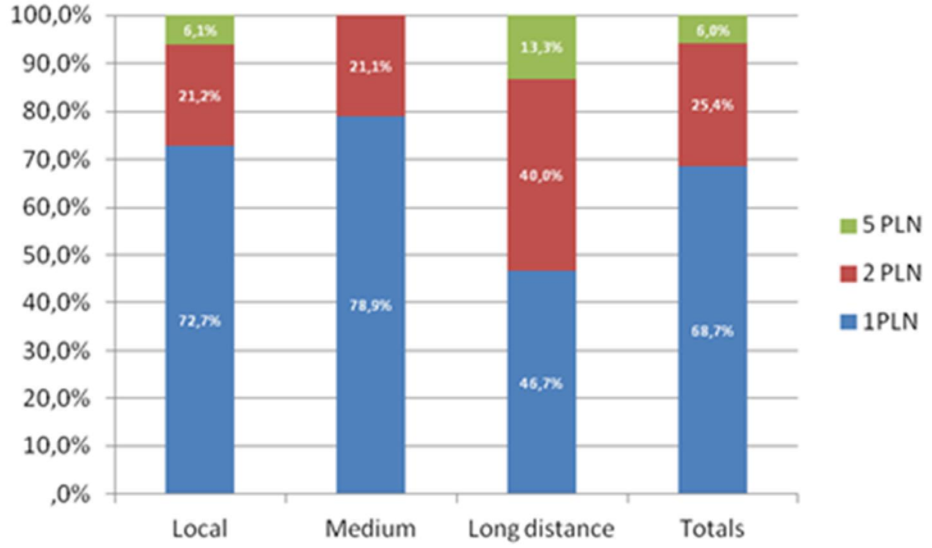
Figure 6-20 Willingness to pay for electronic information on-board among different age groups



Source: Survey for CS 5

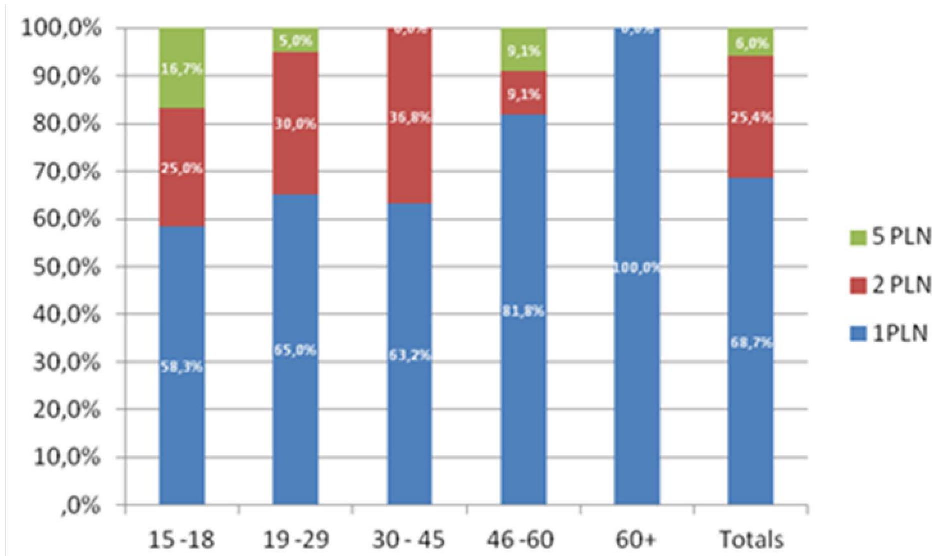
Figure 6-21 Willingness to pay for electronic information on-board among different distance passengers

From those accepting additional payments 69% insist that it should not be more than PLN 1, and PLN 2 is the ceiling for another 25.4%.



Source: Survey for CS 5

Figure 6-22 User acceptance of ticket price increase in exchange for introduction of electronic information on-board of vehicle among different distance passengers



Source: Survey for CS 5

Figure 6-23 User acceptance of ticket price increase in exchange for introduction of electronic information on-board of vehicle among different age groups

Technical feasibility

No technical barriers.

Organisational feasibility

No barriers of organisational nature are expected.

Administrative burden

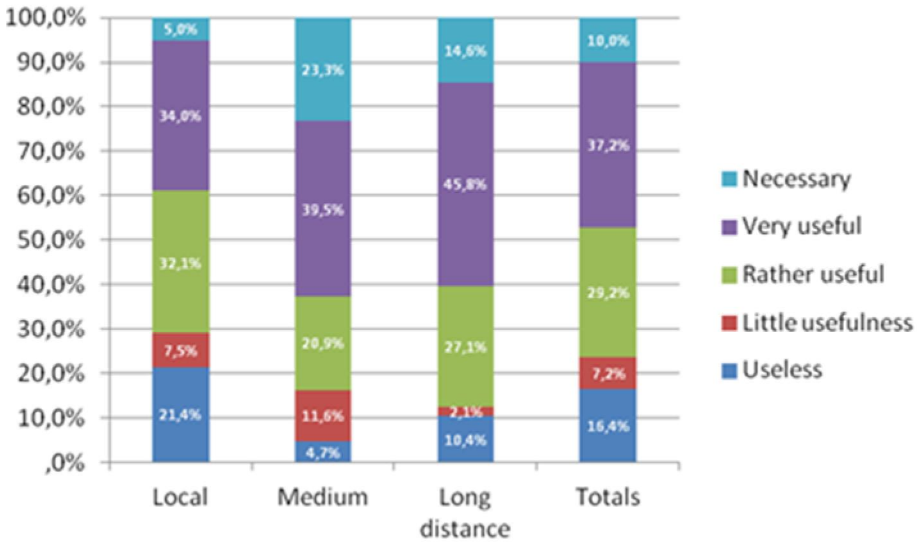
Should not create additional administrative burden.

Legal feasibility

There are no legal barriers.

User acceptance

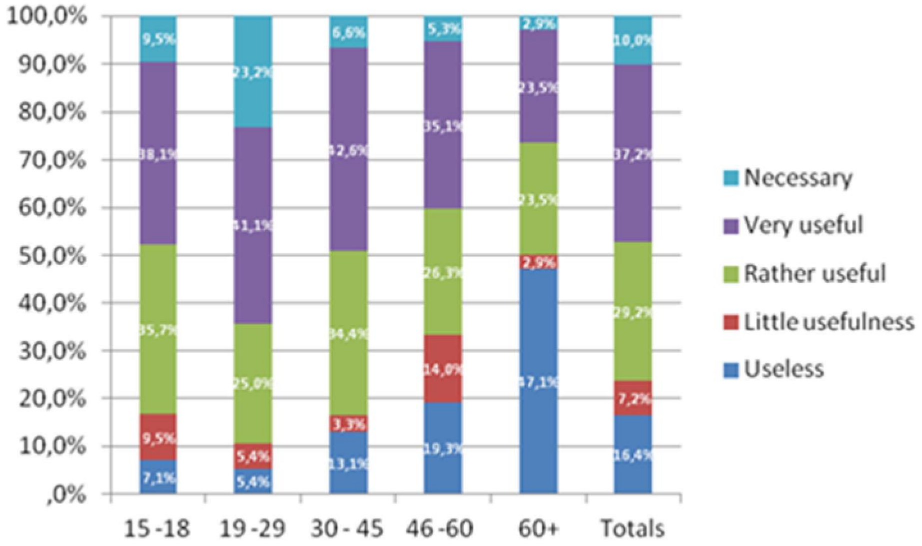
On-board real time information is positively evaluated by the majority of users and considered necessary by 10% of potential users, very useful by 37.2% and useful by 29.2%. The distance factor has some impact but does not change the overall picture significantly. For local travel respondents answers range from necessary 5%, very useful 34%, useful 32.1% to little use 7.5% and no use at all 21.4%. In medium distances those feeling that the proposed improvement is necessary are 23.3%, very useful 39.5%, useful 20.9% with small minority either reluctant (11.6% saying it has little usefulness) or rejecting this application (4.7%). A positive trend is visible in long distances ï here 14.6% of respondents point at necessity of this tool, 45.8% find it very useful and 27.1% useful. Again only a small portion of all respondents answered that it was of little use (2.1%) or rejected it (10.4%).



Source: Survey for CS 5

Figure 6-24 User acceptance of electronic information on-board among different distance passengers

Acceptance levels follow age pattern ï younger users accept it more easily than older. Highest acceptance (expressed necessity for this solution) is in the age group 19-29 years and reaches 23.3% followed by 15-18 year olds (9.5%). In other groups it is 6.6% (30-45 years), 5.3% (46-60) and 2.9% (60+). A very useful rating is given by 38.1% of youngest users, 41.1% of members of 19-29 year old group, 42.6% by those aged 30-45, 35.1% by those between 46 and 60 years and 23.5% by aged 60 and more. As useful solution is accepted by 35.7% of users from first group, 25% from the second, 34.4% of 30-45 year olds, by 26.3% of 46-60 year olds and by 23.5% of oldest users. Opposition is strongest in the 60+ group with more than 47% rejecting it followed by 46-60 age range group where opposition is at 19.3%.



Source: Survey for CS 5

Figure 6-25 User acceptance of electronic information on-board among different age groups

6.6.3 Assessment of Interest for Travellers

Door to door travel time

The system does not have direct impact on travel time except for interchanges. If the system provides information not only about bus that the traveller currently uses but also about the location of other buses, the interchange can be planned ahead. In some instances, when very short time is allocated for the interchange, the user might be able to rush to catch the departing connecting bus and save much time otherwise consumed by waiting for next connection.

Door to door travel costs

No impact on travel cost.

Comfort and convenience

This system increases comfort and convenience significantly. Real time information accompanied by displayed data on interchanges and possible following connections allows for in-journey planning. This is especially useful, if the current bus is late and the whole pre-planned travel options are no longer valid.

Safety

No impact on safety.

Security

No impact on security.

Accessibility for mobility impaired passengers

No impact on access by people with reduced mobility.

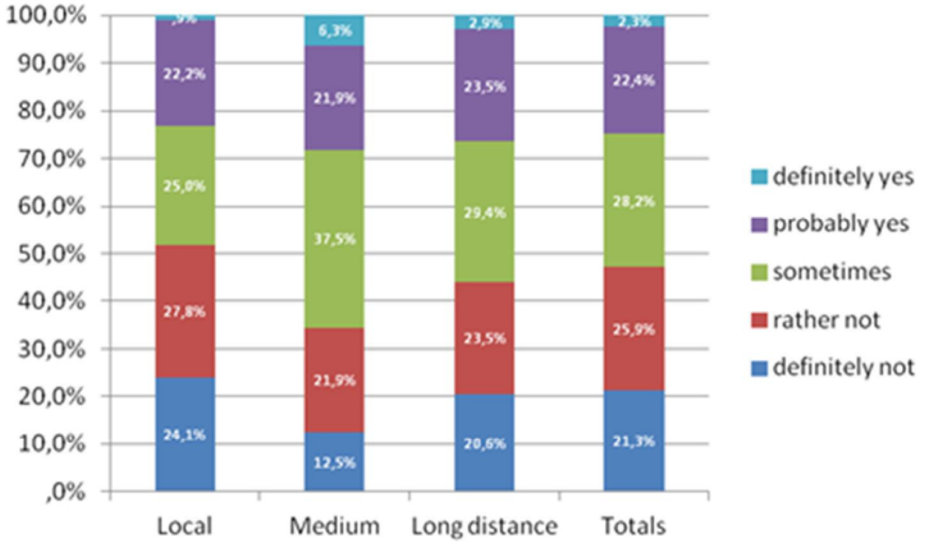
6.6.4 Assessment of Modal Change

Car usage

Car usage is likely to decline due to modal shift occurring from car to bus (see below).

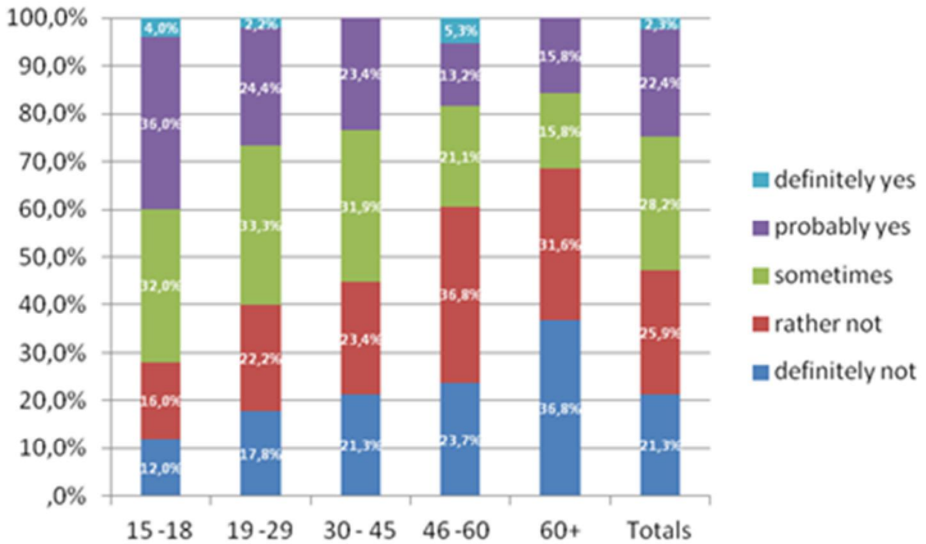
Bus and coach usage

Impact on modal shift is possible with 2.3% of users expressing willingness to shift to bus from car, 22.4% declaring a high probability of such a move and 28.2% offering an occasional switch.



Source: Survey for CS 5

Figure 6-26 Modal shift in response to the introduction of electronic on-board information among different distance travellers



Source: Survey for CS 5

Figure 6-27 Modal shift in response to the introduction of electronic on-board information among different age groups

Rail usage

No impact on rail due to very low density and frequency of rail services in the area.

Ferry usage

Not applicable.

Aeroplane usage

Not *applicable*

6.6.5 Assessment of Other Impacts

Increased mobility

There is very limited impact on increased mobility. More comfortable convenient public transport is likely to attract more users. But those users will rather come from other modes (in this case private car users) and not from new demand.

Congestion

This is a rural setting with very low levels of congestion.

CO2 emissions

There will be some positive impact on CO2 emissions, if the predicted modal shift from passenger car occurs.

Contribution to user pays principle

No contribution to user pay principle.

European economic progress

Does not have direct impact on large scale economic progress. By improving interconnections might facilitate local commuter travel but effects will be limited and local only.

Territorial cohesion

No significant impact.

6.6.6 Assessment against Main Criteria – Summary

Table 6-3 Real-time information on-board the vehicle - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	€
Financial viability	X
Technical feasibility	*0*
Organisational feasibility	✓
Administrative burden	*0*
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	(✓)*
D2D travel costs	*0*
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	-
Bus and coach usage	+
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	✓
Congestion in overcrowded corridors	*0*
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	*0*
Territorial cohesion	*0*

*For majority of travellers no impact but for those making interconnections potential time savings might be very significant (on some routes even more than 1-2 h).

6.7 ASSESSMENT OF THE SOLUTION - TICKET PURCHASING VIA MOBILE PHONES / INTERNET

6.7.1 Specific Description of the Solution

Ticket purchasing via mobile phones or internet, called also mobile ticketing, includes the following functionalities: ticket sale, issue, validation and eventually also refunds and cancellations, analysis of ticket holder activity. This solution reduces the production and distribution costs connected with traditional paper-based ticketing and can increase transport usersôconvenience. Different applications for mobile ticketing have been already developed including integrated ticketing for several transport modes or combining the transport ticket with event ticketing. The ticket can be purchased through SMS, secure mobile phone (or smartphone) application or online which can allow the user to set up an account and using different payment options. There are many applications available which can be easily transferred to different areas. Transferability can cause difficulties in rural areas where the access to internet and mobile phones is more limited than in cities. In the case of this region mobile phones access is not a problem but internet access is very limited.

6.7.2 Assessment of Applicability

Investment costs

There is no data available concerning the investment costs in these systems, but they are certainly not trivial.

Operation and maintenance costs

Operation and maintenance costs are low.

Financial viability

Whilst there are costs in ensuring a secure SMS ticketing system, these can be outbalanced by cost-savings resulting from reductions in ticket-sales staff, in physical ticket production and in the reduction of ticketless travel.

Therefore it is not a major concern that the willingness to pay for the implementation of ticket purchasing via mobile phones / internet in the study area is rather low. The figures below show the usersôwillingness to pay among different user age groups and among different distance travellers. The highest acceptance (37.5%) is noted for users 19-25 years old. Then with increasing age the willingness to pay decreases. Taking distance travelled into consideration a large discrepancy can be noted between local and long distance travellers. For long distance usersôwillingness to pay is at the level of 37.5% while for the local passengers only at 14.5%. That is due to the fact that the majority of frequent local travellers uses monthly or other season tickets and they are not interested in changing the method of payment.

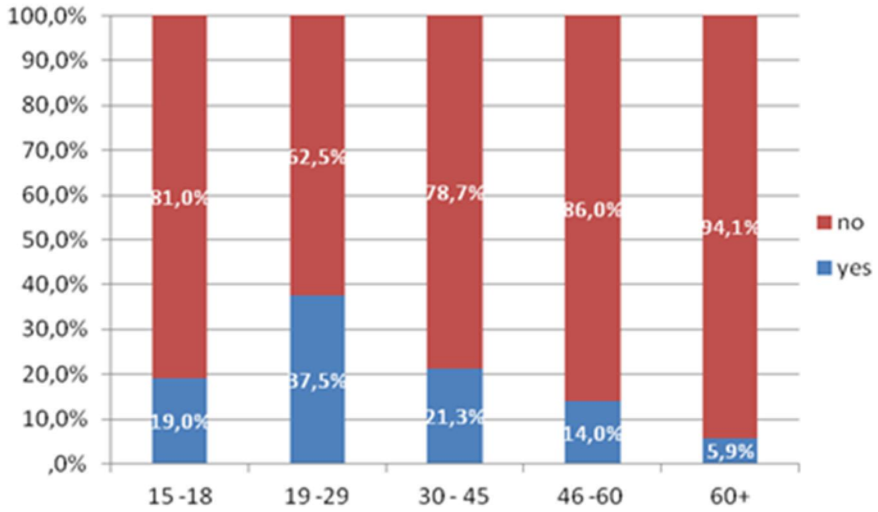


Figure 6-28 Willingness to pay for ticket purchasing via mobile phones / internet among different age groups

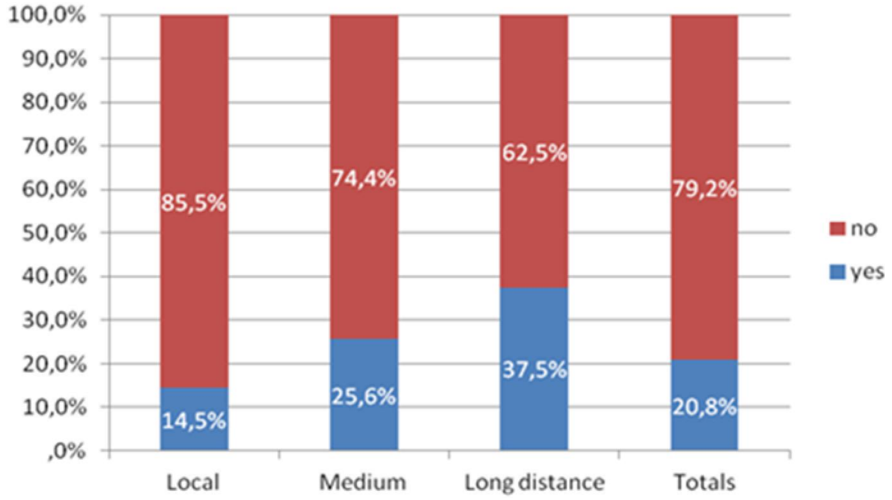
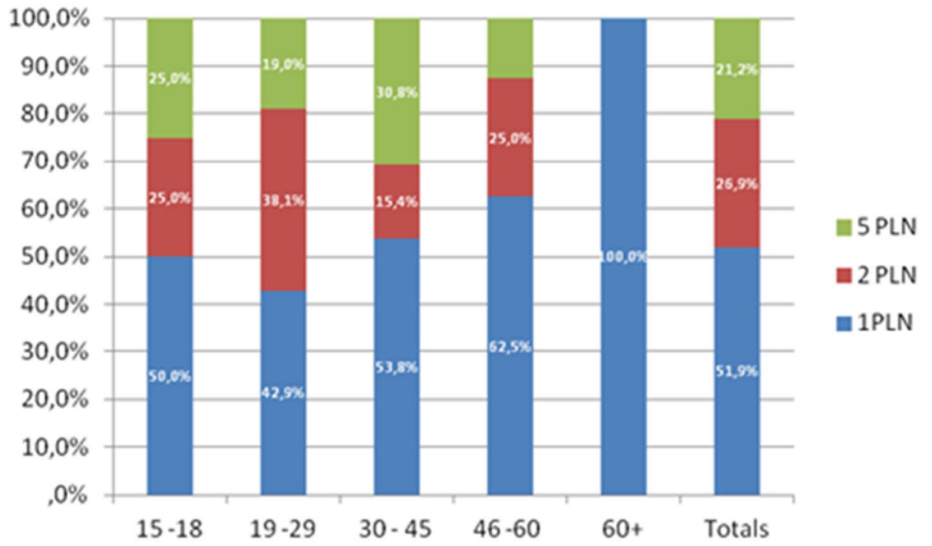


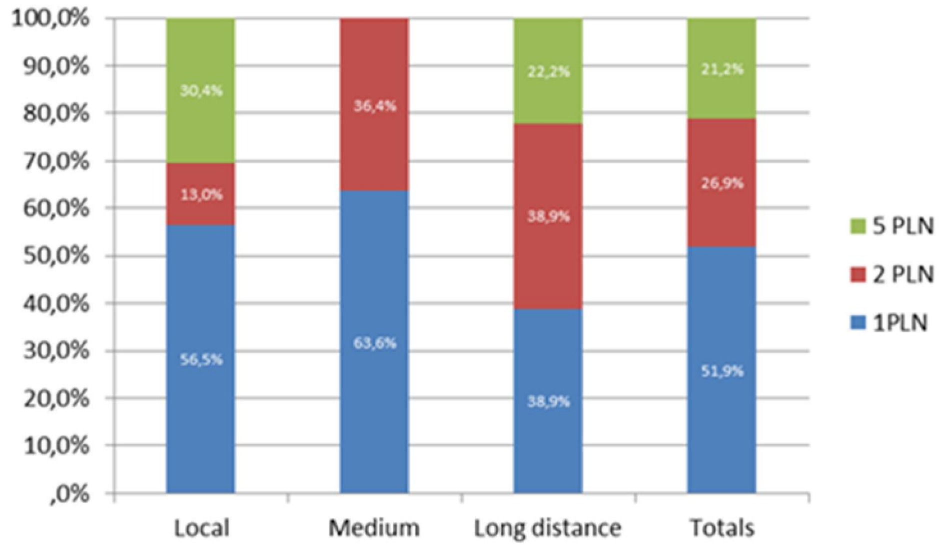
Figure 6-29 Willingness to pay for ticket purchasing via mobile phones / internet among different distance travellers

The next figures present which increase of ticket price can be acceptable by the users (among those who are willing to pay). The majority of respondents accepts amount of PLN 1 or 2 (ca. ú 0.25 ï 0.50), within the passenger group of above 60 years old that is 100% for PLN 1. 39&% of people between 19 and 45 years accept a price increase of price of PLN 2, while for other age segments the share is much lower. Taking segmentation by distance travelled, medium and long-distance trips should be considered since for local journeys the number of passengers willing to pay is minimal. For long-distance travellers the willingness to pay more than PLN 1 is much higher than for medium distance journeys (61% instead of 36%).



Source: Survey for CS 5

Figure 6-30 User acceptance of ticket price increase in exchange for introduction of ticket purchasing via mobile phones / internet among different age groups



Source: Survey for CS 5

Figure 6-31 User acceptance of ticket price increase in exchange for introduction of ticket purchasing via mobile phones / internet among different distance travellers

Technical feasibility

No significant technical barriers exist. The technology is available. Many applications are in use.

Organisational feasibility

There are no organisational problems.

Administrative burden

No significant administrative barriers exist.

Legal feasibility

There are no legal barriers.

User and public acceptance

Public acceptance, which in this case also equates to potential user acceptance is generally high. In total more than 50% transport users consider this solution as necessary, very useful or useful. It is somewhat surprising that by the majority of short distance travellers this is seen as useless, but it can be explained by the fact that they prefer either monthly tickets (these are mostly regular travellers) or find it easier to buy directly on-board. Highest acceptance levels are expressed by 19-45 year olds. It is a positive pattern which shows that customers which are most sought after from the marketing point of view - people who have some disposable income (those in employment) are more inclined to use electronic tickets. Taking distance travelled into consideration attractiveness of this solution increases with medium distance travellers (close to 70% total positive answers) and is even higher with long distance travellers (80% positive answers). Among long distance travellers there is significantly higher share of those finding the proposed solution necessary or very useful as compared to mid-distance customers, of which the majority are evaluating it as rather useful.

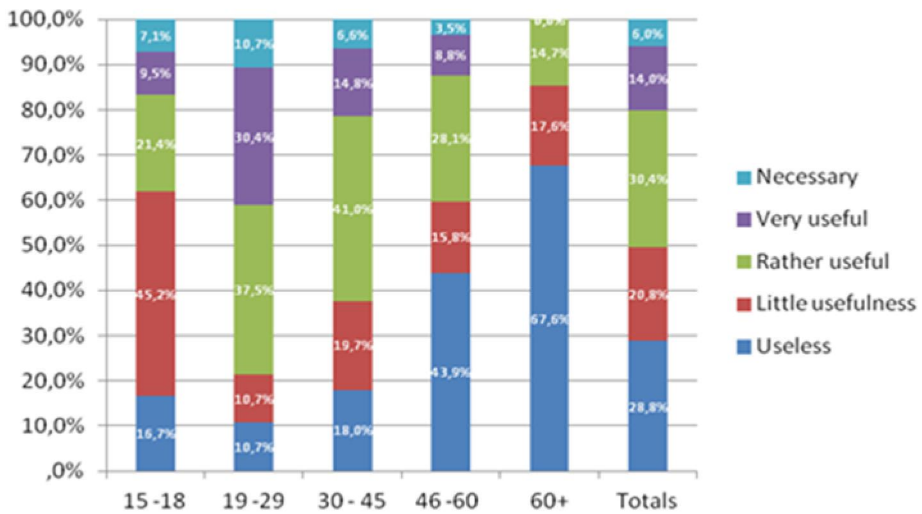


Figure 6-32 User acceptance of ticket purchasing via mobile phones / internet among different age groups

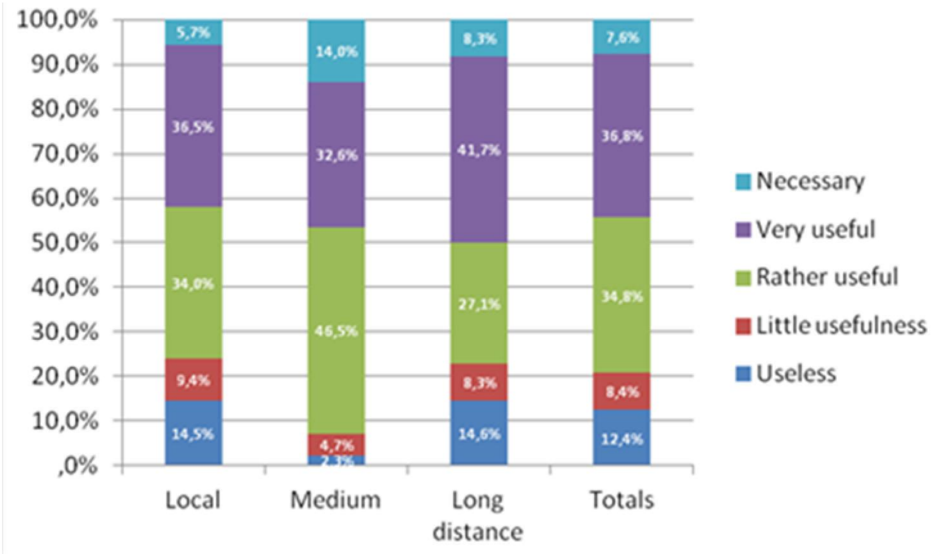


Figure 6-33 User acceptance of ticket purchasing via mobile phones / internet among different distance travellers

There are however certain additional considerations regarding rural areas. As it has been identified by the interviews conducted in focus groups, necessary access to the internet and skills can be a barrier especially for older users. For mobile phones the access in studied region is at a high level but some problems may cause limitations of mobile phones coverage in rural and forestry areas.

6.7.3 Assessment of Interest for Travellers

Door to door travel time

This can have slight impact on travel time. Tickets are purchased prior to the journey therefore additional time is not needed for buying ticket in a ticket booth. Also drivers are not burdened with ticket sales which reduces time spent at bus stops.

Door to door travel costs

There is no impact on travel cost.

Comfort and convenience

There is a significant impact on comfort and convenience. As it is proved by the results of focus groups interviews ticket availability 24h/day eliminates the problem of ticket sales for rural routes and outside the ticket booth opening hours. There can be also a situation when ticket purchased via electronic means guarantees place in bus while purchase on the way is only possible if there are still free places in the bus. But there also some disadvantages of ticket purchasing via mobile phone/internet in rural areas. Passengers must have access to the Internet and need to know how to operate it. For older passengers this is significant barrier as they are not familiar with this technology in everyday life. Some passengers are reluctant to purchase tickets via electronic means due to the fear of fraud. That is also especially symptomatic for rural areas that people are reluctant to purchase tickets via electronic means due to lack of confidence in validity of electronic ticket as opposed to ñmaterialò printed ticket. That has been noticed in focus group interview that customers are not confident that driver will accept electronic ticket presented for instance on mobile phone. On some remote rural areas there might be slow transfer of data or interruptions might occur ï in this case passenger might have paid for the ticket but might be unable to receive confirmation to the mobile phone. That is also general feature that there is significantly more burden on the passenger with electronic ticket (for instance with self-printing or downloading and checking correctness as opposed to transport operator issued paper ticket) and some passengers especially in rural remote areas do not have printer available at home to print ticket. Generally for ticket purchasing via mobile phones if the phone battery runs out, the mobile ticket is made unusable.

This service is most popular among younger users which could often use reduced fare (e.g. students). It was often the case that whole bus was reserved by those low fare passengers resulting in reduced operator income.

Safety

No impact on safety.

Security

No impact on personal security.

Accessibility for mobility impaired passengers

No significant impact.

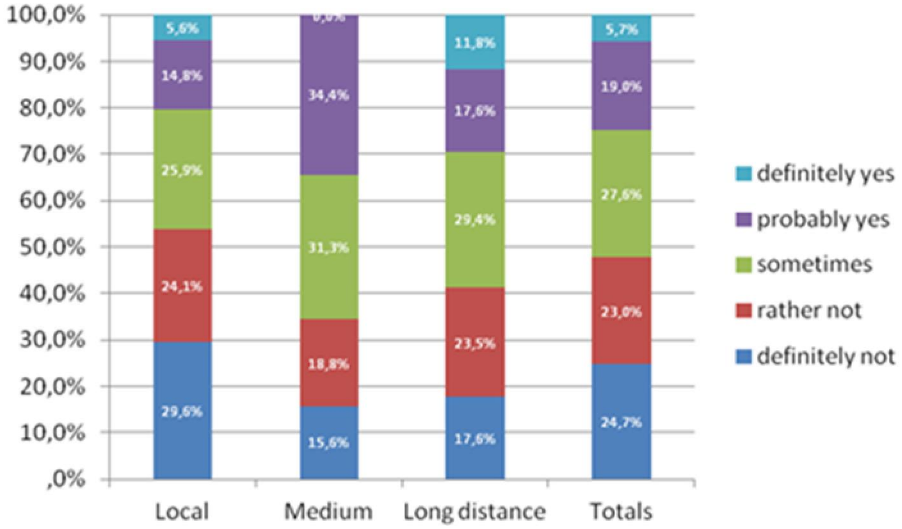
6.7.4 Assessment of Modal Change

Car usage

There is some potential impact on modal shift. In this area only serious competitor of bus transport is use of personal car (see below).

Bus and coach usage

The possible impact on modal shift could be significant. Although only 5.7% of those questioned declared the definite desire to change to bus use, as many as 19% declares likely change and further 27.6% occasional change to bus use. Taking distance travelled into consideration, for medium distance passengers the modal shift could be the highest since in the case of 30-45 years old passengers, who are most willing to switch to buses.



Source: Survey for CS 5

Figure 6-34 Modal shift in response to the introduction of ticket purchasing via mobile phones / internet among different distance travellers

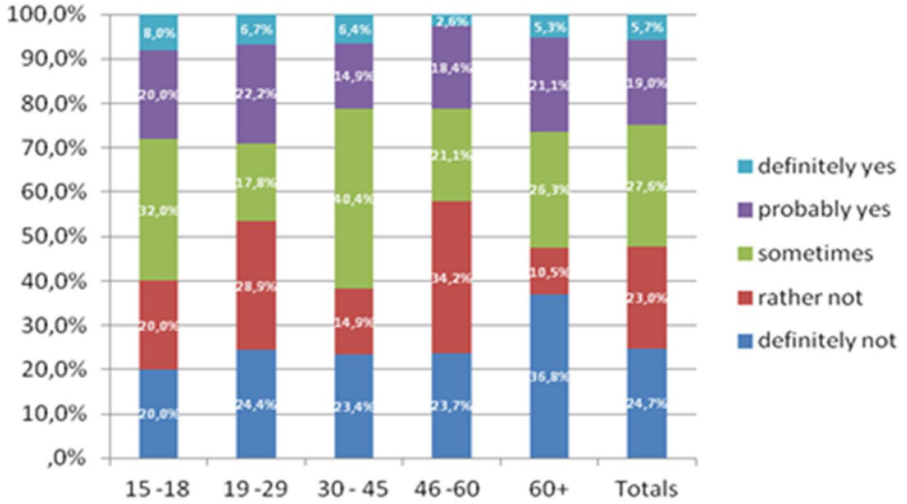


Figure 6-35 Modal shift in response to the introduction of ticket purchasing via mobile phones / internet among different age groups

Rail usage

No significant impact on rail usage due to very limited rail network in the area and sporadic service.

Ferry usage

Not applicable

Aeroplane usage

Not applicable

6.7.5 Assessment of Other Impacts

Increased mobility

It is not predicted that implementation of this solution will significantly change the mobility in rural areas. A slight increase can result from the stimulating mobility of young transport users who can feel more free to organise the travel with use of mobile phone.

Congestion

This is rural setting where congestion is not a significant factor in the transport system.

CO2 emissions

Small positive effect on CO_2 emissions due to the probable modal shift from cars.

Contribution to user pays principle

No contribution to User Pays principle

European economic progress

No impact.

Territorial cohesion

No impact.

6.7.6 Assessment against Main Criteria – Summary

Table 6-4 Ticket purchasing via mobile phones/internet - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	0
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	0
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	0
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

6.8 Assessment of the Solution - Real-time Information on Bus Position via Mobile Phone/Internet

6.8.1 Specific Description of the Solution

This solution allows passenger to track the position of the bus using internet based application on the computer or mobile phone.

6.8.2 Assessment of Applicability

Investment costs

This solution has not yet been implemented in the region. The cost could be estimated based on other similar projects. The system of real time information about bus position for internet application in Poznan will cost about ú 20 million.

Operation and maintenance costs

Similarly to the investment costs the annual operation and maintenance costs could in this case only be estimated based on other projects. The monthly cost for a vehicle varies depending on the scope of monitoring involved and the number of vehicles. The price offered by commercial providers of this ITC service range from ú 15 to ú 35 per vehicle. However in the case of public transport there is an option of building their own operations centre. Then the costs will depend on running costs of this operations centre, but in general (in case of big bus fleets) will be competitive against commercial outsourcing of this service.

Financial viability

Financial viability is low due to the fact that operator will be most likely forced to carry all costs. There is a strong reluctance to pay for ICT solutions among users. Potential users are very unlikely to pay for real time monitoring of vehicles. Only 18% of them have expressed willingness to pay and even then 62% of those no more than PLN 1 and further 33% no more than PLN 2.

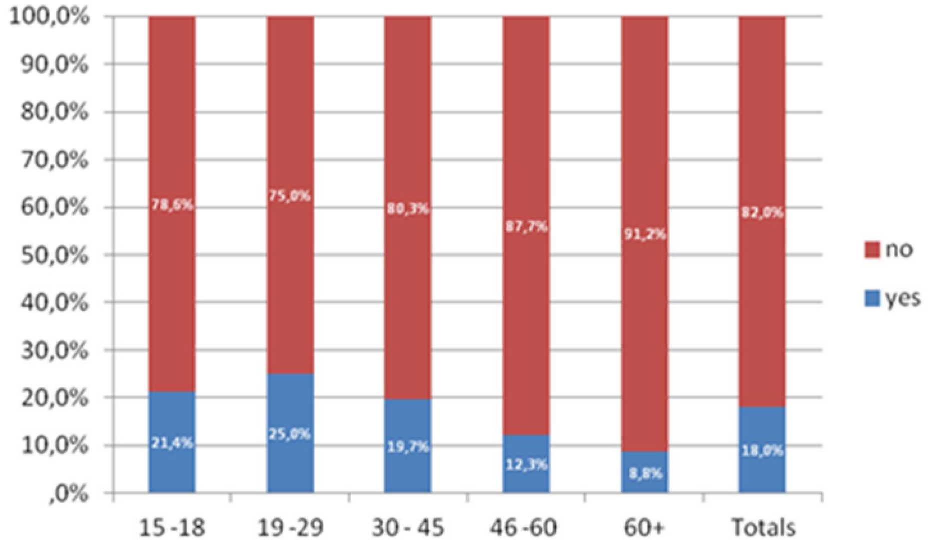


Figure 6-36 Willingness to pay for bus positioning services provided by mobile phone/internet among different age groups

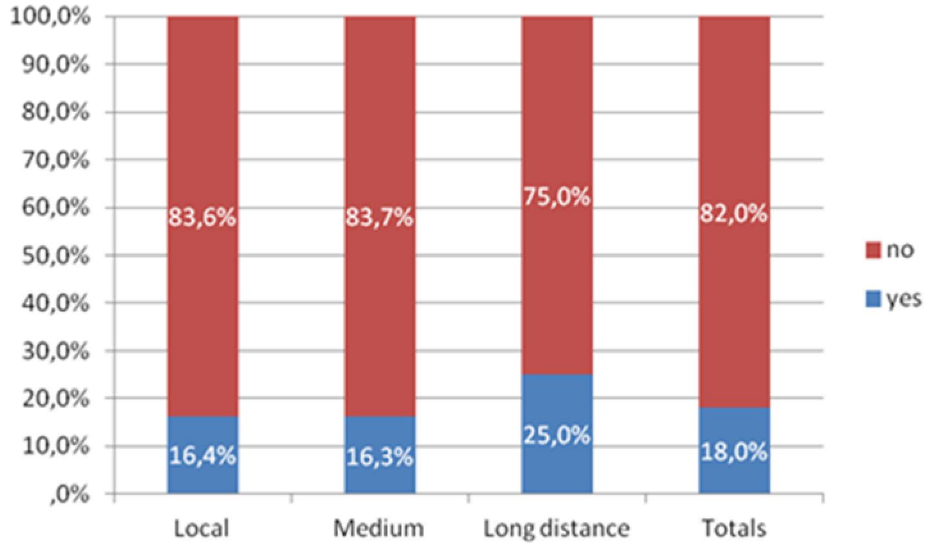


Figure 6-37 Willingness to pay for bus positioning services provided by mobile phone/internet among different distance passengers

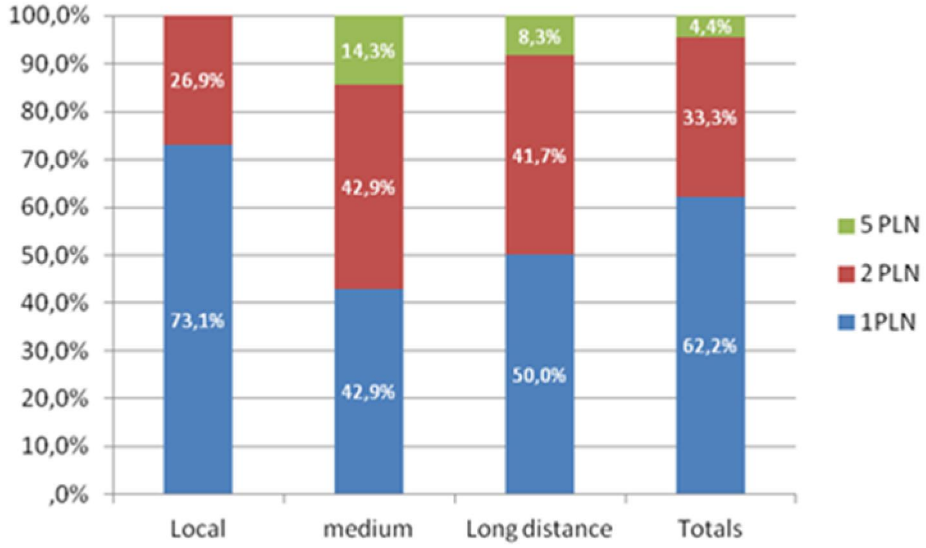


Figure 6-38 User acceptance of ticket price increase in exchange for introduction of bus positioning via mobile phone/internet among different distance passengers

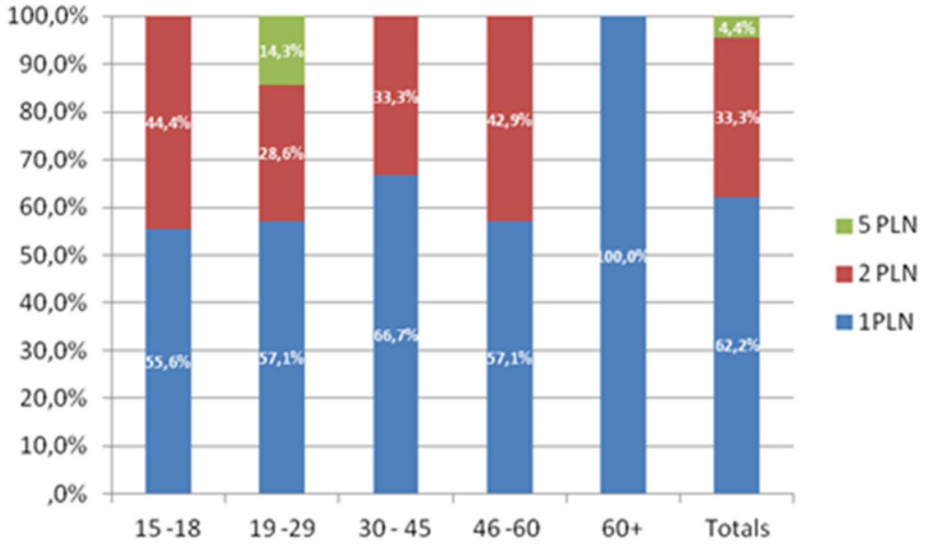


Figure 6-39 User acceptance of ticket price increase in exchange for introduction of bus positioning via mobile phone/internet among different age groups

Technical feasibility

There are no technical barriers. The technology exists and is currently based on GPS.

Organisational feasibility

There are no significant organisational barriers.

Administrative burden

No administrative barriers to implementation of this ICT are expected. Only in the case that a decision is made to build an in-house operation centre there will be staffing issues.

Legal feasibility

No legal barriers exist. This ICT could be implemented under current law.

User and public acceptance

This ICT is considered necessary by 5.2% of passengers, very useful by 21.6% and useful by 24%. 22.4 % of users do not believe in its potential while 26.8% reject it. The travel distance dimension is significant factor in shaping acceptance. The longer the distance the more importance is given to this tool. For short distance only 3.1% of passengers consider it necessary, while figures for medium and long routes are 7% and 10.4%. Similarly as very useful this tool is treated only by 17.6% of short distance travellers and by 27.9% of medium and 29.2% of long distance travellers. As useful it is accepted by 22.6% local users and 20.9% of medium range and 31.3% of long distance passengers.

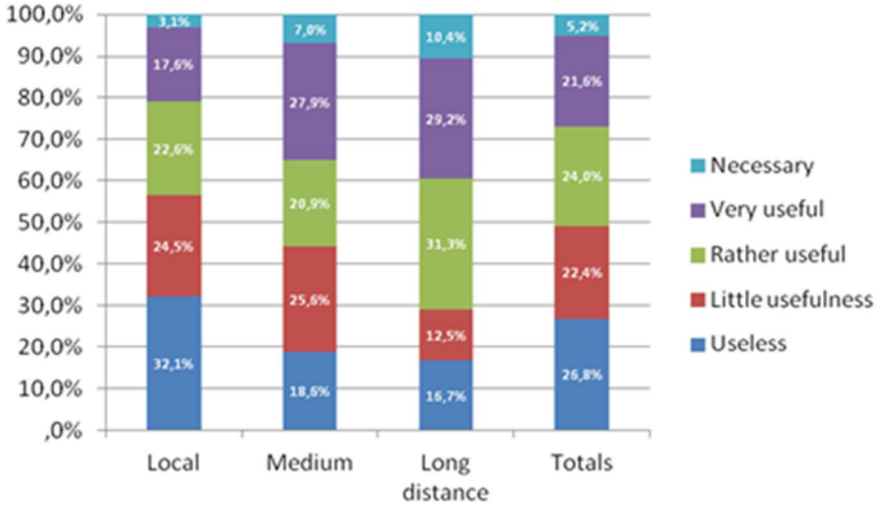


Figure 6-40 User acceptance of bus positioning service via mobile phone/internet among different distance passengers

Acceptance levels change with age almost proportionally. For the youngest users the highest acceptance is 7.1% (age group 15-18) and 10.7% (age group 19-29). For both groups a very useful valuation was given by correspondingly 21.4% and 41.1% and a useful assessment by 40.5% for the first group and 21.4% for the second. In other age groups results were as follow: for 30-45 range: necessary 4.9%, very useful 18%, useful 26.2%. For 46-60 years a necessary ranking was given by 1.8%, very useful by 12.3%, useful by 22.8%. The age group 60+ ranks this solution as very useful in only 11.8% of answers and useful in 5.9%. Within this group there is the strongest resistance to new technology based tools ï 61.8% of users reject it while for 20.6% it is of little use. Corresponding figures for 46-60 category are: 40.4% and 22.8%, and for 30-45 years respectively: 19.7% and 31.1%.

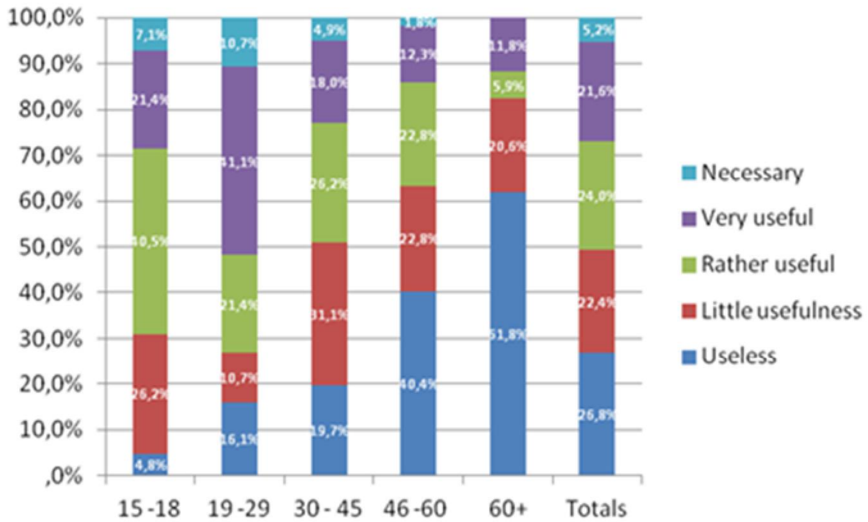


Figure 6-41 User acceptance of bus positioning service via mobile phone/internet among different age groups

6.8.3 Assessment of Interest for Travellers

Door to door travel time

Travel time could be significantly reduced allowing users to leave home for a bus stop at appropriate time. The savings (considering that this is rural setting) could be as high as 20 minutes accordingly to user opinions.

Door to door travel costs

No impact expected unless the operator decides to charge extra for this service (or make it paid service). In Poznan it costs PLN 0.5 per SMS.

Comfort and convenience

The solution has very high impact on user convenience. This ICT allows for exact information as to the location of a particular vehicle. This in turn allows saving time by elimination of waiting times at bus stops. It is most useful when a bus is delayed because it allows for direct time savings.

Safety

No direct impact on safety.

Security

Improves personal security due to reduced time of waiting at the bus stop which in rural areas could be in secluded locations.

Accessibility for mobility impaired passengers

No impact on mobility for impaired passengers.

6.8.4 Assessment of Modal Change

Car usage

Car usage is likely to be reduced (see below).

Bus and coach usage

Some modal shift effects could be expected from this solution. It could attract 1.7% current users of cars to the mode with further 11.5% probably shifting and 30.5% declaring occasional shift to bus. What is interesting it is that highest proportion of those who consider a shift are the youngest people. Considering that this question has been asked only to those who have access to the car and knowing that younger drivers are often more likely to use the car wherever possible this result goes against popular beliefs.

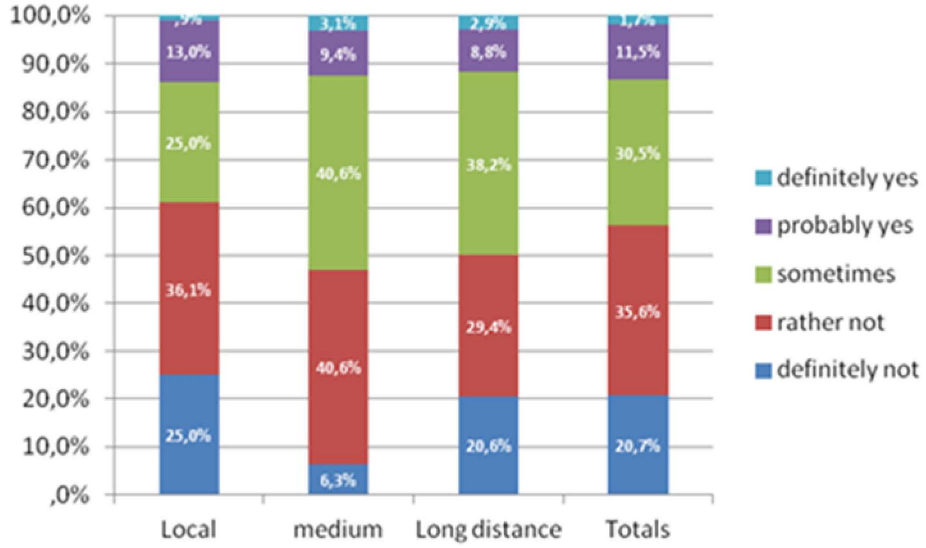


Figure 6-42 Modal shift in response to the introduction of bus positioning via mobile phone/internet among different distance passengers

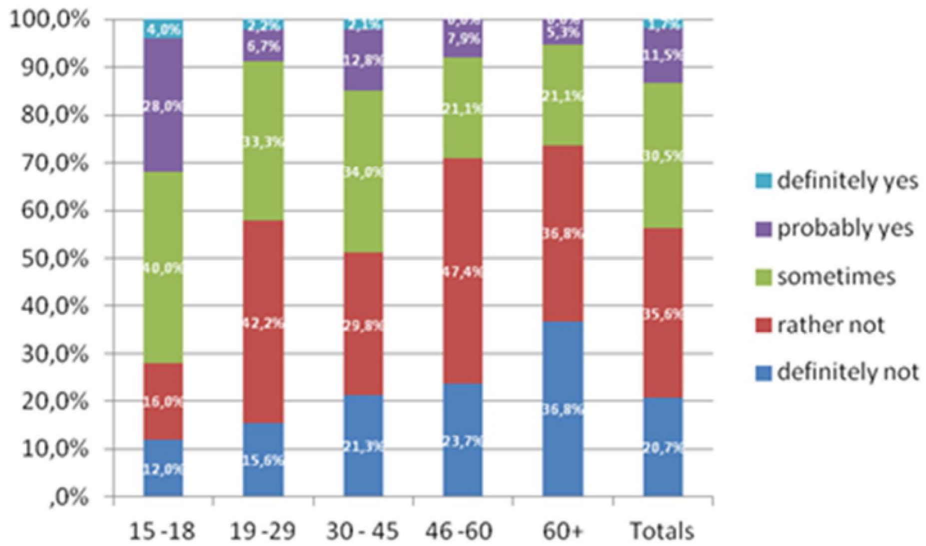


Figure 6-43 Modal shift in response to the introduction of bus positioning via mobile phone/internet among different age groups

Rail usage

No impact on rail usage due to very limited services offered by rail in the described area.

Ferry usage

Not applicable.

Aeroplane usage

Not applicable.

6.8.5 Assessment of Other Impacts

Increased mobility

No significant impact.

Congestion

No impact on congestion ï this is rural area with no congestion to start with.

CO2 emissions

There will be some reduction of CO2 emissions if the stated intentions for a modal shift are followed through.

Contribution to user pays principle

No impact.

European economic progress

No direct impact on economic growth in large scale.

Territorial cohesion

No significant impact.

6.8.6 Assessment against Main Criteria – Summary

Table 6-5 Real-time information on bus position via mobile phone/internet - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	ú
Financial viability	X
Technical feasibility	0
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	0
Comfort and convenience	✓
Safety	0
Security	✓
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	0
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

6.9 Assessment of the Solution - Demand Responsive Services – Possibility for Direct Pick-up/Delivery of Passengers in Response to Prior Request

6.9.1 Specific Description of the Solution

The demand responsive services are advanced, user-oriented forms of public transport characterised by flexible routing and scheduling of small/medium vehicles operating. The implementation of DRT (Demand Responsive Transport) services is highly facilitated by the development of new information and communication technologies, which enable a greater flexibility of operation. DRT is perceived as a very convenient solution especially in areas of low demand and density, e.g. rural areas, where conventional public transport is not efficient.

6.9.2 Assessment of Applicability

Investment costs

The costs for the implementation of DRT in this area have not been estimated. However, the DDS MobiRouter system suggests that a cost around £ 2000/vehicle (€ 2,400) for set up is appropriate. In a fleet of 30 vehicles this would equate to € 72,000 set up costs.

Operation and maintenance costs

The DDS MobiRouter system suggests that the operational overhead per annum is 20% of the set-up costs. In a fleet of 30 vehicles this would equate to an annual operating cost of € 14,400.

Financial viability

The willingness to pay for demand responsive services in the study area is very low, in fact lower than for any other solution. The tables below show the user willingness to pay among different user age groups and among different distance travellers. The highest acceptance (28.6%) is noted for users 19-25 years old. Then with the increasing age the willingness to pay decreases. Taking distance travelled as a differentiating factor for medium distance users willingness to pay is at the highest level of 26% (still low) while for the long-distance passengers only 15%. For long-distances trip planned in advance in particular, demand response services are not treated as an attractive solution.

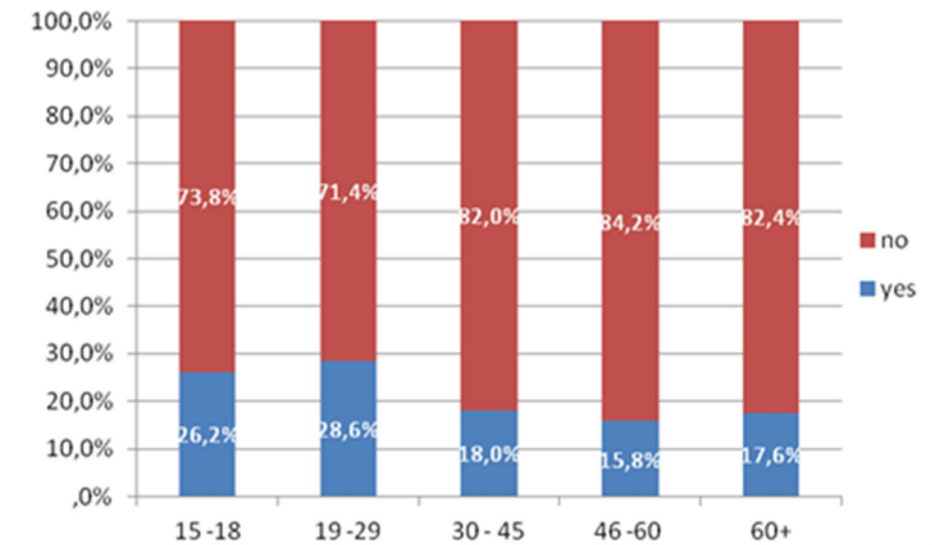


Figure 6-44 Willingness to pay for demand responsive services among different age groups

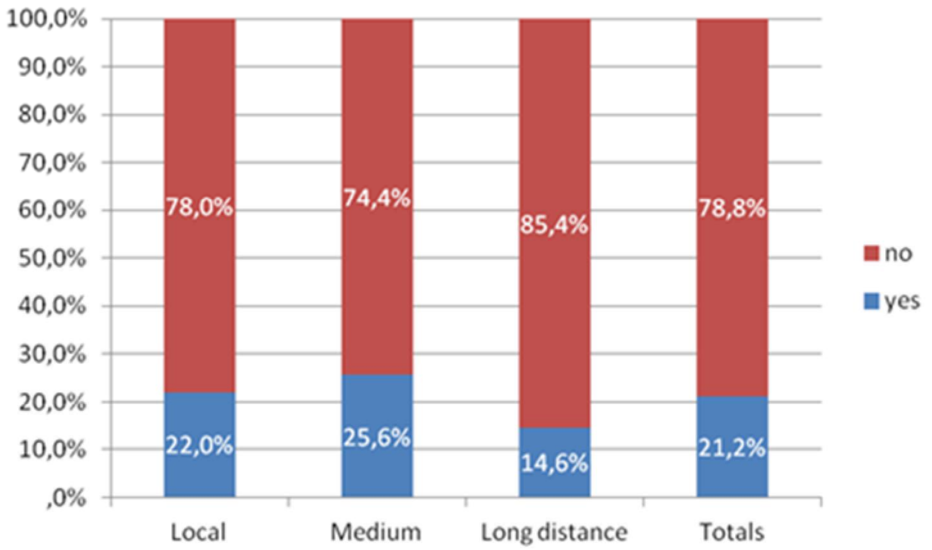


Figure 6-45 Willingness to pay for demand responsive services among different distance travellers

Among those willing to pay there is however better understanding that this type of improvement to transport service can cost additional money. In the case of the most important medium distance passengers, the willingness to pay PLN 5 or more is over 30% and 11% of the 46-60 year olds even being willing to pay more than PLN 10.

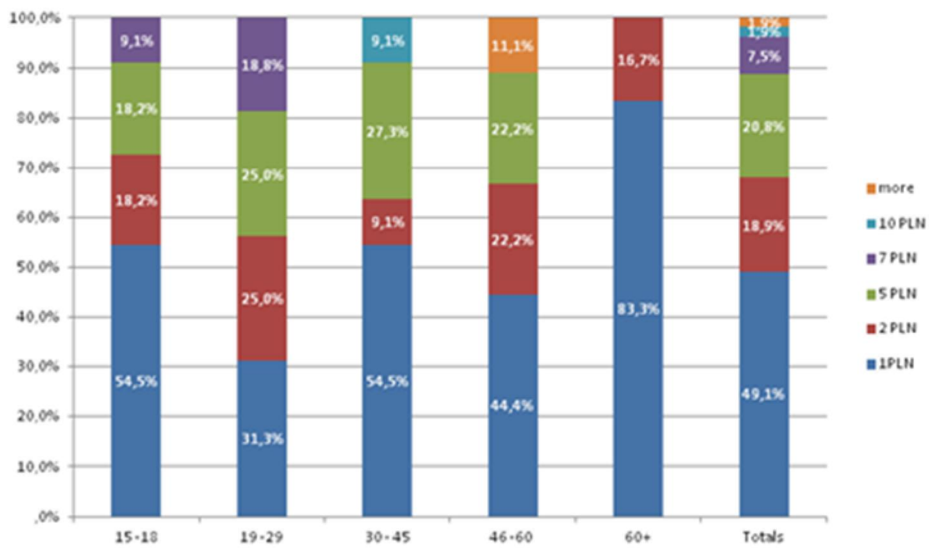


Figure 6-46 User acceptance of ticket price increase in exchange for demand responsive services among different age groups

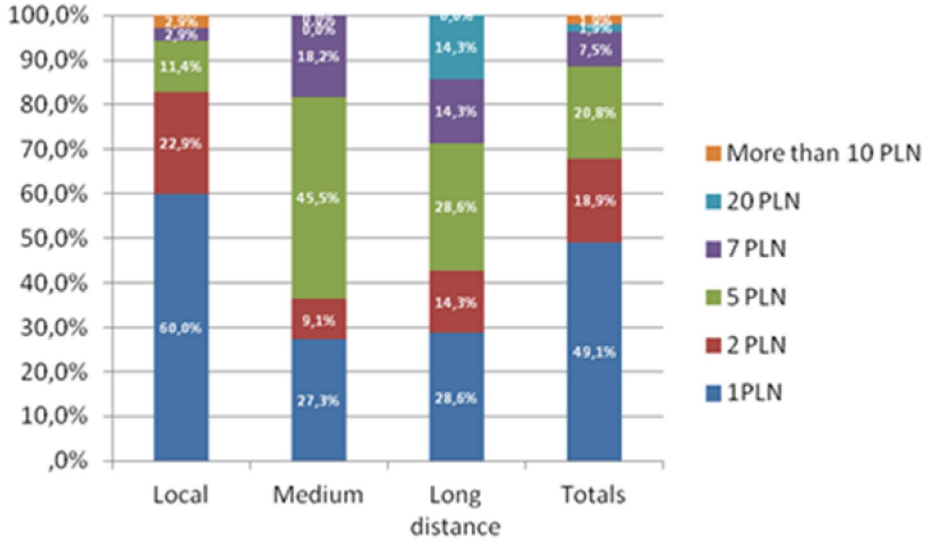


Figure 6-47 User acceptance of ticket price increase in exchange for demand responsive services among different distance travellers

Technical feasibility

No significant technical barriers exist in regard to equipment. The technology is available.

Organisational feasibility

With low organisational capabilities in the transport company it is expected that serious organisational problems can occur in the implementation of demand responsive services. Focus group interviews prove that both transport users and representatives of the transport operator are afraid of the possibility of very poor organisation of the service in the area. However, objectively there is no reason why it should not work here as well as in other rural areas in Europe.

Administrative burden

No significant administrative barriers exist.

Legal feasibility

There should not be any legal barriers.

User and public acceptance

In general the public is not particularly interested in demand responsive bus services with as many as 31.2% rejecting this solution completely and 30.4% being not interested. There are only 1.2% of enthusiasts towards this measure. The rejection of this service is almost equal among all distance groups (63% negative answers in local travellers group, 51% in medium distance travellers and 61% in long distance). What matters more there are few full supporters, with the majority of those accepting it doing so with some reluctance. This is surprising especially within local distance group as this group should benefit most from buses acting almost like taxis. This result could be only explained by lack of belief that this will work and fears that just in time direct delivery is not really plausible given the number of passengers that should be serviced during one bus course. Delays and the impossibility to practically attain perceived flexibility are expected. The opposition among different age groups shows that there are no users at all finding this solution necessary among people older than 30 years. In addition as many as 65% of 60+ find it useless as well as 37% of 46-60 year olds. Altogether rejection or little ï usefulness are attributed to the solution by respectively 52.4% 15-18 year olds, 48,2% 19-29 year olds and 62.3% of 20-45 year olds.

The conclusion for that subject from focus groups interviews is that price is believed to be too high to be really competitive against taxi services. Passengersô expectations are that price for a demand responsive bus service will be much higher than the regular fare, and this is a main reason for their rejection.

However, there is a core group of younger people who would find the service useful or even necessary (19% of 15-18 year olds and 11% of 19 to 29 year olds) and would potentially be very happy users.

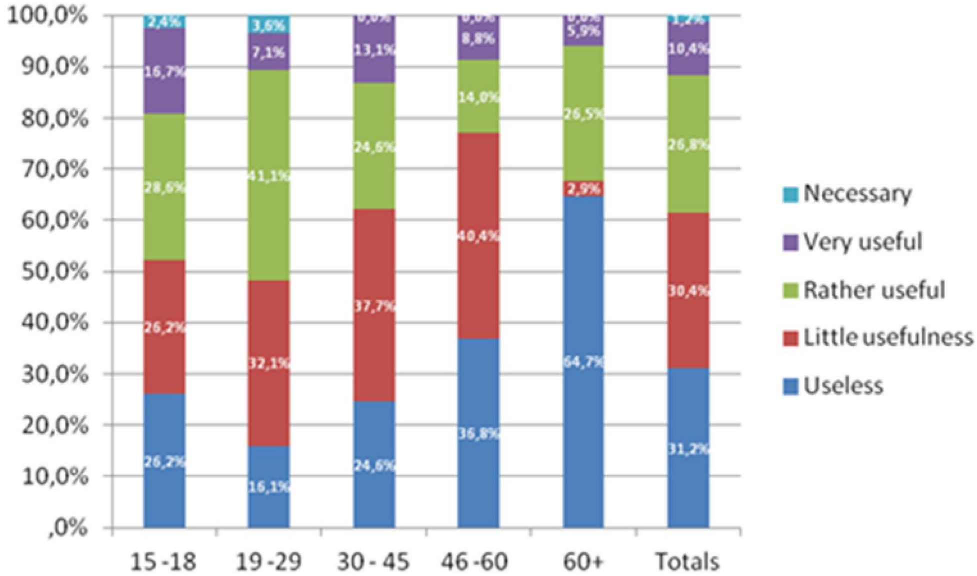


Figure 6-48 User acceptance of demand responsive services among different age groups

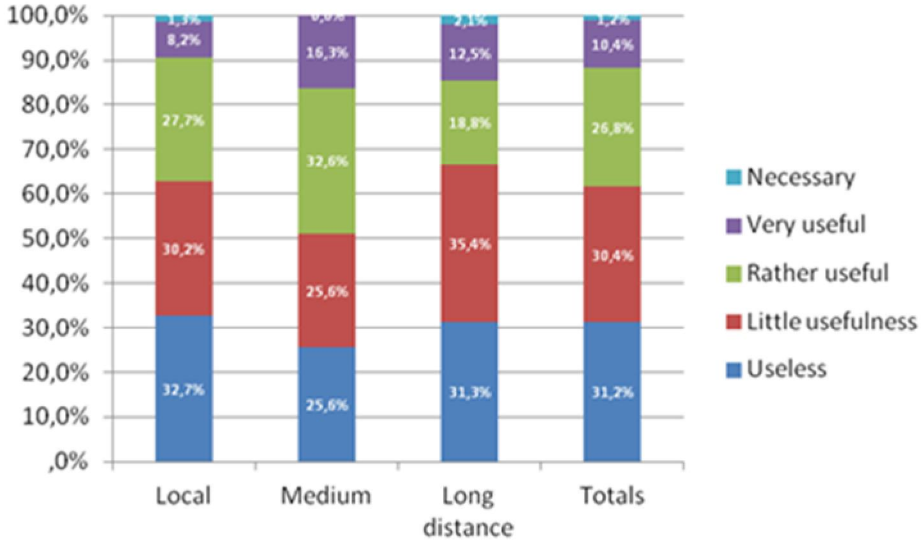


Figure 6-49 User acceptance of demand responsive services among different distance travellers

6.9.3 Assessment of Interest for Travellers

Door to door travel time

When efficiently organised and used DRT can have a positive impact on travel time especially in rural area where regular public transport offers very rare connections (sometimes only. 1 or 2 per day).

Door to door travel costs

Travel costs are expected to be higher with the use of demand responsive services.

Comfort and convenience

DRT can have a very positive impact on travel convenience though provision of the flexible transport services. They could also fill the gap during service break (e.g. night). In the studied rural area scheduled bus services are not operational during the night at all.

Safety

Does not have impact on safety.

Security

DRT increases personal security because it avoids waiting at often secluded bus stops.

Accessibility for mobility impaired passengers

DRT has a positive impact on access by people with reduced mobility because the service, being door to door, makes it unnecessary to walk to a bus stop.

6.9.4 Assessment of Modal Change

Car usage

The impact on car usage is lower than for any of the other solutions, but over 40% of those interviewed still say that they would at least leave their car at home and use DRT sometimes (see below).

Bus and coach usage

Probably the most disappointing result from the survey is that the solution which is as close to the comfort offered by private car as possible has the lowest effect of all solutions in terms of the stated intentions for a modal shift. Only 2.3% of respondents declare that they will definitely change to bus, and 8% declare a high probability of such a move. There are no significant differences among age group of travellers as well as the distance travelled (figures below). As mentioned before the two main reasons for these poor results are the fear of high prices and the fear that the system will not be run efficiently or not work at all.

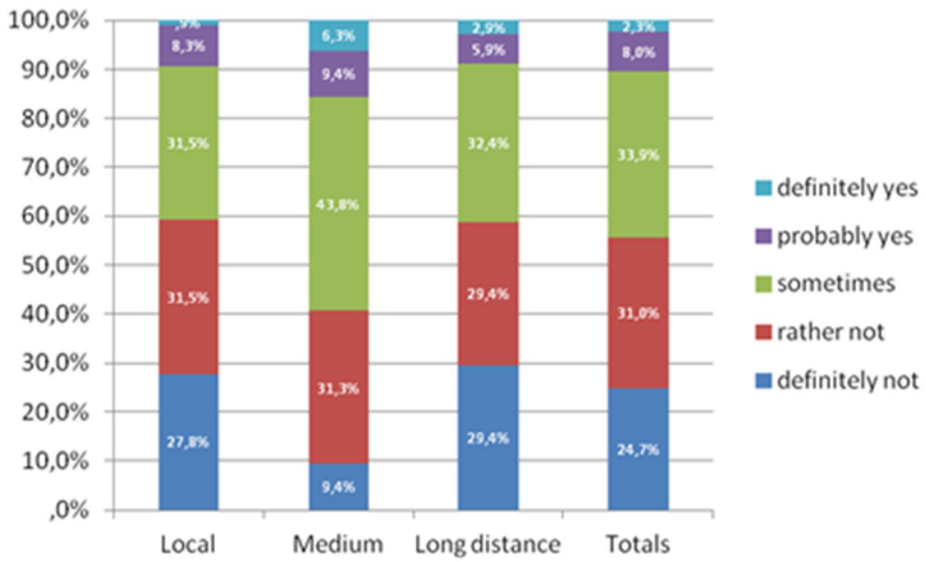


Figure 6-50 Modal shift in response to the introduction of demand responsive services among different distance travellers

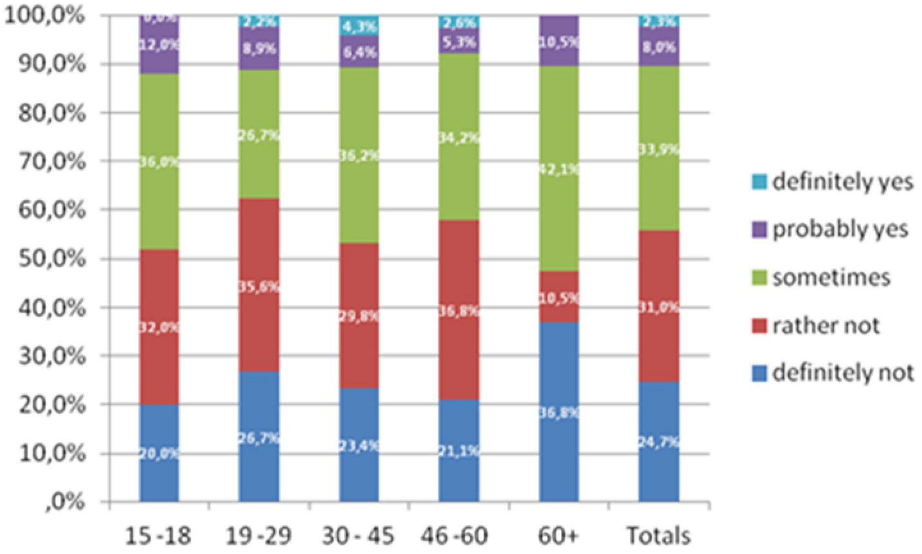


Figure 6-51 Modal shift in response to the introduction of demand responsive services among different age groups

Rail usage

No significant impact on rail usage due to very limited rail network in the area and sporadic service.

Ferry usage

Not applicable

Aeroplane usage

Not applicable

6.9.5 Assessment of Other Impacts

Increased mobility

No impact envisaged.

Congestion

This is rural setting where congestion is not significant factor in transport system.

CO2 emissions

The expected modal shift is low, and therefore the impact on emission will be low as well.

Contribution to user pays principle

DRT does not contribute to User Pays principle

European economic progress

No direct impact on economic progress.

Territorial cohesion

Well organised demand responsive transport services can improve territorial cohesion of the region. The areas which are not well connected (or not connected at all) can gain new potential for development.

6.9.6 Assessment against Main Criteria – Summary

Table 6-6 Demand-responsive services - Point score for the criteria

	Score
Investment costs	úú
Operation and maintenance costs	ú
Financial viability	XX
Technical feasibility	0
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	✓
Public acceptance	0
D2D travel time	✓
D2D travel costs	X
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	✓
Car usage	-
Bus and coach usage	+
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	0
CO2 emissions	(✓)
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	✓

7 CASE STUDY 6 - MOBILE APPLICATIONS FOR TAXI SERVICES

7.1 EXECUTIVE SUMMARY OF THE CASE STUDY

The last generation of what are commonly identified as ñtaxi appsò is a disruptive technology with the potential to promote co-modality because of its capacity to gather the supply of different forms of non-private car transport in the same virtual place. Such apps have evolved from simple taxi company directories to complex platforms able to provide access to a set of services ranging from taxis, to for-hire vehicles, to limousines, to car sharing.

This case study analyses the scope for taxi apps in four cities: two large US metropolitan cities, one east coast and one west coast, and two UK capital cities (London and Edinburgh). Operational data can be sensitive and has been anonymised. The development of taxi apps seems to be correlated with taxi market expansion. The penetration of taxi apps is greater in cities with long waiting times associated to traditional booking systems.

The taxi segment alone (not considering other services promoted by taxi apps) serves more than 5 million trips per year in the west coast US city and more than 14 million in the east coast city, with turnovers of $ 100 million and $ 250 million respectively. The west coast city has three main origins of taxi trips: residential locations (28%), evening entertainment venues (20%) and the airport (18%). Trips starting from residential locations are traditionally dominated by dispatched trips and so constitute the most promising market for taxi apps. Most of trips are engaged by phone booking (50%) and hailing (20%); apps are still a minority booking method used in only 10% of cases.

The diffusion of taxi apps is giving rise to different reactions among the stakeholders of the taxi industry. Dispatching companies and taxi drivers worry about the diversion of potential customers to different kinds of non-private cars. For dispatching companies apps are also competitors within the same market, while the opposition of the taxi drivers is mitigated by the opportunities generated by the apps both in terms of market expansion and of ñattraction of business to my carò. Additional matters of concerns for drivers are ñtop slicingò, reliability of payment methods, and privacy issues with the ñrate my driverò function. The strongest opposition comes from the market regulators, who still do not know how to deal with this almost unknown and quickly changing player. Responses include denial, ignoring and rejection of apps.

The main costs to develop and run a taxi app are generated by driver recruitment and retention, marketing within regulator communities, and challenges to its legality. Revenues are collected on both a per use basis (the common method when bookings are dispatched to drivers directly) or through subscriptions (frequent for apps forwarding bookings to dispatching companies). From the technical point of view the apps must be able supply at least three services: vehicle location, booking, and payment. No real barrier exists to the implementation of such functions. The most burdensome features to develop are the API links between the apps and existing software and information services. The apps are increasingly permeating the market. The strong competition that exists exposes badly planned, marketed or poorly operated apps to quick failures. The next generation of ñtaxi appsò will probably implement price comparison.

Apps cannot reduce door-to-door travel time but they can reduce the delay between booking and service delivery. Theoretically, passenger costs should be unaffected because taxis fares are generally regulated, though this is not always the case and differs in the short term, where fares remain consistent, and the longer term where the (perverse) effect of competition from higher priced app services pushes the regulated fare up as a result of income-based models used to determine taxi fare rates.

7.2 THE BACKGROUND OF THE CASE STUDY

7.2.1 Motivation for this Case Study

The case study reviews the development of mobile applications (apps) applied to the taxi industry, using the experience of two specific differing apps in peer cities. Apps have a demonstrable impact on the use of taxis and similar services also served through ôtaxiö apps, and have been suggested to increase the accessibility, ease of use and convenience of the taxi mode. The potential benefits of the ‘taxi app’ extend to the (various) passenger(s) both current and intending but should also be considered in terms of positive and negative impacts on the industry and on the regulating authorities. Taxi apps have developed rapidly, with next ‘generations’ and new functionality emerging approximately every 6 to 12 months. As a result rapid changes in their use and utility are commonplace. The technology will alter the methods by which consumers consider approach and use taxis, often positively. Some literature relates to the ‘taxi app’ as being disruptive.

‘Disruptive’ technologies, those that radically alter our relationship with a service, fundamentally change the nature of the product and affect the user, provider and controlling authority in equal, if opposing measures. This is true in the case of the taxi app, which has developed to date to include four notable generations of apps at the time of writing, discussed below. Each presents a new method of achieving a basic service relating to location, booking, reporting and payment. Much of the current development reflects the availability and capability of the hardware, with the ultimate function (the booking of a taxi to a specified location) actually achieving little more than the traditional phone call. It is the hardware, the ubiquitous nature of the smartphones, and the willingness of the user and intermediate app manufacturer that creates a new paradigm in accessing taxi services.

7.2.2 Main Features of the Taxi App

To explore in more detail, the "taxi app" should be more precisely split by function and location. Functions may differ by location given differences in legislation across cities and countries but more fundamentally reflecting differences in the market of each. App functionality may also be grouped into generations, broadly chronological distinctions of app and function, applied in this case study to allow for a consistency in discussion. It should be noted that not all apps will fall into single generations or categorisations.

Taxi App Generations are broadly defined as:

Generation 1: Taxi company directories, providing broad listings and telephone numbers.

Generation 2: Taxi company booking, using existing infrastructure, typically existing taxi dispatch company systems. Examples include TaxiMagic. The term ‘white label’ is also used in subsequent text to describe third party apps branded to a named taxi company.

Generation 3: Taxi / for-hire vehicle (FHV) direct booking, using bespoke infrastructure to bypass existing taxi dispatch systems, typically engaging drivers directly and using a single vehicle type on a single platform. Examples include Hailo, Get Taxi.

Generation 4: Taxi / FHV and car sharing, offering a wider range of vehicle type on a common platform. Examples include Uber (UberX / UberSUV / UberTaxi / UberBlack)

As each location may impact differently on a ‘global’ product, apps may differ slightly between locations, even where provided by the same manufacturer offering (ostensibly) the same services. This is well illustrated in the instance of Uber, a San Francisco-based provider, offering differing combinations of ‘products’ depending on the acceptance and prevailing legislation in each country.

Taxi app manufacturers can be local, but are dominated by large international (multinational) providers. Hailo originated in the London market and has built up a large global presence; Uber originates in San Francisco with a similar international reach. The market for small independent apps has been significantly reduced (removed) by the presence of international, well-funded, suppliers. Geographical limitations are more likely to follow the spatial boundaries defined in licensing regulation, then any specific geographical distinction. This said, the economic viability of an app will reflect on the extent to which market demand and available supply can support the operation of an app.

Economic potential

There are four fundamental economic relationships in the provision taxi apps. These can be defined as:

- Passenger (as an app customer) to app, that is the willingness of a customer to accept any booking charge or additional costs associated with using an app-based taxi booking. This is a particular issue in terms of ‘surge pricing’, a policy adopted by some app providers and resulting in higher pricing at points of greater demand. This issue has created a disagreement in some jurisdictions between app supplier and licensing authority.

- Driver (as an app customer) to app, where the majority of app suppliers consider drivers, as well as their passengers, to be their customers. This differs in apps to dispatch, see below. Not only does an app need to appeal to its passengers, it needs to provide a sufficiently broad range of taxi suppliers. Each is independent, in that taxi apps require sufficient supply to be attractive to users in the long run, and sufficient passengers to be attractive to drivers. Absence of either reduces relevance and may exclude the app in some markets.
- Dispatch company (as an app customer) to app. The third relationship relates to agreements between app manufacturers and dispatch companies. A number of current and previous generation apps have provided services via existing dispatch companies. This business model has benefit in that it disrupts existing relationships less than apps serving drivers directly, but suffers from the additional costs of directing bookings through an historic framework, and may have little impact on service improvement given that supply structures remain the same. Dispatch companies that operate their own apps fit into this category.
- App to regulator. The most complex relationship exists between the app supplier and the regulator (if any relationship exists at all). Taxi regulations date from the 17th century, with many current rules unable to provide the flexibility appropriate to app use. Many cities have chosen to oppose the widespread introduction of some apps where existing rules are infringed by their presence.

Predominant form of settlement

The majority of taxi apps that have proven successful, that is those that have survived and grown, exist in larger urban areas. Urban density, population size, and regulatory structure, are all fundamental elements in the success (or otherwise) of taxi apps. Smaller communities, which may benefit from the presence of apps, are less likely to offer a sufficiently attractive market for global players, and may be served by second tier app providers, white label providers, or not at all.

Accessibility on the European level

Taxi apps are fundamentally accessible to individuals with unrestricted access to smartphones, and widespread in most countries. The vast majority of cities with a significant taxi provision are also well served with taxi apps. This case study identifies two different, taxi apps with widespread market take and provide comparisons between days, and various other market players in each area.

7.2.3 Stakeholders Involved

There are four key stakeholder groups, initially defined above and including:

- Current and potential taxi passengers;
- Taxi drivers and drivers of taxi-like vehicles;
- Taxi dispatch companies;
- Taxi regulators, or bodies concerned with regulations of transportation including taxis.

Taxi regulators can include cities and districts, with a common distinction between bodies which regulate traditional taxis (Hackney carriages), and regulators of private hire, for-hire or limousine-type vehicles.

7.2.4 Methodology of the Case Study

The case study methodology seeks to:

- Collect and analyse data regarding the use of apps;
- Examine current reporting related to the use of apps;
- Interview taxi providers.

Operational data must be considered on a consistent and like-for-like basis. The comparison between operations with taxi app use, and those without is further complicated by the nature of the relationship between the provider and the service delivery. Potential complications relate to double counting trips, where a trip has been identified through a taxi app to dispatch, and within the dispatched trip log itself. Commercial sensitivities are also significant in that both app providers and regulators can face significant legal challenges by jurisdiction, and have been reluctant to provide an open data source for this reason.

7.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

7.3.1 General Description of the Case Study

The case study concentrates on the use of two taxi apps, óHailoô a third generation taxi app accepting and submitting bookings from intending passengers directly to driver; and óUberô a third and fourth generation app (as dictated by location) accepting and submitting bookings to a variety of vehicle types including taxis, limousines and car share services.

The fundamental product of each of these apps is the delivery of personal pre-arranged transport from door to door. Each offers a service that avoids the traditional radio booking methods that have been established for many decades. The nature of this relationship is complex and may be described in some locations as being at the edge of licensed control. Existing licensed operators and many regulators also highlight some discrepancies in the charging and fare mechanisms that may be described as working against the intent of some licensing controls, though this differs between the two apps, as discussed below.

7.3.2 Data Used

Three primary datasets are applied in addition to a review of local operating conditions, also described below.

- Operational data obtained from a variety of sources setting out operational data from peer cities, detailed below;
- Taxi user data obtained through street surveys undertaken in the period May ï July 2013;
- Operator perception data obtained through focus group and structured interview in the same period.

Operating patterns

Operating patterns are determined using primary data obtained from taxi dispatch services, including app-based companies, and reported data provided via city administrations. Operational data is included as available from US cities. Table 7-1 sets out the market structure in each in terms of taxis, able to operate from street and when dispatched, for-hire vehicles, able to operate when dispatched alone and limousines, being dispatched and subject to additional operating criteria such as additional fares.

Table 7-1 City licensing structure and primary apps

City	Taxis	FHV / PHV	Limousines	Apps (Primary)
West Coast USA	Yes, defined numbers	Yes, defined numbers	Yes, open market, controlled by state	Uber UberX Taxi Magic óWhite Labelô Lyft Car2Go
East Coast USA	Yes, defined numbers	No	Yes, open market, controlled by Commonwealth	Uber Uber Taxi Uber SUV óWhite Labelô Hailo
London, UK	Yes, open numbers, subject to ókknowledgeô	Yes, open market	No	Hailo Get Taxi óWhite Labelô Uber LUX Uber X
Edinburgh, UK	Yes, defined numbers	Yes, open market	No	óWhite Labelô

Source: Interview surveys

Operating Patterns: West Coast USA

Taxis (UK hackney carriages) are permitted to operate on street to pick up on demand (hailing), at taxi stands (ranking) and in response to pre-arranged (dispatched) bookings. For-hire vehicles (UK private hire vehicles ï PHV) are able to pick up dispatched trips only. This is the primary distinction that separates taxis from other taxi-like vehicles. The city is also served by limousines (which operate in a similar manner to for-hire services) which are controlled by the state authorities, rather than the city authorities, and do not need to comply with many of the conditions required of taxis, such as determined fare and vehicle type requirements.

The separation of taxis and limousines, particularly that differing authorities retain responsibility (city and state) is repeated in other US cities, and provides a disconnect (conflict) between the operating and enforcement power on the street. A similar situation may be argued in European authorities where differences between the licensing requirements placed on taxis and PHVs differ, as is the case in the majority of UK cities operating a two-tier system.

A limitation is placed on the numbers of taxis that may be licensed (license cap), calculated against measurable service standards. A cap is also in place on the numbers of FHVs that may operate in the city. Limousines, which are controlled by the state, are not limited in number. Car share services (such as those provided by Lyft and UberX) are not required to be licensed as vehicles for hire.

Very recent developments, occurring since the initial data collection include the development of an additional operating category, a transportation network company (TNC), proposed to allow for a distinct licensing category specific to some forms of app-based vehicle operation. The category has been developed but not yet implemented.

Operating Patterns: East Coast USA

This operates as a ósingle tierô city, defined as permitting taxis alone, without additional categories licensed by the city. As in the case of the west coast city, this city is also served by limousine services licensed by the state (rather than the city itself), allowing for two effective vehicle types.

A limitation is placed on the number of taxis that may be licensed. No other taxi-like vehicles are licensed by the city. Limousines, which are controlled by the state, are not limited in number. Car share services are not required to be licensed as vehicles for hire.

Operating Patterns: London, UK

Transport for London (TfL) licenses a dual structure of taxis and for-hire vehicles (private hire / minicabs). Taxi licensing is undertaken by TfL, and includes relationships with individual London boroughs for the provision of taxi card services.

There are no license number limitations on taxis, nor on PHVs. Taxi drivers are required to undertake the ‘knowledge’ test, a local operating entry test. The ‘knowledge’ places a barrier on entry through strict quality control. There are no car-sharing services of the types seen in the USA, at the time of writing.

Operating patterns: Edinburgh, UK

The City of Edinburgh Council licenses a dual system of taxis and private hire cars (PHVs). Taxi licensing is undertaken by the city, under the auspices of the Civic Government (Scotland) Act 1982. There are no car-sharing services in Edinburgh of the type seen in the USA, at the time of writing.

7.3.3 Data Collection and Analysis

Data analysis of the peer cities provides an overview of the extent of taxi use, and can be further analysed in respect of days of travel, as discussed in subsequent sections. Data provided is set out in a common format to indicate the total number of trips made (size of market) and average trip distance. The combination of these two data points is used to indicate the potential revenue stream, and compare it to uptake in apps. Operational data has been provided by US cities only, see Table 7-2.

Table 7-2 Operational and income statistics

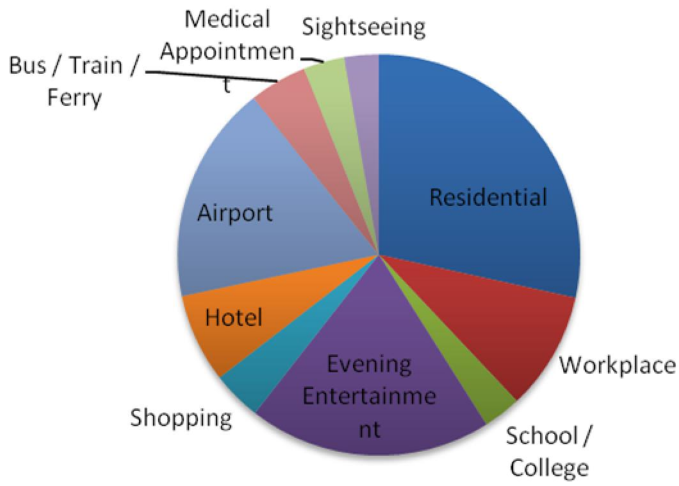
Metric	West Coast US	East Coast US
Total revenue trips (all taxis)	5,219,433	14,642,369
Total estimated fare revenue	$ 97,123,147	$ 252,165,357
Average Trip Distance	5.9 miles	
Average Trip Fare		$ 15.00

Source: Licensing Authorities

Data collection and analysis – public demand data

Public demand data has been collected in one jurisdiction – the west coast US city. A pedestrian survey was undertaken in the period between March and June 2013, using both pedestrian intercept and on-line survey techniques. A total of 800 survey responses were received addressing attitudes toward taxi use and taxi apps. The jurisdiction is the most mature of the case study locations having both the greatest number of apps and the widest range of app generations.

The survey identified the primary origins from which taxi trips were made in the city, as shown in Figure 7-1. Choice of engagement method, of which apps are one, differ, with centrally located trip origins tending to be better served by cruising and ranking markets than residential locations, which are more likely to be served by dispatched taxis.



Source: Pedestrian Intercept Surveys

Figure 7-1 Taxi trip origins, west coast public survey

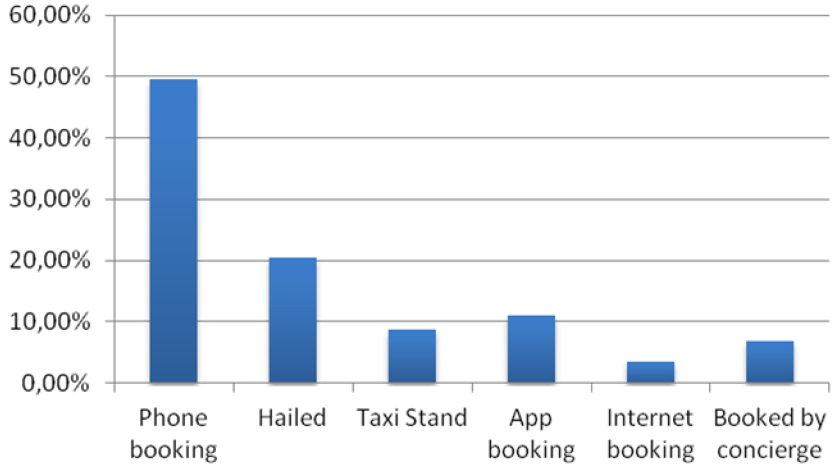
This split mirrors that in many other cities, with a majority of trips originating from residential locations (28%), closely followed by evening entertainment (20%) and trips from the airport (18%). The three groups offer distinct and different market opportunities for apps, reflecting the differences in the traditional methods by which such trips may be engaged.

Residential trips, particularly those from more distant suburbs, tend to be dominated by dispatched trips. This reflects the relative low densities of demand, which limit the commercial opportunity for cruising taxis.

City centre trips, including those from entertainment venues, are more likely to be served by the taxi cruising and ranking markets. Concentrations of demand into defined areas, or at defined stances, are better suited to cruising and ranking taxis, reducing, but not excluding, opportunities for apps. Cities with lower levels of traditional taxi service appear to attract greater interest in app-based services even in traditional cruising markets and in particular demographic groups (particularly affluent communities).

Airport-originating trips reflect a further pattern of engagement based on defined stances permitted by the airport. The relationships include an additional market participant, the airports, most of which derive economic gain in the form of airport concessions ï competitively tendered óright to operateô The resulting relationship encourages the use of airport-controlled taxis using airport designated facilities, and is often supported by a significant additional charge levied on non-airport taxis and/or distant (less convenient) pick up points to reinforce the economic arrangement between airport and concession holder. The opportunities for app-based engagement are limited in the case of airport originating trips.

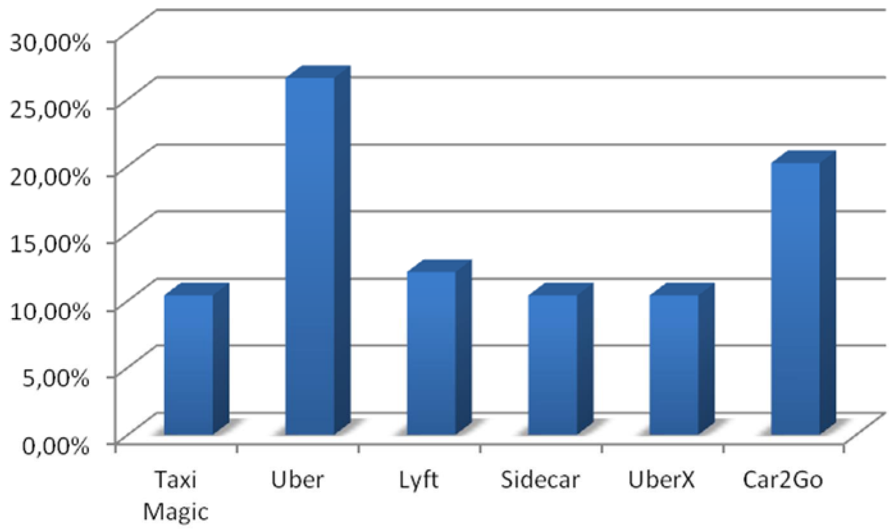
The total number of trips by each engagement method was calculated on the basis of reported choices. Taxi app use represents a minority method, with a majority of trips (49%) being engaged by phone and 20% by hailing. This is shown in Figure 7-2.



Source: Pedestrian Intercept Surveys

Figure 7-2 Taxi engagement method

Distinctions should also be made between the services provided by the differing apps because each differs slightly and may appeal to differing market segments. Six apps were reported as used in the west coast case study city at the time of the survey (see Figure 7-3), of which the traditional taxi market was served by one alone (Taxi Magic). The distinction relates to categories of vehicles for hire, which include licensed taxis and licensed for-hire vehicles (FHVs) ï served by Taxi Magic and both controlled by the city, and limousines, served by Uber and controlled by the state. A distinction exists in licensing law between taxis, the only vehicle category legally entitled to cruise and rank and FHVs (and limousines) restricted to pre-arranged dispatched trips. Additional vehicle categories ï car sharing (Lyft, Sidecar and UberX) and short term lease (Car2Go) are also popular in the city.



Source: Pedestrian Intercept Surveys

Figure 7-3 'Taxi' Apps reported market share

Distinction between vehicle types and the categorisation of apps is significant and most notable in that the presence of the app has an impact on the validity or enforceability of particular restrictions by vehicle type. The most popular app (Uber) does not work with taxis in the west coast city but rather makes bookings direct to limousine vehicles, not controlled by the city. Costs to passengers using Uber are higher than those charged in traditional taxis, and this suggests that the Uber app has a higher income clientele than the traditional taxi user.

A fourth (and fifth) vehicle category ï car share and short term lease ï are effectively unlicensed vehicles, the app providing booking to individuals offering lifts. Three apps serve the shared market

(Lyft, Sidecar and UberX), the latter (Uber) offering access through a common platform with its other vehicle categories. It is notable that the reported use of apps for taxi and taxi-like vehicles is dominated by vehicles that are not taxis.

Data Collection and Analysis – Operator and Driver response to apps

A series of operator and driver interviews were undertaken across all four jurisdictions. A single structured interview form was used for each, allowing comments on given subjects. The response of the taxi and private hire market to the development of mobile applications has been mixed, with a degree of hostility both on the part of the operator and the regulator, and with a more muted response on the part of drivers. Apps remain a new, and unknown, market participant. The extent of functionalities available has developed rapidly, and continues to develop, creating an apparent ongoing concern or a 'war of attrition', also expressed as a market take on the part of incoming app providers. The nature of the market take is more complex than at first apparent, as many app providers suggest there is growth and new market segments emerging, rather than a loss of market. The logic expressed by apps suggests that previously suppressed demand has resulted in market growth, while many existing operators see the incursion as directly reducing their own market share. It is likely that the truth lies somewhere between these extremes, and will differ by location.

It is likely that app-based engagements are taking some market share from existing companies, both competitively (within the market) and, through attrition, to parallel markets. The latter element (attrition) should be of some concern to the regulator as it relates to the diversion of taxi trips to non-taxi vehicles, some of which may not be licensed or fall within the control of the city served. Moreover, as frequently presented by the traditional taxi trade, some incoming apps have chosen to avoid or ignore licensed maximum fares charging above the levels that may be afforded by some or permitted in licensing law.

Taxi driver communities may also be less opposed than at first appears. The apps do, after all, offer new business, both diverting business to the driver with app and growing the market. Logic suggests a desire not just to be tied to one app but to many, as each brings with it the opportunity for work. A reported downside lies in the methods and reliability of payment systems, though criticism was also levelled against reliability and speed of payment of credit card receipts to the driver by traditional taxi companies.

Additional concerns emerge as some apps take a percentage of income ('top slice'), and some insist that credit cards are accepted without additional fee, creating further problems for the regulators in their role as arbiter of fares and fees. This is a greater problem in a market in which some app providers choose to ignore the fare structures dictated by the regulator.

Some drivers have also raised concerns over privacy as regards "rate my driver" type functionality. It is observed that the popularity of apps as a method of getting a taxi is very much dependent on local factors such as market supply, fare setting methods and alternative public transport provision. It appears that a critical mass is required on both the demand and supply sides in order that both driver and consumer have confidence in the app delivering on its promises.

Regulator, and industry operator communities appear to be the most opposed and with reason, in that the app has changed the market, or will change the market, in a way not envisaged at the time of legislation. Few city codes and regulations fully accommodate the operation of apps, with many app developers seeking to sidestep traditional definitions to expand their market share. Responses include denial of apps, ignoring of apps, and rejection, including the current view of rogue status in some countries. The extent of reaction and legislation brought in will impact on the development and opportunity offered. Significant and basic questions need be considered that return to the fundamentals of regulation - in whose interest is the regulation and what is its outcome.

7.4 Assessment of the Solution – Mobile Applications for Taxi Services

7.4.1 Taxi Apps and Taxi Like Apps

The development of the taxi app has had a significant impact on the markets into which it has been introduced. The case study does not seek to identify one brand of app as being preferable to any other, but does identify both the circumstances in which apps have been successful. As the technologies develop, so do the opportunities beyond the known traditional use of the taxi. A distinction can be made between opportunities that enhance current use, the opportunity to verify route and meter rate for the passenger, and those which allow for innovation or new uses, new markets and new income streams to the taxi operator. These are addressed below in terms of market application, traveller and operator impacts, as well as impacts on the regulator.

7.4.2 Assessment of Applicability

The development (application) of apps within the taxi industry should be recognised as a significant development with the potential to provide a step change in service delivery. This disruptive technology should not, however, be achieved at the cost of passenger protection – the most common justification for regulation. The relationship between apps and the taxi regulating community has a mixed record, with many instances of clear hostility on both sides. Market uncertainty has resulted, with a significant split between small (and very small) app manufacturers, of which there are many hundreds, who may be unaware of the legal implications of the regulations applied to the taxi market, and much larger players, of which there are around a dozen. Large players, those with traction, best typified by multi-national companies are both aware of and willing to invest significant time and costs in defending a legal position as well as aggressively marketing their product.

Investment costs

A significant difference is noted between the cost of development of taxi apps, and their successful application. The online presence, the development of the app itself, is a minor part of the total costs experienced by many of the successful taxi apps seen in the market to date. Those achieving "traction" within the market tend to reflect large investments in driver recruitment and retention, and marketing within the regulator communities. Typical costs elements for the most successful apps can include:

- App technology, the cost all writing software code,
- Linking software [Application Programming Interface – API] appropriate for combination with existing booking systems,
- Driver recruitment and retention, including agreement with existing companies
- Marketing to passengers, including prolonged campaigns and price subvention
- Marketing to regulators, including cost of required changes to basic software and any additional licensing requirements, such as the need to become a licensed broker, where the app provider registers and operates in the same way as other dispatch companies (e.g. Toronto)
- Proactive legal advice, such as providing legal counsel supporting "e-hailing" (e.g. New York)
- Reactive legal defence, typically defending action by existing taxi operators, taxi regulators and national competition and safety authorities (e.g. Colorado State Public Utilities Commission)

Most successful taxi apps have significant investment capital. In operation two methods of income generation exist in the long term, charging for use on a per use basis, or charging a subscription. The latter, subscription charges, is most common in apps to dispatch. The former, a pay-per-use charging scheme, has been applied in the majority of apps to driver. In this model the driver is responsible for a flat rate [or percentage] fee for each booking made through the app. This would typically be subtracted from the payment made by passenger by credit card to the app provider, and forward it from the provider to the driver.

No jurisdiction allows for additional charges to be raised against the passenger, though some apps do make these charges, and may be considered to be doing so illegally. The most common method for additional passenger charging relates to the requirement for compulsory "gratuities", which can be as high as 20% of the fare. Some systems go further in defining charges without reference to an existing defined tariff, which can diverge significantly.

Operation and maintenance costs

The automated nature of the app, and its distribution via smartphone to both passenger and driver makes the operating costs of the booking function relatively low. A typical cost charged to the driver might equate $1 (ú 0.80) of which a fraction is required to cover electronic operation. The remaining cost is being associated with legal defence and marketing, discussed below.

Financial viability

The financial viability of an app is more closely associated with challenges to its legality, than to the technical operating costs it incurs. The viability of an app may rest upon the extent to which its legality is challenged, rather than the basic costs of operation itself. Marketing, including that of alternative suppliers will impact on the viability of an individual app, and this may be illustrated by the extension of the Uber ớamilyô to include a wide range of similar service types, based on the same fundamental platform.

Costs and benefit ratios have not been made available to the case study, but may be estimated in relation to the total numbers of trips and market take. In the case of the West Coast case study, an estimated ớaxiô market of 5,219,433 journeys is identified. App use represents 11% of the total market though the latter app figure is slightly misleading as only 1 app (Taxi Magic) is actually applied to booking taxis. The remaining apps book alternative vehicle types, including the Uber App (Uber Black and Uber SUV) which book vehicles registered as Limousines (and thus are additional to the stated taxi use figure rather than included within it).

A rough estimate of use based on public stated behaviour (public intercept survey), and city provided taxi market figures suggests that the most widely used app (Uber Black) may receive around 150,000 bookings per annum (based on 2012 figures), the value of which is also obscured by the fact that Uber charges are not consistent with published taxi fares.

However, even without knowing precise figures, it seems safe to assume that at least the big players in the market, who are constantly increasing the number of towns in which they operate, are profitable businesses.

Technical feasibility

The basic technical requirements for a successful application relates to 3 elements: the ability to locate a passenger vehicle, the ability to transmit and receive booking, and the ability to facilitate payment. Each of these elements are well catered for by current app-based technologies. Additional features may develop from the set of information, such as the upward feed of information from app to regulator, itself a desirable requirement, and potential inclusion of metrics already collected by companies, but not currently shared, such as driver ratings.

Relatively few genuine technical barriers exist to the operation of taxi apps. The most significant challenge relates to the development of API links between apps and existing software. An API link relates to the accessing of one system, i.e. the app, to a third party system, i.e. the dispatch system of an existing operation. This challenge exists in relation to apps to dispatch, and is not applicable in apps to driver. Revised smartphone operating systems will also create a challenge, but this is typical of this range of technologies.

Organisational feasibility

The complexity within which the taxi app operates depends on the structure of the industry in each location and the choice of operating model adopted by the app itself. Apps to dispatch tend to operate with greater organisational complexities than those to driver. Regulation may also have a role in enhancing complexities, particularly in locations where regulations prohibit many of the operating practices adopted by some apps.

Administrative burden

Legal feasibility Significant challenges exist in relation to each location. As the regulations pertaining to taxi control differ significantly between locations a single universal review on legality is not possible. Key issues relate to the actual definitions as to what an app achieves. This is sensitive around the discussion whether the app replaces a pre-booked trip i.e. is an electronic pre-booking; or replaces a street hail i.e. is an electronic hail ï e-hail. Further location specific issues will relate to the licensing requirements for booking offices and physical location requirements for these defined.

There are further, less contentious, issues specific to the handling of personal information, storage and wider application. These relate to the extent to which an individual may be tracked using a system. Most systems use anonymous information that reduces the legal impacts of such application, with many systems automatically deleting data in a defined period. The external uses of information tend to require that further applications are not personally identifiable, though some service level and personal service contracts may justify proportionate use of personal information following currently appropriate data privacy approaches.

In none of the case study locations have app manufacturers volunteered operational statistics, even in locations where such statistics are required of the traditional taxi industry. Indeed the choice to avoid the use of licensed taxis by some of the apps reduces the administrative burden further by side stepping many of the regulations that have been developed to enhance passenger safety and industry security. While these regulations may not be perfect in their structure, most dating from legislation enacted prior to the development of apps, their purpose remains significant. Avoidance of current regulation creates significant conflict between traditional operators, and some of the incoming suppliers, including accusations of unfair competition, and passenger exploitation. The resulting challenge, defence, and counterchallenge may harm the industry, and limit the impact of app development.

User acceptance

In spite of the hostility by driver and dispatchers not using the apps, those who do actually use it clearly appreciate the competitive edge that they are getting.

Public acceptance

The taxi app offers a significant benefit to passengers and reducing booking times and achieving better service levels. This can be achieved where Taxi apps have large market penetration, in terms of access to drivers, whether directly or via dispatch companies; and operate legally. User acceptance is generally high, and notably skewed towards the higher income uses. The app, regardless of legality, or indeed of actual provider, is widely accepted amongst ớapp awareô individuals. Patterns of use have expanded demonstrably within a very short period time, and so little prospect of diminishing. This said, user acceptance will continue to the point of diminishing returns. Badly planned, marketed or poorly operating apps are likely to fail quickly. Key to this is the delivery of services is advertised. Apps which are unable to maintain driver involvement are likely to decline. Moreover, the rapid development of price comparison sites in other areas of transportation may transfer readily to the taxi app market, reducing customer loyalty, and moving bookings from first tier taxi apps, two second tier óprice comparison taxi appsô, apps which seek lowest price across a range of primary taxi booking services.

7.4.3 Assessment of Interest for Travellers

Door to door travel time

Door-to-door travel times are not impacted by the expansion of taxi apps. However, a critical time reduction may be achieved in the delay between initial booking and service delivery. Where this is included in a calculation of global journey time, i.e. time need from booking to drop off, journey time may actually reduce, and this is a better indicator of service level than purely basing the analysis on door to door travel time. Locations with extended traditional taxi waiting times are likely to be more impacted by the introduction taxi apps, than locations with good levels of taxi service. The city of Edinburgh, with the lowest market penetration by apps, offers the highest level of traditional taxi booking service, measured on booking time delay, while the city with the longest delays (West Coast) displays the greatest market penetration taxi and taxi like apps.

Door to door travel costs

The taxi app should, in theory, not impact on the door to door travel costs experienced by passengers. Taxi fares are regulated and defined in each of the locations included in the case study. That said, however, perverse incentives appear to apply, suggesting value associated with apps and beyond those seen in the traditional taxi industry. Both Hailo and Uber allow booking fees to be assessed and charged in many instances. Moreover the Uber app can charge significantly greater amounts then would be experienced in using a taxi, even a taxi booked through an alternative taxi app. The result can be a large increase in the trip cost experienced by users of some apps, while many users will (at the same time) express a preference for this (higher-priced) service, the economic explanation for which relates purely to service level benefits (quality) rather than cost.

Comfort and convenience

Additional value arises from certainty of booking, a major issue in two of the case study locations. Both Hailo and Uber include visual mapping of vehicle location, reducing uncertainty. Further ôvehicle qualityôbenefits may also be attributed to vehicle types where limousines, rather than taxis, are used, but this is not the case in all apps.

Safety

There are no direct safety impacts, although a significant number of operators have highlighted the potential reduction or invalidity of insurance in some apps, insofar as there is no guarantee provided by established companies. Moreover, illegally constituted bookings would negate any existing (standing) insurance.

Security

There is no impact on security.

Accessibility for mobility impaired passengers

Opportunities exist for further development of taxi apps to include access to wheelchair vehicles, and accessible vehicles scheduling. This area of development has not been fully explored to date.

7.4.4 Assessment of Modal Change

The development of taxi apps has, in all of the case study locations, resulted in additional taxi use. This use has expanded the market for taxis, and is visible in operation data from the US cities.

Table 7-3 West Coast taxi use statistics 2009 - 2012

YEAR	2009 - 2010	2010 - 2011	2011 – 2012
Total (Odometer) Miles	53,124,959	57,248,383	68,096,348

Source: Licensing Authority

Modal diversion is less defined, whether trips represent totally new travel, or diversion from other modes, though public demand in city centre locations has increased above the rate of economic development, suggesting that trips would have been made by an alternative mode in preceding years.

Car usage

Where taxis replace a trip by private car, they are still trips just made simply by a different type of car, and where they replace a public transport trip they increasing car (taxi) usage.

Bus and coach usage

It is to be expected that the increase in taxi use will also imply a reduction in the use of public transport.

Rail usage
No impact expected.

Ferry usage

No impact.

Aeroplane usage
No impact.

7.4.5 Assessment of Other Impacts

To the member of the public seeking reliability, speed and service, the taxi app is already a reality. While the consumer may play between alternatives, taking a look at the latest or the most visible app, the need to make taxi bookings and the need to have a reliable service will be understood far more than the legal framework under which such services are provided. This reflects the nature of the internet-type mentality underlying both the apps and their users. Here then the critical and most important point is that the taxi user will continue to seek better, more reliable services, and better value. The taxi appears, and is likely, to contribute to better services and possibly to a small extent also increasing mobility.

Increased mobility

As stated above, it is expected that the apps contribute to a small increase in mobility.

Congestion

Where the taxi app increases mobility or leads to the replacement of a public transport trip in a major city, it will also contribute to congestion. In comparison to the use of a private car, a taxi trips avoids a car driving around in search of a parking space, but on the other side they increase mileage through the trips to the next taxi station in the best place and driving around waiting for a hail, as in many cities, in the worst case.

CO2 emissions

To the same extent as taxis add to congestion, they also add to CO2 emissions. A further aggravating factor is that they are usually large cars with much higher fuel consumption and emissions than the average private car ï in Europe even more so than in the US.

Contribution to user pays principle

No impact.

European economic progress

No impact.

Territorial cohesion

No impact.

7.4.6 Assessment against Main Criteria – Summary

Table 7-4 Mobile Applications for Taxi Services - Point score for the criteria

	Score
Investment costs	úúú
Operation and maintenance costs	€
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	(X)
Administrative burden	X
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	(X)
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	*0*
Bus and coach usage	*0*
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	X
CO2 emissions	X
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

8 CASE STUDY 7 - BIKE SHARING IN VIENNA AND THE SURROUNDING REGION

8.1 EXECUTIVE SUMMARY OF THE CASE STUDY

In this case study, the focus is on the bike sharing schemes in Vienna and the surrounding region and contains the findings from the telephone surveys carried out to capture the user responses to two different bike-sharing schemes in and around Vienna. The survey was carried out in Vienna (Citytbike) and Lower Austria (nextbike). The survey conducted in Lower Austria was designed to be comparable to a survey conducted in 2009, while the survey in Vienna is the first of its kind.

In Vienna, the survey revealed that more than 90% of the people know about the bike-sharing scheme, which has been served for Vienna for 10 years. Among the respondents in Vienna, 28% of the people have already used it.

In Lower Austria, a comparison of the surveys revealed there is an increase of bicycle use in general (including non-shared bicycle) used while awareness of the bike sharing scheme that is employed in the region is low. Meanwhile, awareness of the Viennese bike-sharing scheme has become higher over the four year period in Lower Austria. 17% of the respondents in Lower Austria have used the shared bike in Lower Austria at least once and 10% of the respondents have used the shared bicycle in Vienna.

Despite the high level of awareness, the majority of the respondents have not yet used the bike sharing schemes. The most typical reason for not using shared bike is the ownership of the own bicycle.

In both federal states, people tend to get to know about the bike-sharing on the street ï either at the renting stations or by seeing shared bikes in use. This strongly implies that visibility of the bike-sharing schemes on the street is an important factor to make the people aware of it and it may take long time with a number of stations and bicycles until a certain proportion of the people know the system.

Regarding ICT-relevant aspects asked in the survey, roughly two-thirds of the respondents recognise themselves as familiar with the ICT-based user interface in general. Bike-sharing being focused, about half of the respondents, especially ones in Lower Austria, still wish to pay in cash, while booking/identification system employing card or phone-based system appears to be accepted widely. The development with ICTs including reporting broken bikes via app, short-term (last-minutes) reservation as well as information about bicycle condition over the smartphone app are evaluated as useful development, while identification methods other than phone-based or card-based methods tend to be evaluated less useful.

8.2 THE BACKGROUND OF THE CASE STUDY

8.2.1 Motivation for this Case Study

The city of Vienna and also the federal state of Lower Austria has a long tradition of bike sharing schemes. Bikes are shared in cities, small towns and rural touristic regions. In 2009, Vienna University of Technology (TUW) conducted a telephone survey among the population in Lower Austria about their knowledge and usage of bike sharing. In spring 2013, four years after the first survey, the same survey was carried out again for comparison. The telephone survey was expanded to the city of Vienna to enable comparison between urban and rural areas.

8.2.2 General Description of the Region

The survey was carried out to the population in two federal states (*Länder*) in the eastern part of Austria, namely Lower Austria and Vienna. In Lower Austria, the survey was carried out in 20 municipalities which are the same as the survey in 2009. These municipalities were chosen to cover various types of municipalities such as rural, regional centre or suburb, and to represent the population in the *Land*.

With the coverage in Vienna, thus the survey covers various geographic areas from rural to urban areas. The data from Lower Austria can be interpreted rather from rural area and regional centre while the data from Vienna can be interpreted from urban residents.

Table 8-1 Characteristics of municipalities where CS7 survey was carried out

Federal State	Size Group	City / Town	Characteristics	Inhabitants
Lower Austria	<2,500	Allentsteig	Rural	2,163
		Bad Schönau	Rural	725
		Großmugl	Rural	1,519
		Hennersdorf	Suburb	1,418
		Lengenfeld	Rural	1,373
		Rabenstein	Rural	2,412
		Wallsee	Rural	2,049
	2,500-4,999	Kirchschlag in der Buckligen Welt	Rural	2,960
		Mannersdorf am Leithagebirge	Rural	3,731
		Neuhofen a. d. Ybbs	Rural	2,534
		Raabs an der Thaya	Rural	3,114
		Wieselburg	Rural	3,489
	5,000-9,999	Breitenfurt	Rural	5,323
		Horn	Regional Centre	6,411
		Laa a. d. Thaya	Regional Centre	6,137
		Melk	Regional Centre	5,222
		Wolkersdorf	Regional Centre	6,191
	10,000-19,999	Stockerau	Regional Centre	14,452
		Waidhofen a. d. Ybbs	Regional Centre	11,662
	>20,000	Mödling	Suburb	20,405
Lower Austria Total (including municipalities not surveyed)				1,545,804
Vienna		Wien	Urban	1,550,123

Source: STATISTIK Austria (2003)[12], STATISTIK Austria (2002)[13]

8.2.3 Stakeholders Involved

The main stakeholders involved in this case study are the municipality, the federal state, the system provider/operator and the users. Usually a contract between the municipality and/or the federal state and the operator of a bike sharing scheme is agreed. The model of infrastructure and operation for which a single operator is responsible is the most common contract type. Organisational problems can occur when the infrastructure owner and the operator differ from each other while this is not observed in the case study regions.

In both systems, the public sector supports it. In Vienna, there is a support by the City of Vienna in order to complement public transport (as an eco-friendly efficient mean of transport). In Lower Austria, nextbike is supported by the *Land* to promote cycling and co-modality in the federal state. Furthermore, for both systems, municipalities often support in terms of the public land to implement the renting stations.

The systemꞌs operator is providing the infrastructure, the stations and the bikes. Additionally the distribution, maintenance and reparation of bikes have to be undertaken by the system operator. The users of the bike-sharing scheme rent the bikes against a fee, and they have to return the bike to any bike-sharing station within the scheme.

12 STATISTIK Austria (2003). VOLKSZÄHLUNG Hauptergebnisse I ï Niederösterreich.
13 STATISTIK Austria (2002). VOLKSZÄHLUNG Hauptergebnisse I ï Österreich.

8.2.4 Methodology of the Case Study

The case study was carried out with a telephone survey and the data analysis. As Vienna University of Technology carried out a survey in 2009 in Lower Austria, a comparative analysis is also carried out for Lower Austria.

The telephone survey was carried out as a CATI (computer-aided telephone interview) by a professional telephone survey institution headquartered in Vienna. The survey was carried out in April and May 2013. The survey was carried out from the institution's CATI-studio in Vienna and it was not outsourced to another country. The questionnaire was prepared by TUW in line with the 2009 survey[14] so that comparability is guaranteed, while wording and order was slightly amended with an opinion from an expert at the survey institution.

8.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

8.3.1 General Description of the Case Study

This case study deals with the bike sharing schemes in Vienna and Lower Austria, namely Citybike and nextbike respectively.

"Citytbike" in Vienna is one of the first ICT-based urban bike sharing systems. It is in service since 2003. It serves with 92 stations within about 2km from the city centre at the time of the survey, whilst further expansion is planned to the outer districts. According to the operator, constant increase of users is observed in the recent years. Users check out and in at the fixed stations with a touch-panel terminal with payment function employing debit and credit cards. It is operated by an advertisement company Gewista (a subsidiary of JCDecaux) and it is the predecessor of well-known Vélo'v in Lyon and Vélib' in Paris, which employs the same concept. Nowadays, independently-developed smartphone apps to locate the stations with information about empty lacks and available bicycles add further ICT-relevant measures.

"nextbike" is a different bike sharing scheme employed the Federal States of Lower Austria and Burgenland which are close to Vienna. Differently from Citytbike, nextbike is installed in the outside of the City of Vienna and also in rural areas, notably in cities including Mödling and Wiener Neustadt and in touristic Wachau and Neusiedler See regions. It is a mobile-phone-operated bike sharing system and users check out and in by calling the number written on each bicycle from the mobile phone. The stations are fixed and therefore check-out and check-in are done in fixed places. Similarly to Citybike, the nextbike user can return the bicycle to a different station from check-out. It has to be noted that another non-ICT-based bike-sharing scheme "Freiradl" was in operation until 2009 in Lower Austria and the system was changed to the ICT-based "nextbike" that year.

8.3.2 Data Used

The data used for this case study was collected through a CATI (computer-assisted telephone interview) carried out in April and May 2013. The telephone survey was made to individuals between 15 and over 75 year-old living in Vienna and in selected municipalities in Lower Austria where bike-sharing schemes are in operation. The total number of respondents is 500. 248 among them are from Lower Austria and 252 among them are from Vienna. This proportion well represents the actual proportion of the population in the two federal states.

The aim of the telephone survey was to obtain information about bicycle ownership and usage in general, the awareness and usage experience of bike-sharing schemes, user response to the bike-sharing scheme in general and user respond to identification, authorisation and payment method.

In addition to the CATI, the data from another CATI carried out in 2009 with the same questionnaire is used for comparison. This 2009 CATI was only undertaken in Lower Austria and thus the comparison is only made for the data from Lower Austria.

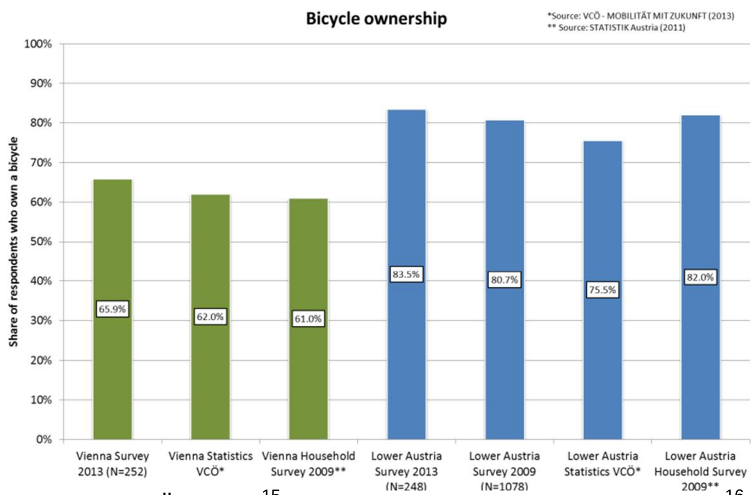
Furthermore, literature research was carried out and Viennese operator was contacted for some background information.

[14] Pfaffenbichler P, Pickl N (2009). Befragung Freiradl, NÖ - Organisation und Auswertung Befragung Freiradl, NÖ. AEA, Wien.

Results of the Specific Survey

In this section, the main result of the CATI in 2013 is presented, together with the CATI in 2009 where applicable. The respondents in terms of gender, age and household size are well representative, while the people with higher education are overrepresented compared to the Austrian average. According to the experts in the survey institution, this is a general tendency when a telephone survey is carried out and such overrepresented respondents with higher education are practically inevitable.

Among the respondents, 66% in Vienna and 84% in Lower Austria owns a bicycle. This is in line with other surveys carried out in recent years.



*Source: VCÖ (2013)[15], **Source: STATISTIK Austria (2011)[16]

Figure 8-1 Bicycle ownership among respondents and data from other surveys

The survey shows that there is a general uptrend regarding bicycle use (including non-shared bicycle) observed from the comparison in Lower Austrian data. People in the rural area tend to use bike-sharing more in Vienna rather than at home in rural area.

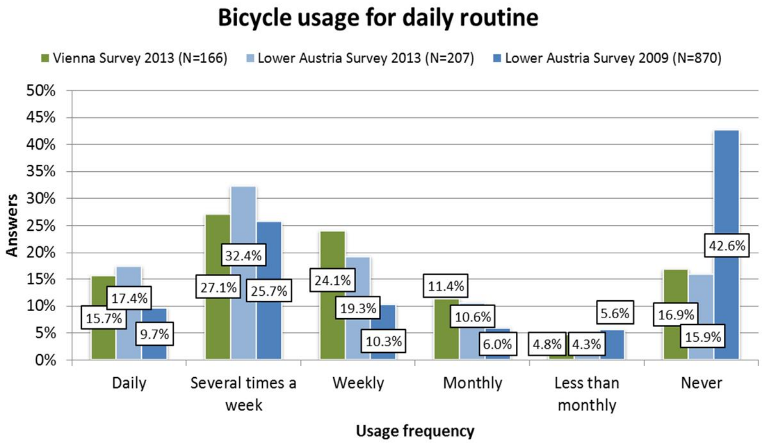


Figure 8-2 Bicycle usage for daily routine trips

[15] VCÖ (2013). Österreicher besitzen mehr als sechs Millionen Fahrräder - Fahrrad braucht nach Winter ein Service - 06.03.2013. Press Release. http://www.vcoe.at/de/presse/aussendungen-archiv/details/items/vcoe-oesterreicher-besitzen-mehr-als-sechs-millionen-fahrraeder-fahrrad-braucht-nach-winter-ein-service-06032013

[16] STATISTIK Austria (2011). Ausstattungsgrad der Haushalte ï Bundesländerergebnisse. http://www.statistik.at/web_de/static/ausstattungsgrad_der_haushalte_-_bundeslaenderergebnisse_059000.pdf

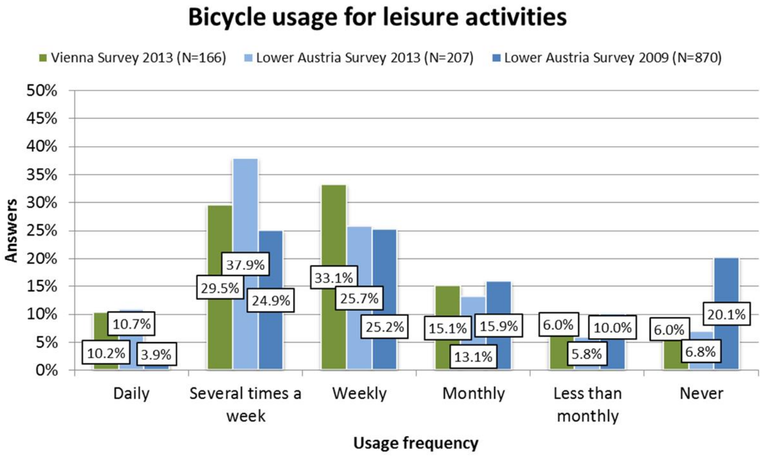


Figure 8-3 Bicycle usage for leisure trips

The awareness of the Citybike by Viennese people is already very high with 9 out of every 10 respondents aware of it. Also the awareness by the Lower Austrians is high with approximately 7 out of every 10 respondents being aware of it, and the 2009-2013 comparison shows an uptrend.

This question included Freiradl that was in operation in Lower Austria until 2009. (Note that the nextbike is in operation since 2009.) Among Lower Austrian inhabitants, there is a downtrend of the awareness of the Lower Austrian bike sharing schemes at large.

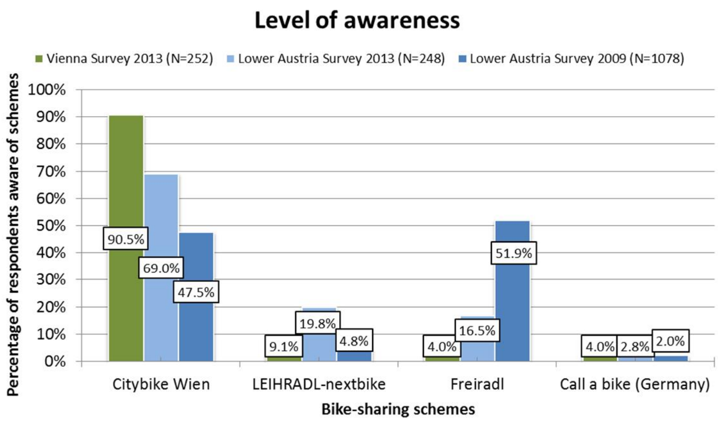


Figure 8-4 Level of awareness of bike-sharing schemes

Visibility on the street plays the most important role to capture awareness of the population. 69% of the respondents in Vienna and 56% of the respondents in Lower Austria state that they got to know the bike-sharing scheme either seeing the station or the bicycle used on the street.

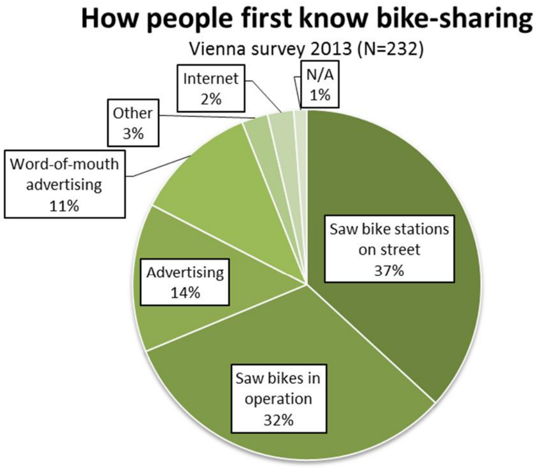


Figure 8-5 The way the respondents got to know about bike-sharing (Vienna)

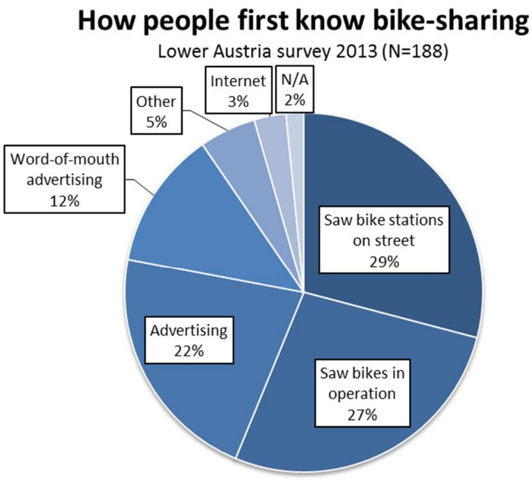


Figure 8-6 The way the respondents got to know about bike-sharing (Lower Austria)

The survey result shows that, desipite the high level of awareness, many of the respondents ï 70.7% in Vienna and 83.0% in Lower Austria ï have never yet used any bike-sharing schemes. 28% of respondents in Vienna have used Citybike at least once, while those from Vienna who have used Lower Austrian system is almost nonexistent. About 10% of the resondents in Lower Austria have used Citybike Wien in Vienna while less have experienced with the Lower Austrian systems. It has to be noted that there is no respondends in the both group (Viennese and Lower Austrian) who have used both Freiradl which existed until 2009 and LEIHRADL-nextbike which is in operation since 2009.

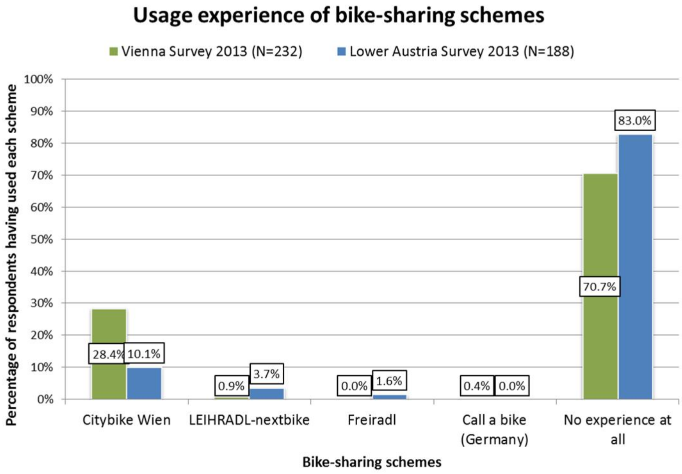


Figure 8-7 Usage experience of bike-sharing schemes

The comparision of 2009 and 2013 survey data about Lower Austrian respondentsô experience on Lower Austrian system (Freiradl and nextbike) shows that the respondents with experience has doubled during the four-year period.

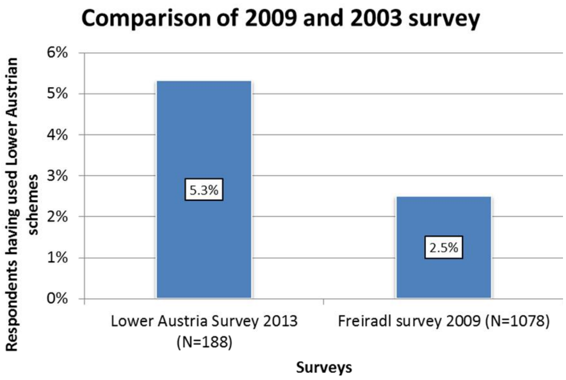


Figure 8-8 Difference between 2009 and 2009 of Lower Austrian respondents usage experience on Lower Austrian bike-sharing schemes

Most of the users do not use the shared bike often and they use typically once or twice a year, whereby the shared bikes are mainly used for leisure trips. Despite such large proportion of the usage for leisure trips, about 10% of the respondents in Lower Austria and 6% in Vienna have used the shared bike for commuting and going home respectively. This implies that the bike-sharing is used as an alternative transport mode for daily travel usages among some users.

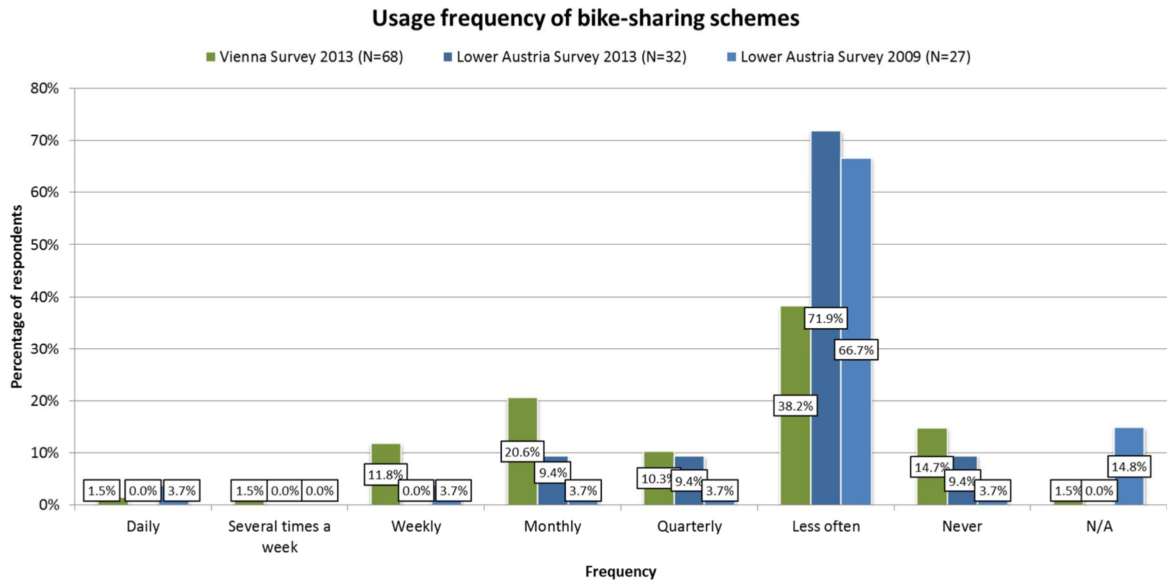


Figure 8-9 Usage frequency of bike-sharing schemes

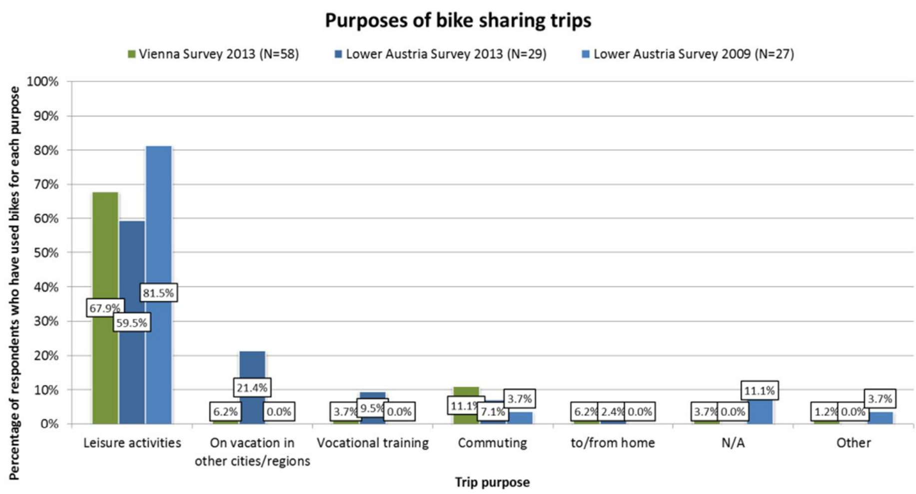


Figure 8-10 Distribution of trip purpose with shared bikes

In the survey, the respondents were asked to indicate what they find as advantages of bike-sharing. Convenience, favourable (cheap) price, and environmental friendliness are often selected as the advantage, while certain number of respondents also point outs simplicity for the usage, cycling being healthy, as well as it is faster than other transport modes and it is fun.

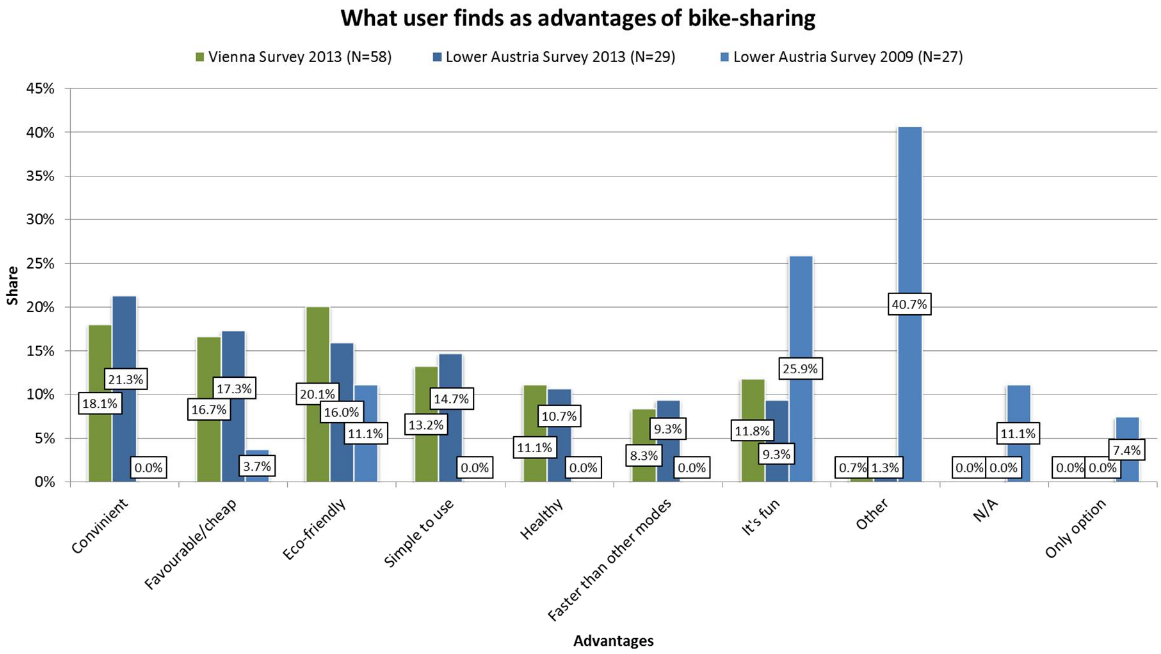


Figure 8-11 Advantages of bike-sharing found by respondents

The typical willingness to pay is around ú 0.50 to ú 1.00 per hour and thus the current pricing seems appropriate. Many people will accept automated booking/identification methods. Especially, card-based or phone-based identification is preferred. The fact that most of the respondents are familiar with the automated ticketing and Internet-based services confirms this. Other state-of-the-art identification methods seem to be unaccepted. About half of the people in Lower Austria and about 30% of the Viennese people still want to pay in cash rather than other methods such as debit or credit cards.

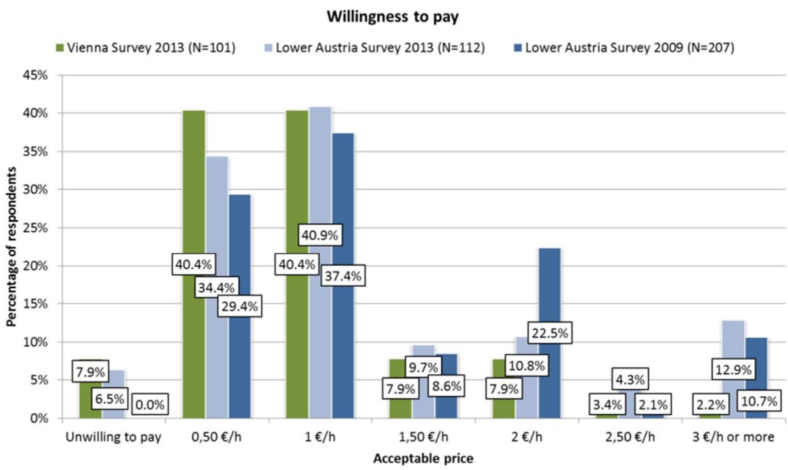


Figure 8-12 Willingness to pay for the shared bike

Table 8-2 Tariff of Citybike Wien in Vienna[17]

Usage period	Tariff
First 1 Hour	Free
Up to 2 Hours	ú 1.00 / use
Up to 3 Hours	ú 2.00 / use
Up to 4 Hours	ú 4.00 / use
Longer use (up to 120 Hours)	ú 4.00 per each one hour

Table 8-3 Tariff of LEIHRADL-nextbike in Lower Austria[18]

Usage period	Tariff
First 30 minutes (only in Wiener Neustadt, St. Pölten, and some area just north of Vienna)	Free
Per Hour	ú 1.00
Per day maximum	ú 8.00

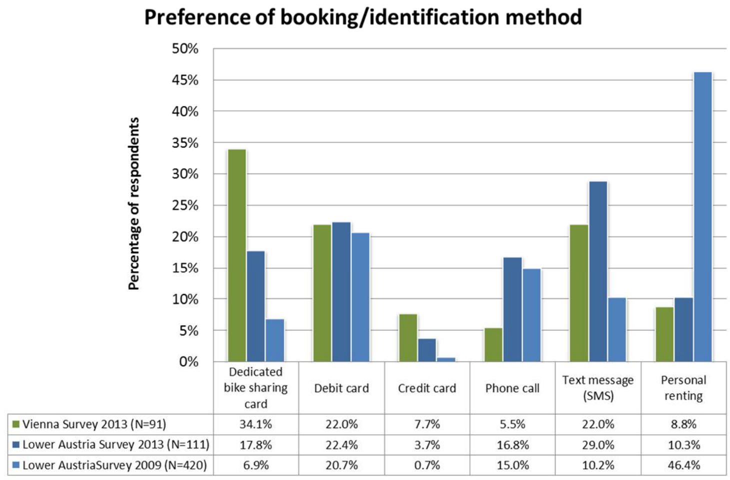


Figure 8-13 Preference for different booking/identification method by respondents

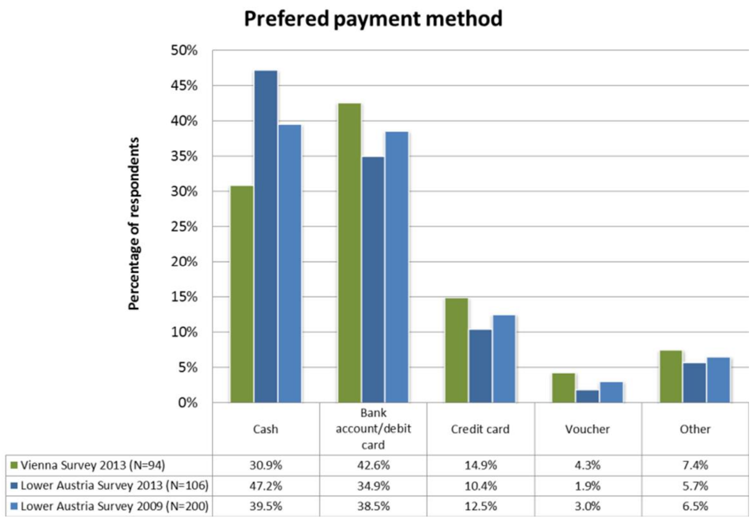


Figure 8-14 Preference for different payment method by respondents

[17] Source: Citybike Wien (2013). CITYBIKE WIEN TARIFEò available at http://www.citybikewien.at/, retrieved on 24 June 2013

[18] Source: NÖ Energie- & Umweltagentur Betriebs GmbH (2013). .Fahrpreise available at http://www.nextbike.at/1377.html, retrieved on 24 June 2013

Further development of reporting broken bicycles by users (e.g. through apps), app indicating general conditions of bicycles and short-term reservation (especially when there are only a few bikes available at the station) are found useful by the users. Among non-users, certain proportion between one-third and two-thirds find themselves as potential uses of the shared bikes. However, they require denser networks of the stations, easy booking system, and better bicycles to be shared.

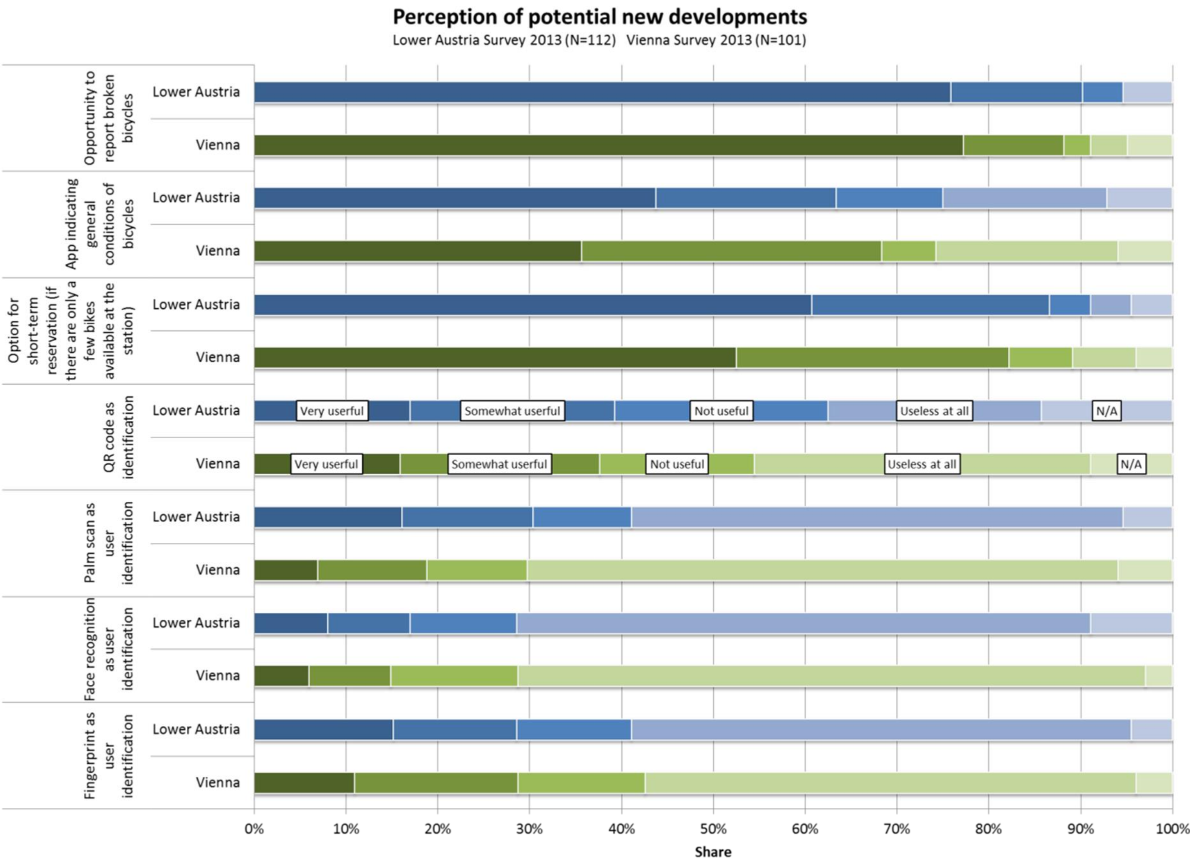


Figure 8-15 Perception of potential new developments by respondents

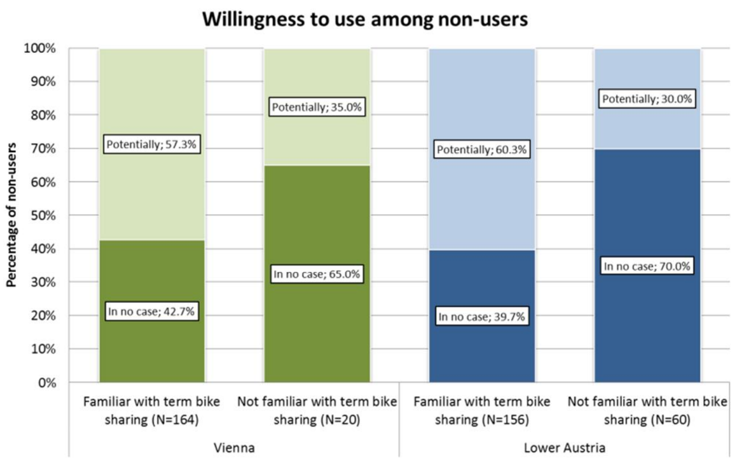
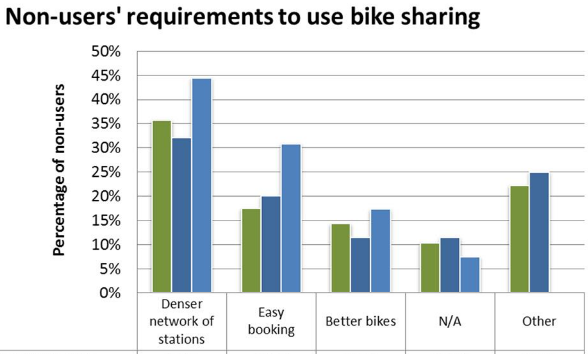


Figure 8-16 Willingness to use among non-users



	Denser network of stations	Easy booking	Better bikes	N/A	Other
Vienna Survey 2013 (N=184)	35.7%	17.5%	14.3%	10.3%	22.2%
Lower Austria Survey 2013 (N=216)	32.1%	20.0%	11.4%	11.4%	25.0%
Lower Austria Survey 2009 (N=272)	44.4%	30.9%	17.3%	7.4%	0.0%

Figure 8-17 Non-users' requirements to use shared bikes

Information received from other surveys for this case study

There is no information received from other surveys.

CATI in 2009 in Lower Austria

As already mentioned, in 2009 a telephone survey (CATI) was already carried out in the federal state of Lower Austria and the data from this is used for comparison. The questionnaires used in the 2009 survey and 2013 survey are the same. The information used in the case study is integrated in the figures of the survey results for comparison.

Data collected through literature and by contacting to the operator

A review of the literature is made to obtain information about investment and operating cost as well as some other criteria for implementation of the two different types of the bike sharing schemes.

The type used by Citybike Vienna ï with fixed station with terminals that enables registration, identification and payment and bicycle docks with which shared bikes are parked ï and the type used in Lower Austria ï with fixed station without terminals and registration, identification and payment through the mobile phone ï have different characteristics regarding the investment and operating costs.

A handbook about bike sharing schemes (OBIS handbook[19]) quote implementation costs for schemes from 2500 Euro up to 3000 Euro per shared bike. The investment costs for the construction of a new station in Vienna prices about 50,000 up to 70,000 ú according to another literature[20]. A city in Austria, Graz (265,318 inhabitants), is planning to introduce the same bike-sharing schema as running in Vienna in 2014 and the city estimates that between 500,000 and 1,000,000 Euro for 30 bike-sharing stations will be needed as the initial cost[21].

The information related to the operational cost of Citybike Vienna is limited while it is assumed that it costs of ú 25,000 per station. The handbook states running costs in this model per bike of ú1,500 up to ú 2,500.

This bike-sharing model including Citybike Vienna is typically funded by the advertisement on the shared bikes as well as on other public spaces. It should be noted that the size of the city and the metropolitan area does matter to make it feasible. The literature cited here mentions that this model is less applicable for smaller communities than 100,000 inhabitants as it tends to be difficult to achieve a critical mass of the users as well as the income from the advertisement.

[19] OBIS (2011). Optimising Bike Sharing in European Cities - A Handbook.
[20] Von Sassen W. (2009). Öffentliche Fahrradverleihsysteme im Vergleich ï Analyse, Bewertung und Entwicklungsperspektiven. Trier
[21] http://derstandard.at/1373513991538/Graz-soll-Leihradsystem-nach-Wiener-Muster-bekommen

Another example case can be found in the handbook about ĩBicing Barcelonaò bike sharing scheme, which employs similar system as Citybike Vienna. It shows that among the initial costs by far the highest share of cost is for the station implementation (70%) followed by the costs for the shared bikes (17%). Table 8-4 shows the total share of operational costs for the same bike-sharing scheme. Redistribution of bikes (30%), bike maintenance (22%) and station maintenance (20%) are the most cost-intensive operational aspects.

Table 8-4 Implementation costs of Bicing Barcelona

Infrastructure & Implementation	Share of total costs
Station implementation: terminals, docking points and locking technology, station planning, ground work and cabling	70%
Bikes	17%
Set-up operations: workshop and logistics	6%
Communication	5%
Administration	2%

Source: OBIS handbook 2011

Table 8-5 Operational cost distribution of Bicing Barcelona

Running Costs	Share of total costs
Redistribution of bikes	30%
Bike Maintenance	22%
Station Maintenance	20%
Back-end system	14%
Administration	13%
Replacements (bikes, stations)	1%

Source: OBIS handbook 2011

ĩnextbikeò specifies in its advertising brochure targeted at municipalities the estimated implementation and running yearly cost of the bike-sharing scheme[22]. To launch a standard bike station including 6 bike racks and 4 bike-sharing bikes, the initial cost for the municipality will be 4,600 Euro. This includes 6 bike racks, 4 shared bikes, a notice board, planning the rental network with the help of the community, a general map for orientation, promotion material, customer service and system management, maintenance of the bikes during the first year of its operation while it does not include the cost for the land acquisition if necessary and any taxes. The pure operational costs were not obtained during the research.

8.4 Assessment of the Solution - Bike Sharing in Vienna and the Surrounding Region

8.4.1 Specific Description of the Solution

The solution covered by this case study is the bike-sharing schemes.

8.4.2 Assessment of Applicability

Investment costs

The investment cost depends much on the type chosen and the number of bicycles per station. If a terminal-based system (as Citybike Vienna) is installed with 10 to 15 bicycles per station, the initial investment cost is as high as ú 500,000 to 1,000,000 for a medium-sized system with approximately 30 stations. If the mobile phone-based system (as nextbike in Lower Austria) is chosen, for the similar scale, the initial investment cost will be from around ú 150,000 (4-5 bikes per station) to ú 450,000 (10-

[22] http://www.nextbike.at/uploads/media/Infoblatt_nextbike_2014_01.pdf

15 bikes per station), much depending on the number of the shared bikes in each station. Thus the investment cost is somewhat high.

Operation and maintenance costs

The running cost including maintenance costs of the scheme with fixed station with terminals is estimated to be ú 25,000 per station per year or between ú 1,500 and ú 2,500 per shared bicycle. The need for regular maintenance arises mainly for defective docking stations and bikes as well as the rental terminals. Especially card-reading slots are vulnerable to failures and to technical shortcomings concerning the development of the station (e.g. electrical connection).

Financial viability

The investment costs are typically covered by a subsidy from the public sector. In this case the pay-back comes from the social benefit of the bike use in terms of health benefits and reduction of urban congestion through the shift from car to bike use.

In the operational phase, the main income sources for the operator are user charges (including registration fee, per-hour fee, annual membership fee, etc.), letting the shared bikes to advertisement and any subsidies by third parties including the subsidy from the public sector as well as the income from billboard in the public space, right of which is given to the operator in exchange to the management of bike sharing schemes. The income from the user charges typically does not cover the operational cost. Thus any form of subsidy such as the one from advertising or from the public sector will be needed. Where on-going subsidies are needed, the social benefits have again to be taken into account.

Technical feasibility

The system is technically feasible as proven by a number of bike-sharing schemes in operation around different corners of Europe.

Organisational feasibility

Usually a contract between the municipality and the operator of a bike sharing scheme is agreed. The model of infrastructure and operation for which a single operator is responsible is the most common contract type. Organisational problems can occur when the infrastructure owner and the operator differ from each other.

Beside such aspects, another challenge is that if the bicycle sharing scheme is not installed in adequate size, an impact onto the transport system cannot be expected. Therefore, it is important to implement a scheme quickly, as it was the case in Paris: the initial 700 docking stations and 10,000 bicycles were installed within the first six month and the system doubled in size in the following six months. To organise such speed of implementation is one of the important factors for a successful implementation.

Administrative burden

Since the initial investment cost is high, decision making among the stakeholders (politicians, planners, municipalities, etc.) before the implementation can be a complex process. In dense urban areas, arrangement of the location of renting station may incur complicated negotiations with other stakeholders with right of use, typically when on-street parking is converted to the rental station. In addition, for successful implementation, coordination with other urban and regional transport network is inevitable ï this will require an administrative process related to transport planning.

In the operational phase, no particular administrative burden is expected, except for the fact that a certain know-how will be needed for an operator for issues such as re-distribution of the shared bikes and giving an incentive to the renting stations located in unfavourable areas such as the upper end of the slope.

Legal feasibility

Besides aspects such as zoning of public space, and liability and contractual issues (for details, exit clause etc.) there are no legal obstacles to this application.

User acceptance

Bike sharing schemes are generally well recognised and accepted by the citizens although the actual number of the users tends to be limited to a certain percentage among them. Keys for better user acceptance are a dense network of stations, 24-hours operating scheme, and appropriate number of bikes to the city size.

Public acceptance

Even those who have no intention of using a bike will welcome the fact that the cyclists are non-car users and therefore contribute to reducing urban congestion and emissions. Furthermore, the existence of a bike share system in a city conveys a positive image of the city to visitors.

8.4.3 Assessment of Interest for Travellers

Door to door travel time

Bike-sharing systems can remarkably reduce the door to door travel time for users by providing a fast urban transport mode (potentially even faster than the car or public transport) and by serving as a missing link in the public transport system. The bikes can be used for short distances within the city or, if it is employed in the rural area, serve as access and egress transport between the public transport stop and the destination. For ensuring reduced travel times, a specific density and availability of stations and easy access to the bikes will be needed.

Door to door travel costs

The charges are usually cheaper than other modes of transport and most of the schemes offer a free rental period of 30 minutes or 1 hour for each rental. The rental price increases exponentially after the first (free) period such as ú 1.00 for another 30 minutes, then ú 2.00 for further 30 minutes, and ú 4.00 for further 30minutes etc. with a very high daily maximum. In other schemes, the usage is charged from the first minute with a linear charge per time unit, and in such case the daily cap is lower. At large, travel costs are reduced for the users compared to other modes of transport as far as it is used within an ordinary usage period of the bicycle assumed by the operator and represented by the pricing scheme, while it may be more expensive compared to using the own bicycle.

Registration is required in almost all bike sharing schemes to avoid a loss of the bike and to ensure billing and payment. Some schemes have free registration while others employ higher registration fees with some deposit or even unlimited usage of the scheme within the registration period included. Some systems, especially the ones in France, require a substantial deposit at the registration.

Comfort and convenience

Bike-sharing schemes can increase the convenience to people by providing an additional possibility to public transport, especially for short travel distances within cities. Inconveniences such as crowded public transport or congestion can be avoided with it. Weather permitting, through a dense network of bike stations and easy access, users can enjoy an increased flexibility on their daily ways. If the bike-sharing schemes were to be installed in an extremely cold region or in a place where it tends to rain a lot, the comfort and convenience provided by bike-sharing schemes would be fairly limited.

Safety

A comprehensive planning for maintenance is an important factor for the safety ï regularly controlled and maintained bike fleets can account for higher safety for bike users (enough air in tires, control of brakes, lights, etc.). Needless to say, bicycles have a risk to be involved in a traffic accident on the street ï designated bicycle infrastructure will contribute to reduce such risks.

Security

There are no expected impacts on security.

Accessibility for mobility impaired passengers

There are no impacts on the accessibility for impaired.

8.4.4 Assessment of Modal Change

Car usage

There is no data so far to prove that the bike-sharing schemes have any direct impact on car usage in cities, although it seems more than likely that some trips done with the shared bike would be made with car without bike-sharing schemes. In rural areas it is also expected that it serves as an alternative transport to a car, especially by tourists, although, again, no statistics are available so far.

Bus and coach usage

In cities, there will be some modal shift away from public transport to the bikes. In rural areas, it may contribute to an increase in bus and coach usage when it serves as a feeder transport to them. In touristic regions, it may also contribute to increase it when it serves as an alternative to the car-based tourism. The balance between these effects is unknown.

Rail usage

In urban areas, there is no particular impact on rail usage. In rural areas, a similar small increase to the bus and coach usage can be expected.

Ferry usage

There is no impact on ferry usage.

Aeroplane usage

There is no impact on aeroplane usage.

8.4.5 Assessment of Other Impacts

Increased mobility

Both bike-sharing schemes contribute to an increase of mobility by complementing public transport in cities, by covering the access/egress stretches to the railway and buses in rural areas and by encouraging tourists to roam wider parts of the local area.

Congestion

Where the use of bikes replace car trips in urban areas, they will also make a contribution to reducing congestion.

CO2 emissions

Both bike-sharing schemes help to save CO2 emissions if they can contribute to a reduction of car usage.

Contribution to user pays principle

No impact.

European economic progress

No impact.

Territorial cohesion

It can be argues that there is a contribution on a small scale in that the scheme provides more connectivity within a city or within a region, but it is not significant.

8.4.6 Assessment against Main Criteria – Summary

Table 8-6 Bike Sharing in Vienna and surrounding region - Point score for the criteria

	Score (in cities)	Score (rural areas)
Investment costs	úú	úú
Operation and maintenance costs	úú	úú
Financial viability	✓	*0*✓
Technical feasibility	0	0
Organisational feasibility	0	0
Administrative burden	0	0
Legal feasibility	0	0
User acceptance	✓	✓
Public acceptance	✓	✓
D2D travel time	✓	0
D2D travel costs	✓	✓
Comfort and convenience	✓	✓
Safety	0	0
Security	0	0
Accessibility for mobility impaired passengers	0	0
Car usage	-	-
Bus and coach usage	-	+
Rail usage	0	0
Ferry usage	0	0
Aeroplane usage	0	0
Mobility	✓	✓
Congestion in overcrowded corridors	✓	0
CO2 emissions	✓	✓
Contribution to user pays principle	0	0
European economic progress	0	0
Territorial cohesion	0	0

9 CASE STUDY 8 - CAR SHARING IN KARLSRUHE

9.1 EXECUTIVE SUMMARY OF THE CASE STUDY

Car sharing in Karlsruhe, when measured by cars per inhabitant, probably is the most successful system of this kind of mobility concept in the world. It is a system of classical car sharing (car club), where all cars have fixed locations i.e. when renting a car, the user has to pick it up at a distinct location and drop it off at the same point.

The case describes demand and supply structure, pointing out that strong demand occurs mainly in quarters of the town with a high population density, situated directly in or close to the city centre, while usage intensity of the system in remote districts of the area is more moderate.

A variation of demand applies concerning season, weekday and hour of the day, which must be considered by the fleet management, to assure a high availability of cars for the customers but in parallel an efficient usage of the vehicles to enable attractive costs for using the system and a financial viability to run this system economically successful.

The tariff system charges by time and mileage a car is rented, providing discounts for longer trips and in addition requires a monthly membership fee and a one-time charge for registration and a deposit, resulting in every costs per kilometre of about ú 0.40, what is not much higher than the full costs of owing a private car, but enables the customer to choose the right car for a specific purpose among fifty different types of cars.

An analysis of long-term booking behaviour showed that the annual mileage per user significantly decreases with the years to about 1400 kilometres a year. Assuming a consistency in the number of ways undertaken per person, the conclusion can be drawn, that car classical sharing causes a switch in mode choice towards public transport and bike usage. This is backed by results of a mobility survey undertaken in Karlsruhe in 2012.

Comparing this system of classical car sharing with dynamic or floating car sharing, as provided e.g. by Daimler motor company in Ulm since 2009 under the brand car2go, shows severe differences between these systems in user behaviour, efficiency and therefore also in financial viability. The system of dynamic car sharing focuses on a revitalisation of car usage in urban areas, where figures for car ownership and the mode share of car usage decreased in the last decade, especially among younger people, while it is not intended to replace existing car ownership by usage of dynamic car sharing. The existing tariff structure (making long-distance trips unattractive) and the uniform car fleet, consisting of just Smart 2-seater cars, supports this focus of dynamic car sharing, towards a mode shift from public transport and bike usage to car driving in urban areas.

In Karlsruhe the average mileage per car is at 28,000 kilometres, while this benchmark figure for car2go is about a just third of that value for classical car sharing, resulting in a missing profitability.

So classical car sharing can be considered as a mobility concept, which is sustainable, on the ecological as well as on the economical view, while this does not apply for dynamic car sharing, as performed by car2go.

9.2 THE BACKGROUND OF THE CASE STUDY

9.2.1 Motivation for this Case Study

With more than 600 cars and about 10,000 users, in Karlsruhe, a medium sized town of 292,000 inhabitants, car sharing has the highest market penetration in all towns in Germany and probably in the world. With 2.0 cars / 1000 inhabitants the usage of car sharing is twice as high as for example in Berlin, the town where the competitiveness among the six car sharing companies there is higher than anywhere in Germany. And up to now there is no indication of an overall market saturation. So car sharing in Karlsruhe has by far left the phase, where this has been a quite exotic mobility concept.

9.2.2 General Description of the Region

Karlsruhe is situated in the South of Germany about 150 kilometres South of Frankfurt (Main) close to River Rhine, the northern part of the Black Forest and the border to France.
The region considered comprises of the city of Karlsruhe itself (292,000 inhabitants) and selected neighbouring municipalities in the surrounding county ñKarlsruhe, Landò (424,000 inhabitants) where car sharing is available. So the region type is urban and rural close to the city respectively.

For Karlsruhe city a value of about ú 50,000 applies for the GDP/capita, which is about twice the EU average, while it is at ú 28,000 in ñKarlsruhe Landò, meaning about 10% above EU-average. While the industrial sector is still quite strong (electronics, communication, automotive, energy), within the last two decades the service sector (information technologies) has grown massively; e.g. 40% of all e-mail accounts in Germany are hosted at providers situated in Karlsruhe.

The population density in the area varies between values around / above 10,000 inhabitants per square kilometre in the quarter of the inner city of Karlsruhe, and about 250 in some rural areas in the vicinity of the city. The following map shows the population density in the regions covered. Different to the overall trend in Germany the number of inhabitants in Karlsruhe and Karlsruhe Land is still growing.

The accessibility of the Region is well above European level. An East-West and a North-South motorway corridor meet in the area, while on rails the city is served by four high speed lines from Basel to Berlin, Hamburg and the Ruhr area and as well by a TGV-route from Paris to Stuttgart ï Munich. In air transport, Karlsruhe has its own international airport, situated about 40 kilometres South of the city and for intercontinental accessibility the town is connected by high speed trains within one hour to a terminal of Frankfurtôs Rhein-Main Airport, the number one hub in Europe on base of destinations served.

Finally in public transport the region is famous for the ñKarlsruher Modellò[23], i.e. tram-trains connecting the countryside with the city centre in high frequency, which increased the mode share of public transport significantly in the last 20 years.

[23] http://www.karlsruher-modell.de/en/index.html

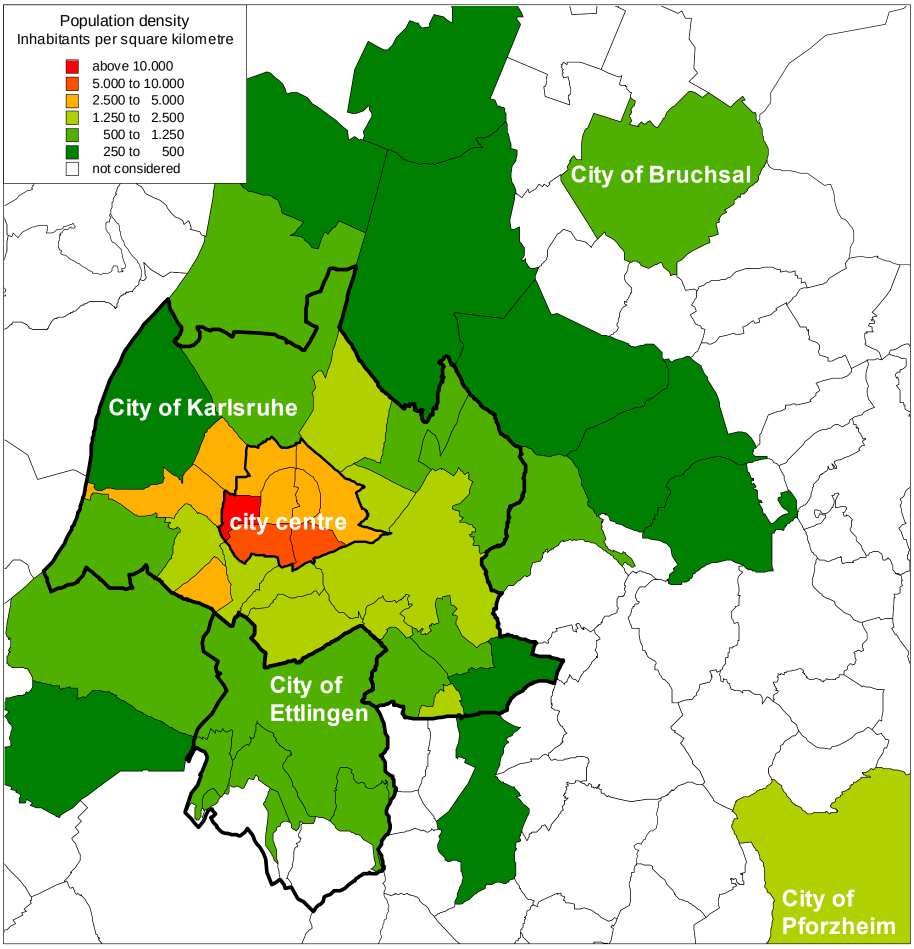


Figure 9-1 Karlsruhe area by population density

9.2.3 Stakeholders Involved

The first stakeholder involved in the case study is the operator of the car sharing in Karlsruhe, the stadtmobil Karlsruhe GmbH&Co KG. The second one is the community of all users of the system during the years between 2008 and 2012, as their anonymised booking data has been made available for this study by the operator.

9.2.4 Methodology of the Case Study

The case study is the description of existing solution for car sharing and compares it with another one. Furthermore two technical solutions necessary to run car sharing are described. This includes desk top research work as well as consultation of stakeholders.

9.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

9.3.1 General Description of the Case Study

The case study describes the existing system from the usersô point of view. Furthermore a quantitative analysis of the supply side and as well of the demand side is undertaken and the reasons for the success will be mentioned. As in addition a long term database on the bookings made is available, an analysis in (changes of) user behaviour is possible and corresponding impacts on user mobility, mode choice and resulting effects on emissions will be identified. In a second stage of the case study, we want to point out the differences between the Karlsruhe car sharing and another more recent form of car sharing, allowing one-way rental with free drop-off of the car.

Historical abstract

- Car sharing in Karlsruhe started in 1995 with a handful of cars and about 50 customers as a small private company.
- In 1997, when meanwhile more than 400 customers used car sharing, this approach for a sustainable mobility received the environmental award of the city of Karlsruhe for non-commercial organisations.
- In 1999 (more than 1300 customers in Karlsruhe) the car sharing organisations of Karlsruhe, Mannheim/Heidelberg and Stuttgart formed the stadtmobil group, consisting of regional independent companies under a common brand.
- In 2000 (1800 customers) stadtmobil Karlsruhe changed its corporate organisation to a limited partnership with a limited liability company as general partner, becoming a full commercial company.
- In 2001 booking of cars via internet was enabled.
- In 2002 a smart card for accessing the cars was introduced.
- In 2005 the city council of Karlsruhe became a customer of stadtmobil.
- In 2006 the regional expansion outside the city of Karlsruhe increased.
- In 2009 the number of cars operated by the stadtmobil group exceeded to more than 1000.
- In 2010 stadtmobil starts its presence on social media.
- In 2012 stadtmobil introduced booking via smartphone app. Karlsruhe is awarded as the German capital of car sharing by the German association of car sharing.
- In 2013 the number of customers of stadtmobil Karlsruhe increases to 10,000.

Working principle

Car sharing in Karlsruhe as operated by stadtmobil follows the system of classical car sharing (car club), where all cars have fixed locations i.e. when renting a car, the user has to pick it up at a distinct location and drop it off at the same point.

Booking

For renting a car the user has to book it via web, by phone a smartphone app 24 hours a day all year round or personally at the stadtmobil office during office hours on Mondays to Fridays. This can be done on the fly for immediate usage up to several months in advance. When booking a car, the user indicates the day and time of rental beginning, the distinct car to be used and the time and day of returning the car. An extension of the rental time is possible, if no other user has already booked the car. Cancellation or rebooking is free of charge until 24 hours in advance. For short term cancellation or rebooking the rentals fees are charged for the period the car isn't booked by another customer. For details of the booking system see chapter 9.5.

Access to the car

The user can access the car at the defined station via a smartcard, enabling him to open the station's safe, where the key for all cars at this station are deposited. At stations providing only a small number of cars, the access to the car is enabled directly at the car (card reader behind windscreen). For the data transfer between booking system and cars / station safe see chapter 9.6.

Costs

For using the car sharing at Karlsruhe one has to be a registered user. Registration applies once personally at the stadtmobil office, signing a membership contract and presenting a valid driver license. For a membership a one-time registration fee of ú 70 and a deposit of ú 330 are charged. Holding a season ticket of the regional transport association entitles for a discount of up to ú 70. In addition a monthly membership fee of ú 5.00 applies. For defined user groups of up to 4 people (e.g. families, companies) the monthly fee is at ú 10.00, additional persons pay ú 2.00.

For **each** car rental the costs compose of three elements:

- Booking fee of ú 1.00 (also applying just once for periodical bookings, e.g. when booking a car every on Mondays from 16:00 to 18:00 until further notice)
- Costs by time depending on the price group the rented car belongs
  - Passenger cars from ú 0.98 to ú 2.90 (for vans ú 3.90) per hour, but during night time in general ú 0.50 per hour
  - Passenger cars from ú 18 to ú 36 (ú 42 for vans) per 24 hours
  - From ú 37 to ú 72 (ú 84 for vans) per weekend (Friday 17:00 until Monday 07:00)
  - From ú 102 to ú 198 (ú 231 for vans) per week
- Costs by distance depending of price group the different cars to rent belong
  - From ú 0.19 to ú 0.27 (ú 0.29 for vans) per kilometre for the first 100 kilometres
  - A discount of ú 0.06 per kilometre applies from the 101st kilometre

The lowest costs indicated apply for small cars (e.g. Peugeot 107), while the highest costs are for comfort cars (e.g. Audi A6).

Fuel costs and co-insurance are included in the booking fees. Each car is equipped with an account card accepted widely at fuel stations all over Germany. Costs paid by the customer directly (e.g. when refuelling abroad) are reimbursed by the car sharing company when presenting the bill at their office. When returning the car, the filling level should be at a fourth in minimum.

The deterrent fee on the co-insurance is at ú 900 but can be lowered to ú 300 by an annual payment of ú 39.

These costs havenõt changed since 2007, although according the federal German statistic office the costs for petrol went up by nearly 12% in 2008 ï 2012, while the costs for diesel increased by 17% in that period. The economies of scale applying with growing numbers of users and cars enabled the car sharing company to keep the pricing constant.

Breaking down all costs i.e. rental costs plus permanent costs (including 10% of registration fee, fictive interest on deposit and monthly fee) applying for users results in ú 0,40 per kilometres on base of an annual mileage of 1,700 kilometres.

The supply side

Starting with a handful of cars in 1995 the fleet of cars provided by stadtmobil Karlsruhe, exceeded 300 vehicles in 2008 and the development since then is still characterised by an annual growth of more than 12%, reaching now (2013) an amount of 635 cars.

Spatial distribution of cars

528 cars or 83% of the fleet are located in the town of Karlsruhe, while the other 107 cars are positioned in 17 municipalities in the surrounding, with a focus in Ettlingen and Pforzheim, each equipped with 20 cars. The supply concentrates on quarters with a high population density and especially in the city centre of Karlsruhe, as in the seven quarters of the inner city 365 cars are provided at 67 different pick-up points. With such a high density of available cars, the users in the city centre of Karlsruhe usually have a choice under of dozens of cars within walking distance.

In the more remote quarters of Karlsruhe the number of cars provided is much lower, there are even four quarters with village style settlement, a hilly landscape hindering bicycle usage and a relatively poor public transport (no tramways just buses) in the Southeast of the town, where there is no supply of car sharing at all.

The same pattern applies for the small town of Ettlingen, situated in the South of Karlsruhe: while the city quarter of the town is equipped with 17 cars, the rural districts of the town just have one or no car sharing vehicle all.

And finally in the smaller municipalities of the larger Karlsruhe region by far not every village is equipped with a car, but only a minority of them has a single or a few pick up stations where usually just one car is positioned at each of them.

This geographic distribution of cars is displayed by their number per region/district on the following map, while the region's colour indicates the annual amount of bookings of these cars.

Fleet structure

The fleet is quite versatile. It consists of 56 different type of cars when taking into account also variants of the same model (e.g. with petrol and diesel engine), forming 19 product classes which belong to eight different tariff groups. This policy of providing many different types of cars follows the principle of providing the right car for the right purpose. The following table shows the numbers of cars provided per tariff group and mentions some typical representatives or remarkable types of car belonging to the group.

The group of small cars consisting of more than 200 vehicles forms the backbone of the fleet. Especially at small stations, equipped with just one car, this type of car is positioned.

The annual mileage per car is at about 28,000 kilometres (nearly constant over the last five years) and cars leave the fleet with a total mileage of about 150,000 kilometres after five to six years of usage. Downward deviations apply for cars preferably used of short-distance trips, while minibuses or vans may reach total mileages of up to 200,000 kilometres. This means that in average more than 100 cars have to be replaced every year and more than 50 cars additionally have to be bought to increase the supply side in line with growing demand. To cope with the seasonality of demand, new cars join the fleet preferably in spring, while old cars leave the fleet in autumn.

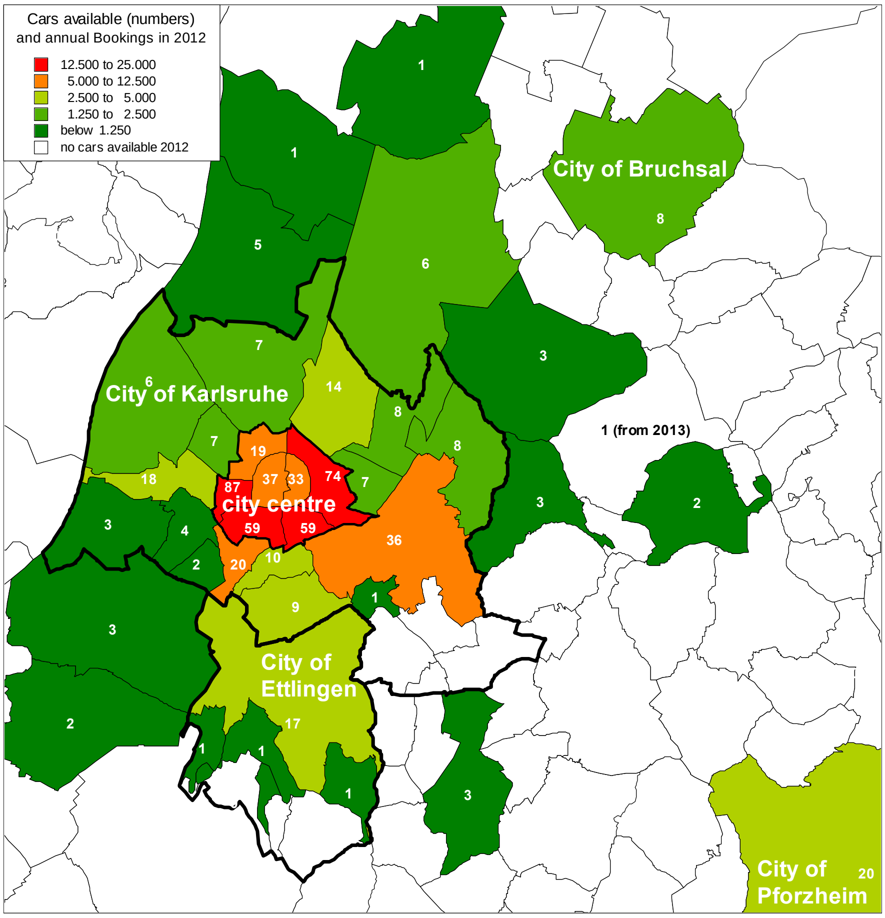


Figure 9-2 Available cars and annual bookings by quarters / municipalities

Table 9-1 Fleet structure of car sharing in Karlsruhe (2013)

Tariff Group	Number of cars	Typical Representative	Remarkable type of cars
Mini	89	Peugeot 107	Fiat 500
Smart	23	Smart	Fiat 500 electric drive
Small	207	Opel Corsa, Ford Fiesta	-
Medium	112	Renault Kangoo, VW Golf	Peugeot 207 Convertible, Mini Cooper, Honda Insight Hybrid, Renault Fluence electric drive, Mazda MX5 Roadster
Estate Car	110	Opel Astra	VW Eos Convertible, Prius electric drive
Large	24	VW Passat	Audi A4, BMW X1, Opel Zafira
Minibus / comfort	56	Mercedes Vivaro / Vito	Audi A6, BMW 5, Ford Galaxy
Van	14	Mercedes Sprinter	Ford Transit

The demand side

From the beginning in 1995 with just 54 car sharers, the demand has grown rapidly with more than 40% per year in average to about 5,700 people in 2008. While in the last two years the user figures developed more moderately, but still with a two digit annual growth rate and will exceed the number of 10,000 customers of stadtmobil Karlsruhe until end of 2013, as shown in the figure below.

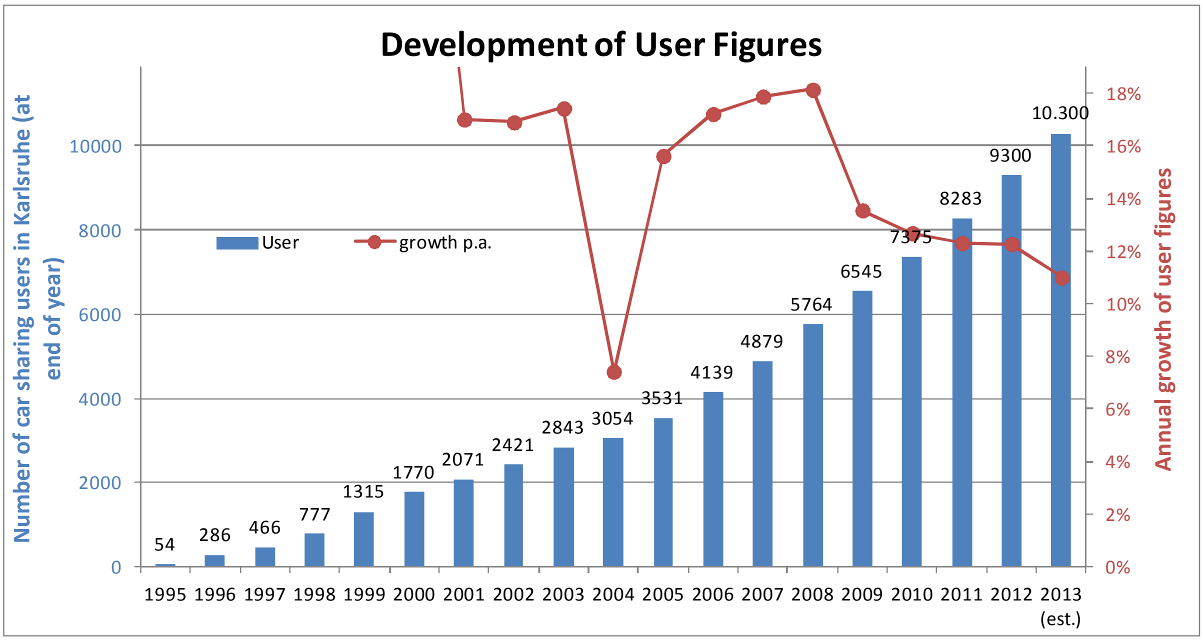


Figure 9-3 Development of user figures

For privacy issues regional data on domicile of users were not made available, but with regional booking data from the database analysed (see chapter 9.3.2) information on spatial distribution of demand exists, as car locations and therefore corresponding bookings shall correlate very well with the number of users per district / quarter as stated by the car sharing company and users in most cases cover the way between their home and the next car station by foot.

So the following map indicates the number of inhabitants per region and in addition a ľbooking indexò which calculates as follows: for all regions, where car sharing is provided, the average number of bookings is calculated. This regional average is then divided by the average value for the sum of all these regions and multiplied with 100. By referencing booking figures to inhabitants the regional market penetration can identified very well, pointing out those districts (in the city of Karlsruhe) where index values of 300 and more occur, as well as those regions where care sharing is hardly used by the population.

As can be seen from the map the intensity of car sharing does not simply just correlate with the number of inhabitants, obviously the centrality of the regions severely affects demand, as the highest index values (295 - 646) apply in the quarters forming the city centre of Karlsruhe, where the majority of daily trips can be done by foot or bike and where public transport is of high quality.

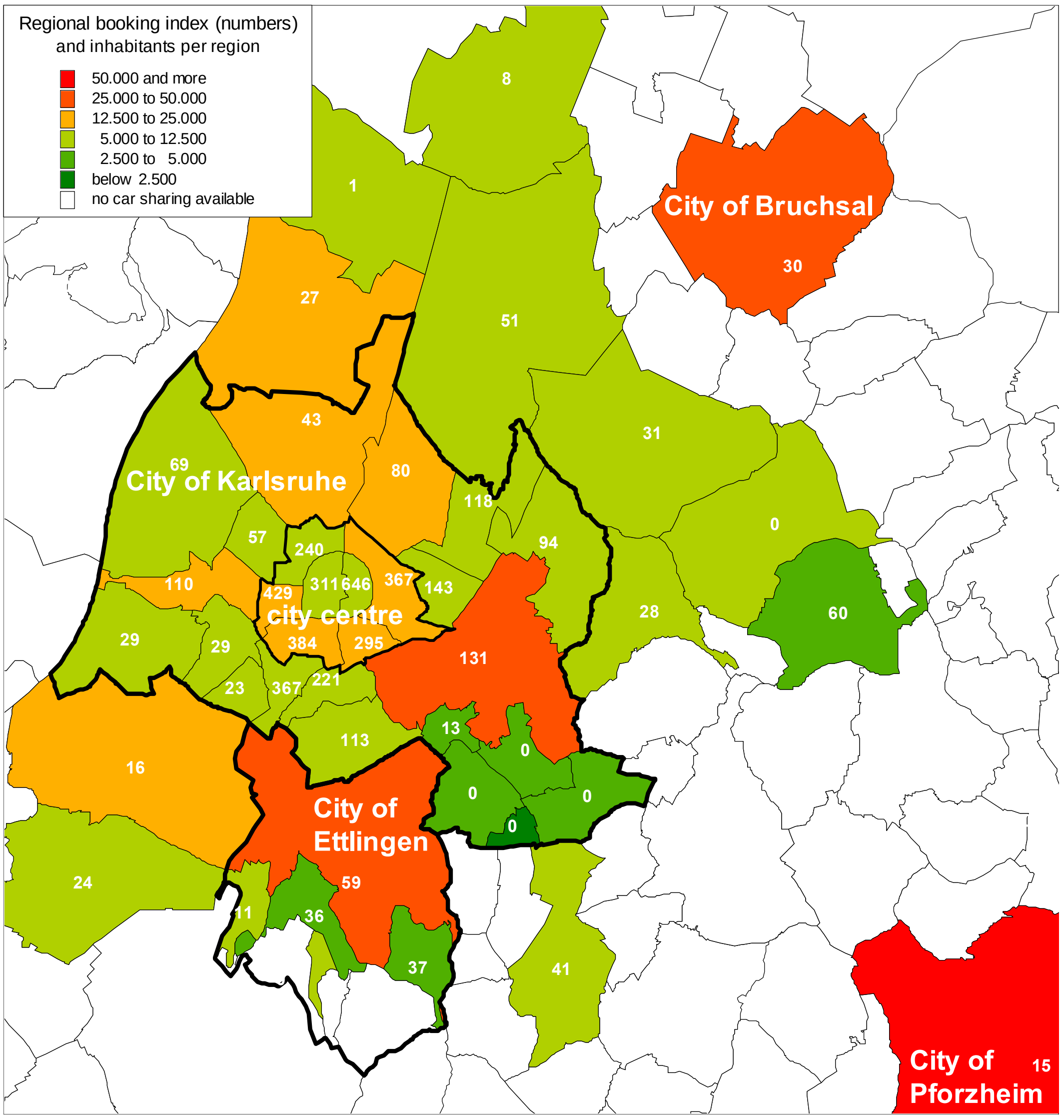


Figure 9-4 Regional booking index and population

Concerning the seasonality of demand analysing the booking data showed the results displayed in Figure 9-5 below, where the monthsôshare on the total annual mileage is displayed. It can be seen, that from May to October the car usage is above average (8.3%) with a peak in August (school holidays), while in January and February demand is on the bottom.

But demand also varies with the time of the day and the weekday, as Figure 9-6 points out by displaying the average number of bookings (starting time) applying for a distinct hour of the day. While almost no one starts renting during the night, there is a morning peak at 8:00 during weekdays followed by secondary peaks on early afternoon and early evening. On Fridays the early evening peak is much more obvious, exceeding the morning peak; a result of the weekend tariff, applicable for renting from 17:00 on Fridays until Monday morning. On Saturdays the absolute peak of the week applies at 10:00 in the morning, caused by typical shopping tours undertaken by car, but also day trips from a serious part of that specific demand. Sunday is the weekday with lowest demand, the peak is between late morning and early afternoon, about 50% below the peak demand on Saturdays.

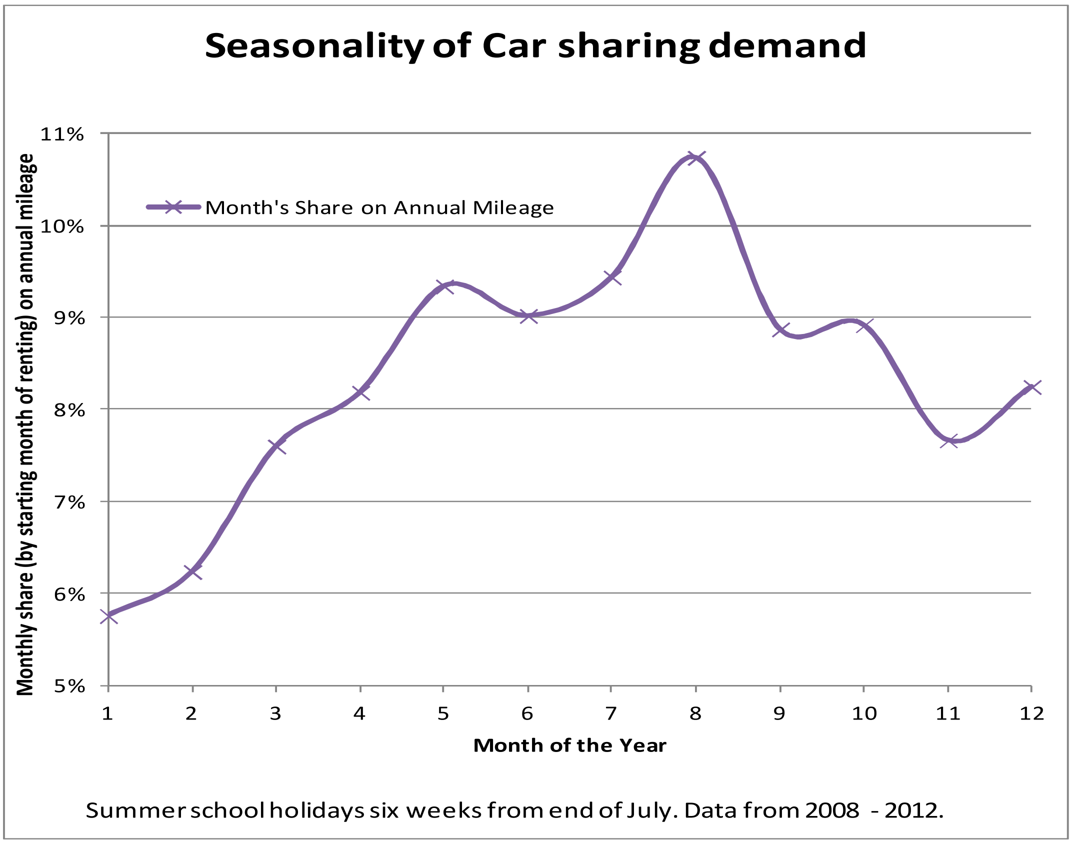


Figure 9-5 Seasonality of demand by month

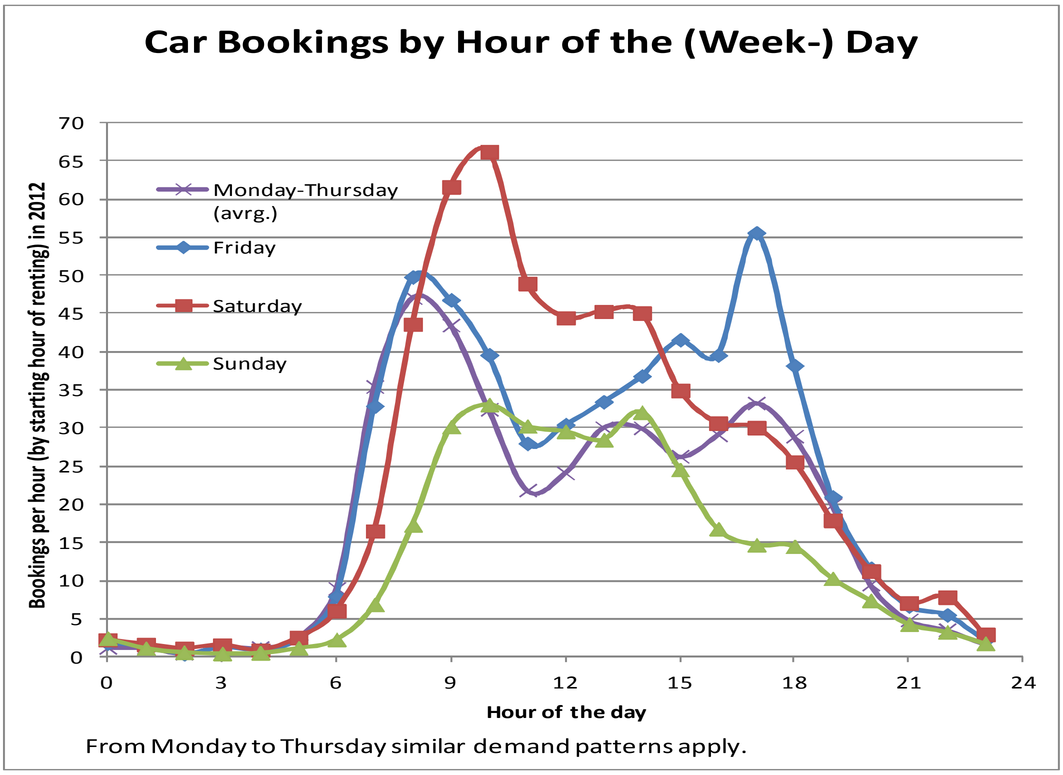


Figure 9-6 Seasonality of demand by weekday and hour of the day

As these demand patterns partially combine (e.g. long term rentals in summer holidays, cars booked for the weekend and those rented on Saturday morning) the vast majority of the fleet is in use on Saturday mornings in August with a peak load factor of up to 95%. To cope with this demand peaks, new cars join the fleet in spring, while old cars leave the fleet in autumn. In addition a number of cars are blocked for private companies or public institutions at a special agreed rate permanently on Mondays to Friday during office hours and therefore available for other users of the system only on weekends, where the peak demand occurs.

To examine the trip lengths the cars are used we analysed the booking information from the period 2008 ï 2012 resulting in the structure as displayed in the following figure.

Out of more than 600,000 bookings within the last five years in more than three fourth of them, the cars were used for short distance trips, meaning a one-way trip length of up to 50 kilometres.

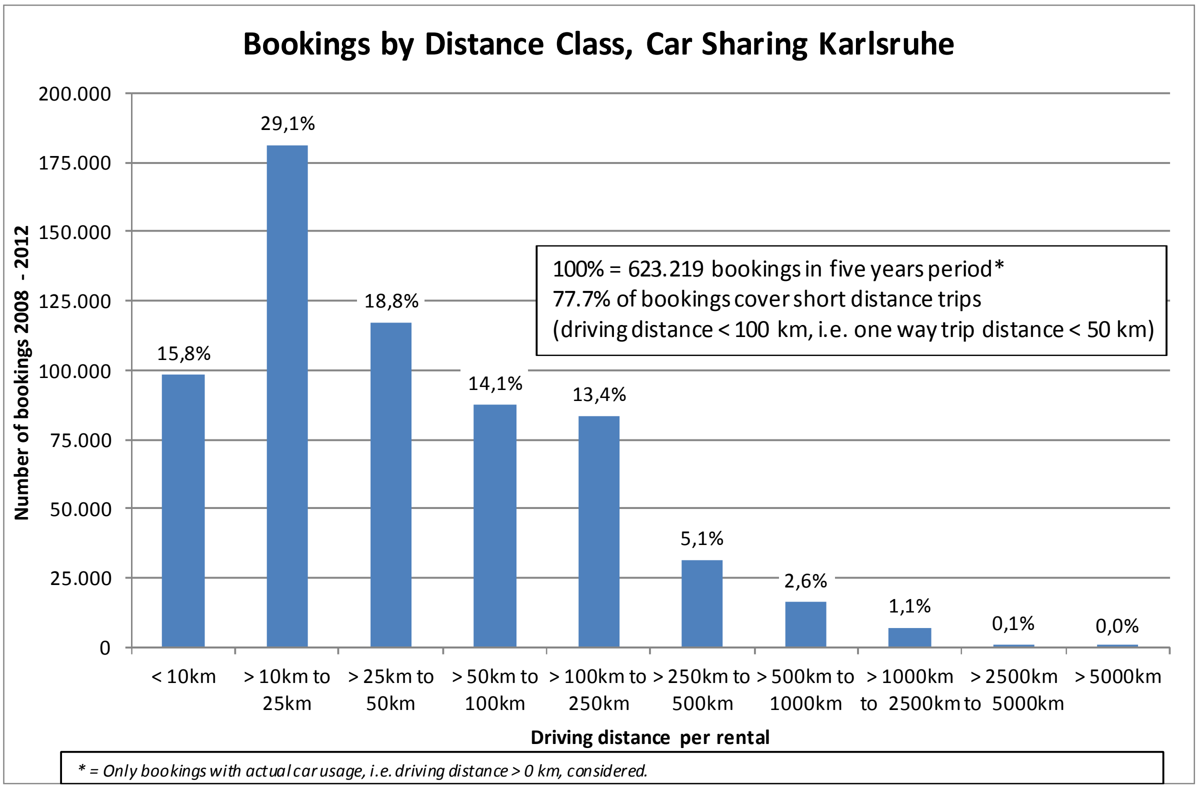


Figure 9-7 Bookings by distance class

Repeating such an analysis on the basis of booking duration (Figure 9-8 below) showed that more than 86% of rentals are not longer than 12 hours. This structure of demand clearly shows that car sharing in a strong majority of cases complements the supply of traditional car rental companies, where usually the minimum rental duration is at 24 hours.

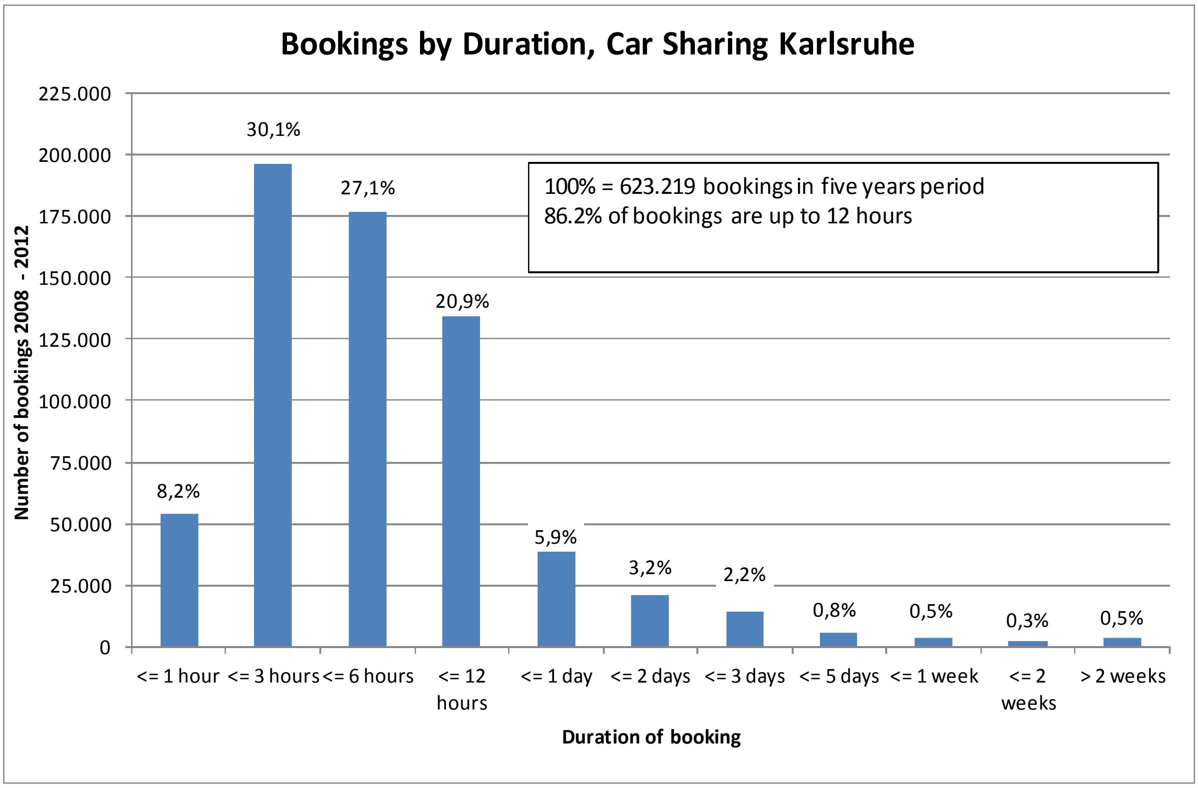


Figure 9-8 Bookings by duration

Comparison to other car sharing systems and benchmarking figures

The philosophy of classic car sharing (as established in Karlsruhe) focuses on:

- You donôt need an own car for your mobility
- If not daily used, itôs cheaper than an own car
- If you actually need a car, then have the right one for your specific needs

In contrary dynamic car sharing e.g. car2go, which has been established first in Ulm, Germany and meanwhile in quite a few cities all over the world by Daimler motor car company, due to the following reasons:

- Young people in urban areas less and less neither use a car, nor buy a car
- The buyer of a new Mercedes meanwhile is older than 50 years
- So people, who donôt want to buy an own car, should at least use one more often

The main differences in the working principle of dynamic car sharing like car2go when comparing with classic car sharing are:

- Pick up / drop off a car is possible freely in a defined zone of a city, as cars have no fixed positioning.
- Booking is just possible on the spot, preferably by smartphone app showing the position of the next available cars (but this is also feasible via internet or by phone call).
- The renting duration is fully flexible and does not need to be indicated when booking. Renting ends when dropping off the car.
- For registration once a fee (if at all) applies, but neither a deposit nor a permanent membership fee is charged.
- Free usage of many public car parks in the defined zone (fees paid by the car sharing company), while on classic car sharing parking fees to be paid are under the responsibility of the user (beside at the fixed station, where a car is positioned).

- Instead of 50 different car types the car2go fleet just consist of one type (Smart 2-seater).

Also the tariff structure of car2go in principle differs significantly from the one of classic car sharing, as displayed in the table below. Originally (when starting in 2009) costs were charged just by booking time: ú 0.19 per minute, accompanied by maximum costs per hour / day / weekend / week respectively, without any distinction if the car is used for driving or just parked and blocked for other users to be booked. No additional costs per driving distance were charged, fuel costs were included in the charged fee. Also no registration fee applied in the first months.

Table 9-2 Comparison of tariff structure, classic and dynamic car sharing

Base: Smart 2-seater	car2go Ulm 2009	car2go Ulm 2010	car2go Ulm 2011	car2go Ulm 2012	stadtmobil Karlsruhe since 2007
Deposit	-	-	-	-	330.00ú
Registration	-	19.00ú	19.00ú	29.00ú	70.00ú
Monthly fee	-	-	-	-	5.00ú
Booking fee	-	-	-	-	1.00ú
Fee per km [0-20]	-	-	-	-	0.19ú
Fee per km [21-100]	-	-	-	0.29ú	0.19ú
Fee per km [>100]	-	-	-	0.24ú	0.13ú
Fee per minute drive	0.19ú	0.19ú	0.24ú	0.29ú	n. a.
Fee per minute park (6:00 - 24:00)	0.19ú	0.19ú	0.09ú	0.09ú	n. a.
Fee per minute park (0:00 - 06:00)	0.19ú	0.19ú	0.09ú	0.09ú	n. a.
Max. per hour drive	9.90ú	9.90ú	12.90ú	12.90ú	1.28ú
Max. per hour park	9.90ú	9.90ú	3.90ú	5.40ú	1.28ú
Max. per day	49.00ú	237.60ú	39.00ú	39.00ú	20.50ú
Weekend (fr 17 - mo 7)	147.00ú	712.80ú	117.00ú	117.00ú	41.00ú
Fee per 7 days	343.00ú	1.663.20ú	273.00ú	273.00ú	112.00ú
Usage outside Germany	-	-	-	250.00ú	-

This indeed very simple and easy to understand tariff structure from 2009 resulted in the acquisition of more than 10,000 users within the first months, which in majority used the offer as originally intended for one way short-distance trips within the city or region of Ulm. Unfortunately (for the car2go company) this tariff structure also enabled car usage for short-time but long distance trips at minimal costs; e.g. for a two day trip from Ulm to Berlin, with a one-way distance of 700 kilometres the costs charged were just 98.00 Euro, about 25% below the fuel costs for covering such a distance. Abolishing the day flat rate in 2010 minimised such trips, but in parallel also for a day trip to the countryside car2go became absolutely unattractive, when comparing with classical car renting, charging a day or a weekend flat, but fuel costs have to be paid by the user. So in 2011 the day / weekend / week rates came back, accompanied by a modification of time costs, now distinguishing between drive mode and park mode, where the car cannot be driven, but is still reserved for the user, bringing up the problem of long-distance trips charged below fuel cots again. In addition a prohibitive fee for using the car outside Germany was established, to reduce the shrinking of the car fleet due to theft (remember: no deposit is taken from the users). An finally in 2012 the tariff structure of car2go changed once more, now introducing a distance component in parallel to the time component of fees, similar to the tariffs of classical car sharing which remained unchanged in price and structure during the time period considered.

The following table shows the resulting costs for some typical use cases with these different tariff structures tested at car2go in the last years and in comparison also for classical car sharing, as charged in Karlsruhe.

Table 9-3 Comparison of costs (examples), classic and dynamic car sharing

Usage examples (Smart 2-seater)	car2go Ulm 2009	car2go Ulm 2010	car2go Ulm 2011	car2go Ulm 2012	stadtmobil Karlsruhe since 2007
Day trip, ex core area 2 h drive + 10 h park, 200 km, total amount	ú 49.00	ú 118.80	ú 39.00	ú 86.20	**€ 48.36€**
Shopping ex core area 0.5 drive + 1.5 h park, 10 km, total amount(*)	ú 19.80	ú 19.80	ú 12.30	ú 14.55	**€ 5.46**
Cinema core area 10 km, 4 h total or twice just 0.25 h drive, total amount	**€ 4.95**	**€ 4.95**	**€ 6.45**	**€ 6.45**	ú 8.02
2 day long-dist trip 14 h drive + 28 h park, 1400 km, total amount	**€ 98.00**	ú 415.80	ú 78.00	ú 413.20	**€ 230.00**
Day trip, ex core area 2 h drive + 10 h park, 200 km, Cent/km	ú 0.25	ú 0.59	ú 0.20	ú 0.43	ú 0.24(**)
Shopping ex core area 0.5 drive + 1.5 h park, 10 km, Cent/km(*)	ú 1.98	ú 1.98	ú 1.23	ú 1.46	ú 0.55(**)
Cinema core area 10 km, 4 h total or twice 0.25h drive, Cent/km	ú 0.50	ú 0.50	ú 0.65	ú 0.65	ú 0.80(**)
2 day long-dist trip 14 h drive + 28 h park, 1400 km, Cent/km	ú 0.07	ú 0.30	ú 0.06	ú 0.30	ú 0.16(**)

(*) = assuming car parked in the car park of a shopping mall, which is not freely accessible.
(**) = costs indicated for car sharing Karlsruhe do not consider the membership fee. With an applying average annual mileage per user of 1,700 km, this results in about ú 0.04 to add per kilometre.

Comparing these figures points out, that meanwhile (in 2012) dynamic car sharing is only cheaper than classical car sharing for the user on short distance trips within the core area, where reserving the car for the way back is not needed. This applies when public transport is available, when alternatively using a taxi is feasible with reasonable costs, or due to the large amount of cars provided, the probability of a car available within walking distance is very high.

In addition, the uniform structure of the car fleet in dynamic car sharing limits the use cases, where the car type provided fits to the user needs. For the weekly shopping, when carrying larger amounts of baggage or goods or for trips with more than two people, car2go, as provided in Ulm isnû an option. Due to the limited usability of these 2-seater vehicles, from 2008 to 2012 their number at stadtmobil Karlsruhe has shrunk about 20%, while the fleet grew by more than 60%.

These differences to classic car sharing make clear, that the mobility concept of dynamic car sharing does not focus on replacing existing private car ownership, but more to promote car usage instead of public transport in urban areas.

Benchmark figures

The following table shows some indicators on the efficiency and using structure of the two different car sharing principles. Please note that data base for classic car sharing (stadtmobil Karlsruhe) has been provided directly by the company for this case study, while for dynamic car sharing (car2go) no figures from the operator were available, so all those data are derived from different sources like press releases or annual reports found on the internet.

The figures differ seriously for the two car sharing principles. While at classic car sharing the average trip distance is at nearly 100 kilometres, in dynamic car sharing cars are used just mainly for short-distance trips of about 10 kilometres in the urban area. For the number of bookings per car and day this value is below one in the classic system, while more than two bookings per day apply in the dynamic system. The usage of a car per time is one power of ten lower in the dynamic system, what clearly indicates, that almost all rentals are one-way rentals, while the usage of the park mode is rarely used. Significant differences can also be found in the number of user per car and in the annual mileage per user. As registration for car2go used to be for free in the first months this system was established in a specific town, many people used the opportunity to join, but quite a few of them then actually did not or just rarely use it.

As at car2go one-way bookings strictly dominate, an efficiency comparison of both systems should not base on daily booking time per car, which is below 1 hour in the dynamic system, while at classical car sharing in Karlsruhe a car in average is booked about 9 hours per day. For that reason one better compares the annual mileage per car and for that key figure the values for classic car sharing are three times higher as those for dynamic car sharing and lie at 28,000 kilometres.

Table 9-4 Benchmark of classic and dynamic car sharing

Benchmark results	stadtmobil Karlsruhe 2008	stadtmobil Karlsruhe 2012	car2go Ulm 2009	car2go worldwide 2011	car2go worldwide 2012
Fleet size	337	564	300	1,125	4,000
No. of users	5,675	9,136	20,500	61,000	100,000
No. of bookings	94,292	165,359	230,000	1,000,000	3,942,000
Mileage / vehicle [km]	27,127	28,431	7,667	8,889	9,855
Daily hours / car	8.8	9.0	0.7	0.8	0.9
Bookings / vehicle p.a.	280	293	767	889	986
Mileage / user [km] p.a.	1,609	1,755	112	164	394
Mileage / booking [km]	97	97	10	10	10
User / Car	16.9	16.2	68.3	54.2	25.0
Car utilisation by time	36.6%	37.4%	2.9%	3.4%	3.8%
Bookings / User	17	18	11	16	39
Hours / trip	11.5	11.2	0.3	0.3	0.3
Hours / User	190	203	3.7	5.5	13.1
Vehicle km	9,128,302	16,035,070	2,300,000	10,000,000	39,420,000
Booked hours	1,080,944	1,850,968	76,667	333,333	1,314,000

So dynamic car sharing can be characterised by: many cars rarely used by many people on rare occasions. This results in a missing financial sustainability, while stadtmobil Karlsruhe achieved that since starting its business of classic car sharing, as this company was never subsidised with public money nor is a subsidiary of a financially strong enterprise. Referring to a statement of Dieter Zetsche, CEO of the Daimler motor company[24] in January 2011, car2go does not pay out in Ulm for the time being, and he furthermore mentioned that profitability of car2go has not been expected in a medium sized town like Ulm (123,000 / 189,000 inhabitants in the municipality / the whole district), but he wants car2go reaching profitability within three years at least in some cities. Meanwhile car2go has been established in 22 cities, still operating in 21 of them, while this offer has been ceased in Lyon, France, in June 2012.

[24] http://www.augsburger-allgemeine.de/illertissen/Car2go-rechnet-sich-nicht-in-Ulm-id9270191.html

9.3.2 Data Used

Key figures concerning dynamic car sharing (i.e. car2go) have been investigated by internet research, mainly from financial reports, press releases and media articles about car2go. Socioeconomic information for the region of Karlsruhe has been derived from the websites of the specific towns and municipalities. While some key figures on car sharing in Karlsruhe have been provided by the operator or are from the company's website, the majority of the data used in this case study has been derived from the complete booking data for the years 2008 to 2012, provided by stadtmobil Karlsruhe. These more than 600,000 data sets consist of the items indicated in the following table.

The last item "Register date of user" originally is the customer ID in the actual booking data. For reasons of data privacy this has been replaced by the date, when the specific user became a customer of stadtmobil Karlsruhe. This data item is necessary to analyse the long term changes in car sharing usage applying for the different users, which is described in the following section.

Table 9-5 Content of booking data sets

Datset ID
Booking channel (e.g. via internet)
Municipality
Quarter/District
Tariff group (one of eight)
Car type (e.g. Opel Astra)
Plate number of car
Begin of booking (date & time)
End of booking (date & time)
Duration of booking [hours]
Distance [kilometres]
Cost [€]
Register date of user

Results on long-term user behaviour

Instead of preparing a survey among the stadtmobil customers on their user behaviour, we analysed the booking data, which were enriched by the register date of the specific user making a booking. The amount of data and due to their completeness their guaranteed representativeness makes this data source prior to interviews. While some of the results are already incorporated in chapter 9.3.1, sections "The supply side" and "The demand side", this section deals with the results on long term user behaviour, concerning the topic, if using car sharing changes mode choice.

For that reason we defined three groups of users for which we analysed their bookings in the five year period from 2008 to 2012:

- New user, starting their membership in 2007 or 2006 (1148 people in 2012),
- experienced user, starting their membership between 2000 and 2002 (774 people in 2012),
- long-term users, starting their membership before 1999 (367 people in 2012).

It should be mentioned that the size of each group has decreased with the five years period considered (migration, leaving car sharing, due to purchase of an own car or needing a car that rarely that car sharing doesn't pay out etc.). To cope with that for the calculation of the total mileage of trips undertaken by these people per year, only those of each group were taken into account, who actually booked a car in a specific year.

The following figure shows the development of the annual mileage per user from the three different user groups. The user group specific average mileage in each year is displayed with spots and this is complemented by the corresponding trend lines.

For new users, driving in average more than 2000 kilometres by car in the first year; the annual mileage decreases continuously, but with sinking percentage by about 20% to an amount of 1600 kilometres in the fifth year. Also for experienced customers their intensity of car sharing usage decreases with the years, but starting from a lower level of demand (1540 kilometres) and by a smaller share (-5.5%). Finally for the old stagers there is almost no change in their annual mileage to be identified: It varies around 1,300 kilometres with a minimal tendency to grow.

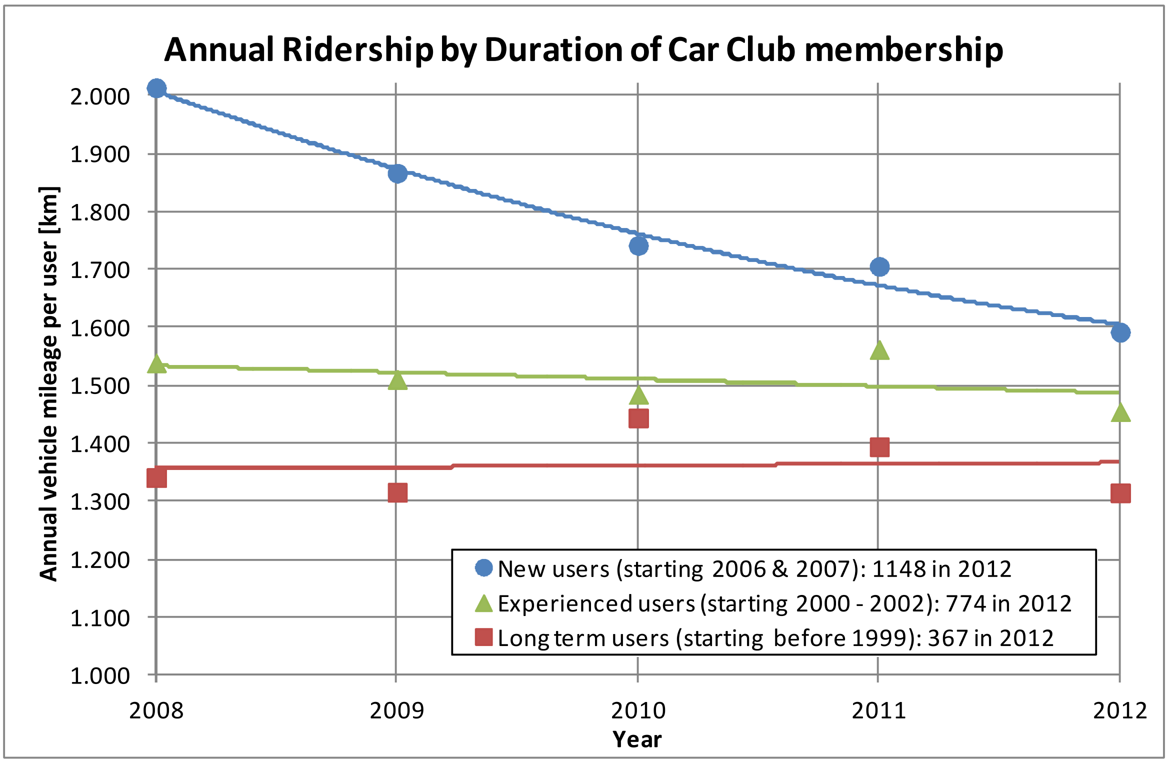


Figure 9-9 Annual ridership by duration of car club membership

Repeating this analysis for the number of annual bookings should similar results as those displayed for the mileage and are shown in Figure 9-10.

But there is one significant difference: While the decrease in mileage for new user is above 20% within the time period considered, their number of trips undertaken diminishes only by about 3.4 trips, what equals to 15.9%. This means that their decrease in demand mainly concerns short-distance trips, while their demand for longer trips remained nearly unchained. So in average this user group undertakes just two more trips by car per year, than experienced or long term users. From this developments in user behaviour one can draw the conclusion, that with long-lasting car sharing usage, a change in mode choice applies especially on short-distance trips, a thesis, which is backed by the long-term analysis of mode choice in passenger transport to/from and within Karlsruhe[25], which developed as shown in Table 9-6.

[25] „Mobilitätsverhalten 2012 – Stadt Karlsruhe", undertaken by omniphon GmbH, Leipzig, 2013; prepared on behalf of the city of Karlsruhe 2013

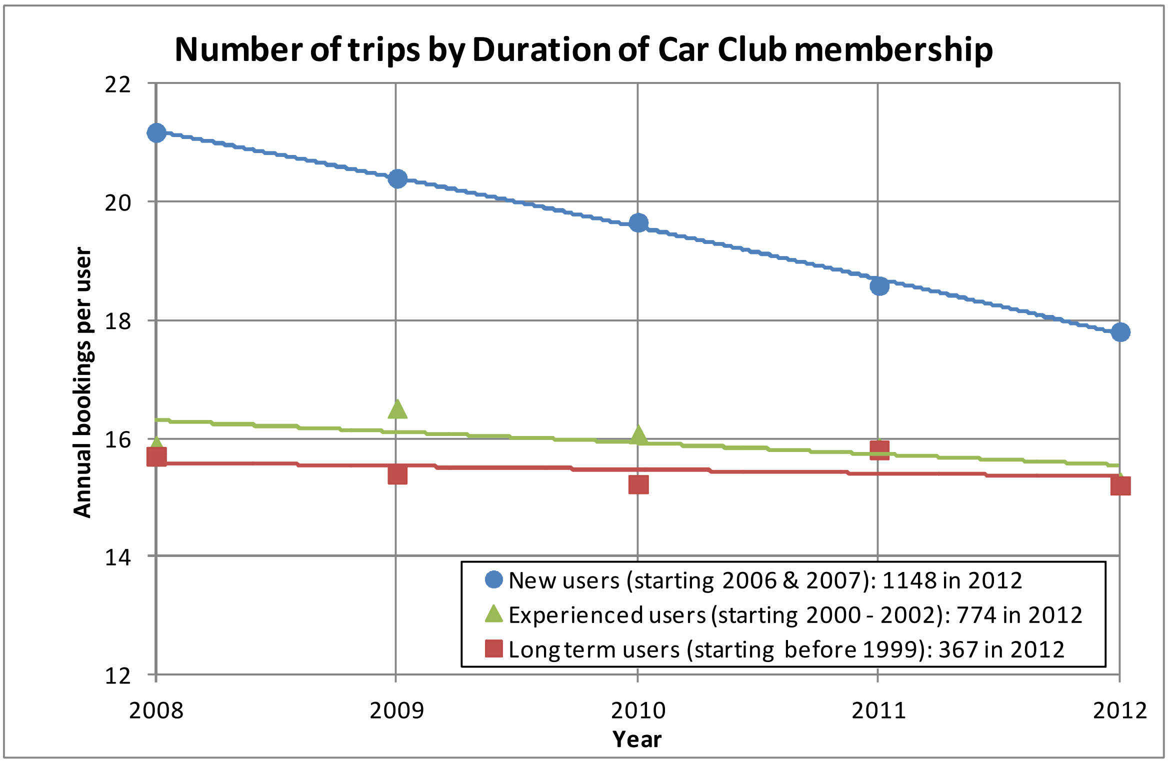


Figure 9-10 Annual number of trips by duration of car club membership

Table 9-6 Long-term mode choice development in Karlsruhe

Mode	Local traffic in Karlsruhe City		Traffic to/from Karlsruhe City	
	2002	2012	2002	2012
By foot	25%	28%	1%	3%
By bike	18%	27%	3%	16%
Car as driver	30%	26%	59%	42%
Car as passenger	9%	7%	17%	13%
Public Transport	18%	15%	20%	26%

Although effects of promoting bike usage in Karlsruhe for the last 10 years may partly overlap the trend in mode choice from car usage to other modes and the development of public transport (ñKarlsruher Modellò) focused in an improvement especially on traffic between suburbs and the city, the vast establishing of car sharing in Karlsruhe may have its part in this development, as reported in the same source for the time being 43% of the households in the city centre of Karlsruhe are not equipped with an own car, while this applies for just 24% in most other parts of the town and in those quarters, where there is no car sharing available, only 11% of households donôt have an own car on their disposal.

Information received from other surveys for this case study

As mentioned in the section before, some figures on mode choice and car ownership have been derived from a mobility study of the city of Karlsruhe.

9.4 Assessment of the Solution - Car Sharing in Karlsruhe

9.4.1 Assessment of Applicability

Investment costs

For setting up a fleet of more than 600 cars with a wide range of different cars as provided by car sharing in Karlsruhe estimated costs total to around ú 10 million, while for implementing a fleet of 300 Smart 2-seater, as done by car2go in Ulm, the estimates costs is around ú 3 million.

At car sharing in Karlsruhe replacing a part of the fleet and for its necessary increase, due to growing demand, it is estimated that the further annual investment costs needed are around ú 2 - 2.5 million. Concerning car2go at Ulm, no figures on necessary replacement or growing of fleet are known, as this fleet has not grown.

For the user of car sharing the investment is just the registration fee (ú 0 to ú 70) and in case of classical car sharing the deposit, which is fully refunded when exiting the system (ú 330). This is minimal when comparing to the costs of buying an own car.

Operation and maintenance costs

On this topic no indications at all were available from the operator of car sharing in Karlsruhe and neither from car2go. Nevertheless the main cost components for operating and maintaining such a system can be mentioned:

- Fuel (as the users pay for that just indirectly);
- Taxes and insurance;
- Staff (administration and maintenance);
- Accruing and imputed interest;
- Rental costs for parking spaces.

Although no indication on these costs has been made available, from a comparison of the costs components applying for a private car[26] the costs applying for a car fleet as provided for car sharing in Karlsruhe sum up to a seven digit number of Euros per year.

Users of classic car sharing only have their monthly membership fee as a kind of ñmaintenance costò.

Financial viability

As stadtmobil Karlsruhe is a limited partnership with a limited liability company as general partner (GmbH & Co KG) which never has received any subsidies and runs the system profitably since 1995, the financial viability of classical car sharing is given. Nevertheless it has to be stated, that sufficient and extensive demand by users is the crucial prerequisite for profitability, as economies of scale apply for quite a few of the cost components of car sharing, a problem the system of dynamic car sharing as implemented e.g. in Ulm has not solved for the time being.

Technical feasibility

As both systems, classic car sharing as well as dynamic car sharing have been established in many cities for quite a few years, the technical feasibility of such systems is given.

Organisational feasibility

As both systems, classic car sharing as well as dynamic car sharing have been established in many cities for quite a few years, the organisational feasibility of such systems is given.

[26] http://www.zukunft-mobilitaet.net/2487/strassenverkehr/die-wahren-kosten-eines-kilometers-autofahrt/

Administrative burden

There are no specific administrative burdens that would be prohibitive.

Legal feasibility

The legal feasibility is given.

User acceptance

As the user figures outlined imply, the principal user acceptance for car sharing irrespective of it being a classic or dynamic system is given. Nevertheless the user acceptance varies strictly with the density of available cars and complementing circumstances like settlement structure, quality of public transport available or the necessity of undertaking daily ways by car.

Public acceptance

Car sharing schemes have a positive public image.

9.4.2 Assessment of Interest for Travellers

Door to door travel time

Using car sharing instead of public transport may shorten travel times, while in comparison to usage of a private car a minimal extension of time needed may apply, depending on the access distance to the position of the car sharing vehicle and the time needed for booking, check-in and checkout procedures.

Door to door travel costs

In comparison to private car usage using car sharing is cheaper up to a distinct annual mileage of about 10,000 kilometres. When comparing to classical car renting car sharing is cheaper on short-time usage, as for rental cars usually a minimum duration of 24 hours applies. Concerning public transport car sharing may be cheaper for multi-person trips, while when travelling alone, public transport in general is significantly cheaper.

Comfort and convenience

Due to the necessity of booking every trip, accessing the car station and undergo the check-in and checkout procedures comfort and convenience of car sharing is slightly lower than that for private car usage, while it may be more convenient to undertake a trip by car sharing than being reliant on the availability of public transport. Also having the choice among different car types may be considered as an increase of comfort, in comparison of owing a single private car.

Safety

When car sharing usage replaces owing an own car (as it is intended by classic car sharing) and therefore less trips are undertaken by car, but more by other modes of transport, an increase of safety may apply. On the other hand, if trips formerly undertaken by public transport are done by car, which is the focus of dynamic car sharing as implemented by car2go, a decrease of safety due to this mode change may apply.

Security

An increase of personal security may apply when using a car instead of public transport, but this is not considered to be at a significant level.

Accessibility for mobility impaired passengers

Using car sharing instead of public transport may improve the accessibility for mobility impaired people, in case they are able to drive a car. On the other hand depending on the length of the access path to the next available car sharing point, accessibility for such users may be more difficult in comparison to a private car parked directly at their home.

9.4.3 Assessment of Modal Change

Car usage

For people not owing a private car alternatively to car sharing, this means of transport could mean a shift towards car usage. On the other hand, people, who replaced their owned car with car sharing, definitely change modal behaviour towards other means of transport in particular public transport. Furthermore, the availability of car sharing will prevent many young people from buying a car in the first place. So, on balance, a shift from car use to the use of buses and train can be expected.

Bus and coach usage

The same arguments as for car usage apply..

Rail usage

The same arguments as for car usage apply.. The same arguments as for car usage apply..

Ferry usage

No impacts.

Aeroplane usage

No impacts.

9.4.4 Assessment of Other Impacts

Increased mobility

The availability of a car on 24/7 basis definitely improves mobility for people not owing a private car, while for people formerly owing a private car, mobility is almost constant. A minor increase may apply when considering access to the car sharing point, while the availability of multiple types of different cars in car sharing improves their mobility slightly.

Congestion

Replacing car ownership by car sharing will lead to less congestion in urban areas, as car sharing users change their modal behaviour towards other modes (public transport, bike).

CO2 emissions

The modal shift and the reduced congestion combine to decrease CO2 emissions.

Contribution to user pays principle

Car sharing does not make any contribution towards paying for the external cost of car use unless a carbon offset is an automatic part of the charge.

European economic progress

Car sharing leads to more efficiency in transport (better usage of vehicles) and therefore makes a small contribution to economic progress in Europe, but not on a European scale.

Territorial cohesion

As car sharing works best in highly populated areas, there is no impact on territorial cohesion.

9.4.5 Assessment against Main Criteria – Summary

Table 9-7 Car Sharing in Karlsruhe - Point score for the criteria

	Score
Investment costs *	úúú
Operation and maintenance costs *	úúú
Financial viability	✓✓
Technical feasibility	0
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	0-✓
D2D travel costs	0-✓
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	+
Ferry usage	0
Aeroplane usage	0
Mobility	0-✓
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

* = for users of the system úú
** = for dynamic car sharing X

9.5 Assessment of the Solution - Karlsruhe Car-Share Booking System

9.5.1 Specific Description of the Solution

In "classical" systems, where each vehicle has its fixed location for picking up / dropping off, the user needs to book a car first, before using it.

The booking system is either a website or an app for smartphones. For booking a car by phone the call centre staffs uses a variant of the website. Online identification of the user is done by log in with user number and password or via phone by name, user number and date of birth stored in the system. Then the booking system displays all pick-up points and cars available in principle in ascending distance around a position to be mentioned by the user (or taken from his default settings, i.e. usually his address known by the system), indicating current times of availability and occupation. Applying filters to this search result (specific date, start time and end time in 30 minutes intervals between on the spot and several months in advance, distinct car type and maximum distance from userȢs location) allows specifying the search. After selecting a specific car for a specific booking period, the user can make an estimation of total costs applicable for this booking, by indicating an intended mileage to travel. The booking finalises by confirming the selection (automatic e-mail is sent to the address stored in the system, also print out of booking confirmation is feasible) and log out. Booking via the app for smartphones mainly uses the same features. When booking by phone, user needs are asked and display results are communicated to the user by the call centre personnel.

The cancellation of bookings is feasible; also rebooking (e.g. extension of booking duration) is possible, subject to availability of alternative times and/or car.

In "dynamic" or "floating" systems, where vehicles (usually just one type of car available) can be picked up/ dropped off at any publicly accessible point within a defined area (usually a distinct town and its suburbs) on the spot and no advance booking applies, booking of cars is done directly at a car available. So the "booking system" is more or less just a GIS application displaying at which exact location a car is available now. Via web or mobile app the user identifies the next available car on a map. If desired the user can select a specific car on this map and block it for 30 minutes free of charge by login with his e-mail address and password stored in the system.

The booking itself starts with identifying by smart card at the car's card reader behind the windscreen which enables the user to open the car and fetch the car key deposited inside the car. The booking is completed when depositing the car key in the key holder fills out the electronic logbook (touch screen) and the user locks the car by smart card at the card reader.

9.5.2 Assessment of Applicability

Investment costs

The booking system of car sharing in Karlsruhe, which is also used by other companies of the stadtmobil group and in principal open to be used by other car sharing operators, does not require any investment costs beside the computer, where it is running. Instead of acquisition costs for using this software a permanent licence fee applies.

Operation and maintenance costs

The costs for running the booking system charged from the company providing the booking software are € 11.00 per vehicle of the car sharing company and month, including maintenance of the system.

Financial viability

Such a booking system is by far is more efficient than administrating the bookings with a stand-alone manual system.

Technical feasibility

As the system is established since many years its technical feasibility is given.

Organisational feasibility

This is a given.

Administrative burden

The system eases the administrative burden considerably.

Legal feasibility

There are no legal barriers for implementation.

User acceptance

The user acceptance of the system is very high. Currently about 60% of the bookings are done via internet.

Public acceptance

This is not an issue, since the general public is not even aware of the system.

9.5.3 Assessment of Interest for Travellers

Door to door travel time

A minimal decrease in booking time may apply when using the internet booking system instead of booking via phone call.

Door to door travel costs

No impact.

Comfort and convenience

The majority of users consider booking via internet as more comfortable than booking via phone call.

Safety

No impact.

Security

No impact.

Accessibility for mobility impaired passengers

No impact.

9.5.4 Assessment of Modal Change

Car usage

No impact.

Bus and coach usage

No impact.

Rail usage

No impact.

Ferry usage

No impact.

Aeroplane usage

No impact.

9.5.5 Assessment of Other Impacts

Increased mobility

No impact.

Congestion

No impact.

CO2 emissions

No impact.

Contribution to user pays principle

No impact.

European economic progress

No impact.

Territorial cohesion

No impact.

9.5.6 Assessment against Main Criteria – Summary

Table 9-8 Karlsruhe car-share booking system - Point score for the criteria

	Score
Investment costs	€€
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	0
Organisational feasibility	0
Administrative burden	✓
Legal feasibility	0
User acceptance	✓
Public acceptance	0
D2D travel time	0-✓
D2D travel costs	0
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	0
Bus and coach usage	0
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	0
CO2 emissions	0
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

9.6 Assessment of the Solution - Data Transfer of Booking Information to/from Pick-up / Drop-off Points of the Cars or the Cars Directly and the Booking System

Two general cases have to be distinguished:

7) ñClassicalò systems, where each vehicle has its fix location for picking up / dropping off;

8) ñDynamicò or ñfloatingò or systems, where vehicles can be picked up / dropped off at any publicly accessible point within a defined area (usually a distinct town and its suburbs).

In ñ**classic" systems** for car usage the client needs to have access to the car key, which is kept in a security container. This container is either stationary at the pick-up / drop off point or just a key holder within car accompanied by a card reader behind the carõs windshield. In consequence the following attributes for a distinct booking have to be transmitted by radio communication between the booking system and the security container / car:

- Registered user identification number;
- Beginning (date and time) of the booked period;
- End (date and time) of the booked period;
- Identification number of car booked.

With his smartcard and the corresponding personal pin code the user identifies himself at the stationary security container to get access to the car key, i.e. checking in. The car technically cannot be used before checking in and check-in only works if it is in line with the data transmitted from the booking system.

After car usage the user puts the car key back into the stationary security container identifying himself again with the smartcard complemented with the personal pin, i.e. checking out. Alternatively the key has to be put in the key holder and the car locked by smartcard at the cars card reader for checking out.

After checking out the car technically cannot be used before another check-in is done.

- Registered user identification number;
- Actual end (date and time) of car usage (pursuant to insurance law);
- Identification number of car

are then transmitted to the booking system.

Note: additional information (mileage as read from odometer, kilometres travelled, whether the car has been refuelled (costs, litres), rating of cleanness, damages at the car etc.) has to be noted in the carõs logbook manually by the user and signed. This information is manually picked by a staff member of the car sharing company within the periodically checks of the carsô conditions. In principal the manual logbook could be replaced by an electronic one where all information collected (either collected electronically or put in by the user) is transmitted electronically to the booking system. In this case all information from the electronic logbook goes to the booking system, which then has not just an interface to the companyõs accounting system, but is more or less interwoven with it. For the time being at the Karlsruhe car sharing, information on mileage and filling level of petrol is already transferred electronically to the booking system; nevertheless the logbook still has to be filled out and signed for legal reasons.

In **dynamic or floating systems**, where cars are used just on the spot, the exact geographic position of a car available for booking is available in the booking system. The user, who wants to take one of the cars, can retrieve this information via a smartphone app or the website of the car sharing company to identify the position of the next available car. Cars available are cars which are neither reserved (see booking system summary) nor for the time being used by another user.

The user then checks in at the car with his smart card at a card reader behind the windshield to open the door. The information that this car is occupied is then transmitted by radio communication to the ñbookingò system (which is more a GIS). After the user identified himself at the touch screen inside the car (entering pin code), rated the car for cleanness etc. and agreed to the conditions of use (this replaces a manual logbook), the car key can be fetched from a holder and the car can be used. Depending on the tariffs a provider offers, during the usage of the car, the user can switch between the drive mode (i.e. the car can be driven) and the ñpark modeò (i.e. the car is still reserved for this specific user and cannot booked by somebody else), but it cannot be moved. Different charges per minute for these two modes apply.

If the user refills at a gas pump, the bill can be paid by a fuel card belonging to the car. After car usage, the user checks out.

- Registered user identification number;
- Actual end (date and time) of car usage;

- Exact geographic position of the car;
- Mileage as read from odometer;
- Amount of time in park and drive mode (if applicable);
- Other details of the car ride (as noted via the touch screen)

are transmitted to the booking system by radio communication.

Concerning privacy protection floating systems enable to collect data, who travelled when from where to where, including places and duration of stopovers, while the classic systems only collect information about who and when.

9.6.1 Assessment of Applicability

Investment costs

The investment cots for a car computer unit including transmitter unit and installation costs are about ú 1,000 per car / per safe at car sharing stations. If a car leaves the fleet, the computer unit can be used for another car.

Operation and maintenance costs

No significant operation and maintenance costs apply, beside those already charged for the booking system, which are at ú 11 per car & month.

Financial viability

As transmitting user data to the car helps to avoid car usage without booking and furthermore abolishes manual collection of user data from the manual logbooks, the system lowers administration costs.

Technical feasibility

This is a given.

Organisational feasibility

This is a given.

Administrative burden

The system lowers the administrative burdens and costs of accounting. Nevertheless a complementing manual log book in the car is still in use for legal reasons.

Legal feasibility

Is given in principal is given, when users identify at the car with their personal pin. As long as the whole fleet is not equipped with that system, the classic manual log book is kept complementary.

User acceptance

Users would welcome the full abolishment of a manual logbook.

Public acceptance

This is not an issue in which the public would take any interest.

9.6.2 Assessment of Interest for Travellers

Door to door travel time

No impact

Door to door travel costs

No impact

Comfort and convenience

Users would welcome the fully abolishment of a manual logbook for added convenience.

Safety

No impact.

Security

No impact.

Accessibility for mobility impaired passengers

No impact.

9.6.3 Assessment of Modal Change

Car usage

No impact.

Bus and coach usage

No impact.

Rail usage

No impact.

Ferry usage

No impact.

Aeroplane usage

No impact.

9.6.4 Assessment of Other Impacts

Increased mobility

No impact.

Congestion

No impact.

CO2 emissions

No impact.

Contribution to user pays principle

No impact.

European economic progress

No impact.

Territorial cohesion

No impact.

9.6.5 Assessment against Main Criteria – Summary

Table 9-9 Karlsruhe car-share booking system - Point score for the criteria

	Score
Investment costs	€€
Operation and maintenance costs	ú
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	✓
Legal feasibility	*0*
User acceptance	✓
Public acceptance	*0*
D2D travel time	*0*-✓
D2D travel costs	*0*
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	*0*
Bus and coach usage	*0*
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	*0*
CO2 emissions	*0*
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

10 CASE STUDY 9 - GRASS-ROOT COOPERATIVE SMARTPHONE-BASED CAR SHARING IN AUSTRIA

10.1 EXECUTIVE SUMMARY OF THE CASE STUDY

This case study investigated four grass-root car-sharing groups in Austrian municipalities where conventional and electric vehicles are shared and booked via a smartphone-based system called CARUSO. This grass-root cooperative car sharing is very well established in all of the four analysed municipalities. Three of the municipalities, Gaubitsch, Thüringerberg and Langenegg, are situated in remote rural areas with dispersed settlement and a scarce public transport network, while the fourth municipality, Bregenz, is a densely-populated urban area with a good public transport network.

The case study consists of focus group interviews and an online survey with the actual users of CARUSO. For comparison the online survey was submitted to CARUSO users and also to users of another grass-root car-sharing platform called Carsharing 24/7, operating mainly in the cities of Vienna and Graz. Additionally, telephone interviews were carried out for analysis of the publicity and experience with car-sharing offers in rural areas in Austria.

The results of the focus group interviews give an overview about the users of the system and their actual usage. The results also show that the high usability of the CARUSO user interface is seen as a very important advantage for car sharing. Even people with little experience with the Internet can manage their bookings online by themselves. Sharing a car is raising their awareness about their own mobility behaviour and can lead to changes in that. Sharing a car can actually substitute the ownership of a car even in remote rural municipalities.

The results of the online survey show that grass-root car-sharing users are typically between 25 and 55 years old, highly educated compared to the general population, typically with university degrees, and well experienced with ICT-based services. More males in the population are users of grass-root car sharing than females. CARUSO, which is used more in the rural area, is used for various purposes of trip such as shopping, business, private and leisure and covering rather shorter travel distances, while Carsharing 24/7, which is used more in the urban area, is more used for leisure and weekend trips covering longer travel distance. Users are typically motivated by the high purchase and/or ownership cost of their own cars and the practicality of car sharing, as well as their limited need for car usage, and concern about the environment.

The telephone survey revealed that, in spite of wide publicity for the term 'car sharing', nobody has ever tried such an offer.

10.2 THE BACKGROUND OF THE CASE STUDY

10.2.1 Motivation for this Case Study

In rural areas and also in small cities in Austria, people are highly dependent on their car for their mobility. In recent years, grass-root cooperative car sharing has evolved; this enables users to form a car-sharing group. It is used both in urban areas and rural areas. In rural areas car sharing has previously been considered unsuitable. This case study was chosen to take a closer look at this particular system.

10.2.2 General Description of the Region

The case study was carried out in municipalities in two Austrian federal states, in Lower Austria (Gaubitsch), and in Vorarlberg (Bregenz, Thüringerberg and Langenegg).

Table 10-1 Overview of the municipalities where surveyed groups are located

Group/ Municipality	Gaubitsch	Bregenz	Thüringerberg	Langenegg
Federal State	Lower Austria	Vorarlberg	Vorarlberg	Vorarlberg
Inhabitants	892	28,007	671	1,064
Form of settlement	Remote rural area	Urban area	Remote rural area	Remote rural area
Public transport	Very scarce public transport network (bus)	Good public transport network (bus)	Scarce public transport network (bus)	Scarce public transport network (bus)

The three municipalities in remote rural areas are characterised by agricultural infrastructure and tourism, hilly landscapes and a scarce public transport network. In contrast, Bregenz is the capital city of the federal state of Vorarlberg, a densely-populated urban area with a good public transport network with frequent service intervals.

Figure 10-1 Locations of the groups surveyed

10.2.3 Stakeholders Involved

There are three main stakeholders involved in grass-root cooperative car sharing, shown in Table 10-2 below.

Table 10-2 Stakeholders and their roles

Stakeholders	System Provider	Group Organiser	Ordinary Users
Roles	Provision of • On-board system • Reservation system • Drive Log • Insurance	• Procurement of shared cars • Contract management • Accounting • Usage of shared car • Payment of user fee	• Usages of shared car that belongs to the group • Payment of user fee
Who can be?	Developer of the system	Private person, municipal office, company, association, etc.	Any who is admitted to be a member

The CARUSO system provider offers a platform which consists of a booking system via the Internet to be used as the user interface and a smartphone app to be installed in the shared car to record the location of the car. A smartphone app to be used as a user interface is under development at the time of the survey as is a non-smartphone on-board system. An additional insurance policy dedicated for CARUSO car-sharing car is supplied by a regional insurance company and provided to the groups via the system provider.

The group organiser takes care of the group including contract management, accounting and so on. The organiser is typically also a user of the shared car.

Each ordinary user books the car via the web browser. Through the booking process, users are shown the availability of cars that belong to the group. The booking is completed with a few mouse clicks and is a fairly easy process. The booking can be made in 30-minute time units. If an electric vehicle (EV) is shared, battery level of the car is shown in the booking system. At the booking system interface, there is a note box in which users can add any information, such as offering a ride share.

10.2.4 Methodology of the Case Study

This case study started with an interview with the system developer. As a desk-based study a comparison with the ñclassicò car-sharing system was made. Focus group interviews with the users were carried out in the aforementioned four car-sharing groups. An online survey was also carried out with the users to capture their profiles and usages. Furthermore, a telephone survey to residents of the rural area was undertaken to capture the publicity of the concept of car sharing.

10.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

10.3.1 General Description of the Case Study

The subject of this case study is grass-root cooperative car sharing.

In contrast to many other existing car-sharing systems in which a car-sharing company provides cars, with grass-root cooperative car sharing it is the actual users who want to share a car ï neighbourhood, office, family, and so on ï who form a group to share an existing or newly purchased car belonging to a user or to the group. The car is shared exclusively among members of each group and therefore no users from other user groups have access. The platform is developed by individuals and is in an experimental phase since 2010. It only provides a reservation and cost-calculation system and an app for a smartphone installed in the shared car to be used as a ñboxò. The cost of car usage is shared by the users and the system developer can cover the cost with an income in a form of software license while so far the software usage is not charged.

In Austria, such grass-root cooperative car sharing is in an experimental phase within a project called CARUSO. In this case study the CARUSO system developer and the users are surveyed to provide a deeper understanding of the system and the user response to it.

10.3.2 Data Used

The data used in this case study consists of three parts: the results from the focus group interviews, the results from the online survey and findings from the telephone survey.

The aim of the focus group interviews with users is to find out how the respondents apply car sharing with the booking system CARUSO in their daily lives, their motivation for starting car sharing and what advantages and disadvantages that the users find in car sharing.

The data obtained from the online survey also contained the user profile as one of key questions is to find out who is actually using the grass-root cooperative car sharing. The online survey was carried out with users of two different private car-sharing platforms in Austria to provide information in a comparable manner. One of the systems is an open peer-to-peer car-sharing system in which any member registered to the system has access to the cars (Carsharing 24/7) the other is a closed grass-root car-sharing system within the user group in which only group members have access to the cars that belong to the group (CARUSO). Carsharing 24/7 tends to be used more in the urban area and CARUSO tends to be used more in the rural area. Detailed information was gathered regarding the demographic profile and mobility profile of those surveyed, as well as their experiences with ICTs - such as to what extent they are used to the internet-based services. It is also interesting to find out the motivation of the users to participate in such grass-root car sharing and to note any possible changes car sharing leads to in their travel behaviour.

For analysing the wider publicity and experience with car-sharing offers in rural areas in Austria a telephone survey was conducted. The focus was on 14 municipalities in the western part (federal state of Vorarlberg) and eastern part (federal states of Burgenland and Lower Austria) of Austria where car sharing offers only exist in a few areas.

Results of the specific survey

The **focus group interviews** revealed that the CARUSO system is very flexible as the car-sharing model differs among the four car-sharing groups in respect of the offered cars, the usage, the hand-over of the key and the pricing for car sharing. Each group has a different background to its formation and different conditions for car sharing. As such, the CARUSO system is very flexible and can easily be adapted to very different groups and conditions. The high usability of the CARUSO system is recognised by the members of the four car-sharing groups as a very important advantage for car sharing. Even the people with little experience with the Internet are able to book for on their own.

Sharing a car raises the awareness of each group member's own mobility behaviour and can lead to behavioural changes. Most of the participants in the focus group interviews own one or more car(s) in their household, and the car-sharing car typically replaces their second car in the households. In some cases sharing a car can substitute the main car even in remote and rural municipalities with scarce public transport.

As the investigated car-sharing groups are also sharing electric vehicles, the CARUSO booking tool is very helpful to estimate the actual driving range of the EV as the battery level is also shown in the booking system.

The motivation for car sharing differs from one group to another but an important common factor is the curiosity as to whether this system will work or not. It is important for people to test such systems to know whether car sharing fits with their mobility behaviour or not. Saving money and saving a second car are also strong motivations for car sharing. If the car is considered as a mean of transport among others and not as a status symbol, and/or it is used for special purposes, the willingness for car sharing is higher.

The findings from the **online survey**, which was not only carried out for CARUSO users but also Carsharing 24/7 users, revealed that more males than females are using grass-root car sharing. Typical users are between 26 and 50 years old, and the users tend to be highly educated compared to the Austrian average. Other aspects such as occupation and car ownership and their usage appear to be around the average. The respondents who do not own a car usually have access to cars of other family members, relatives and/or friends, while most of them prefer the car-sharing vehicle to such other accessible vehicles. Regarding the experiences with ICTs, there seems no practical barrier as most of the users recognise themselves as fairly experienced with the Internet or any other ICT-based services. These features are common among CARUSO and Carsharing 24/7 users.

An important difference between CARUSO and Carsharing 24/7 is found through the online survey is that the CARUSO users, who tend to be in the rural area, appear to use the grass-root car sharing more as their second car, while Carsharing 24/7 users, who tend to be in the urban area, appear to use the car-sharing vehicle more as their main car. Among Carsharing 24/7 users, it seems that there are more people who offer their own cars for sharing. This implies that in the urban area there are many car owners who are ready to offer their car for car sharing.

Regarding the usage of the car-sharing cars, the usage patterns of the two systems are fairly different. CARUSO users tend to use the car-sharing car more for daily travel purposes for shorter distance while the Carsharing 24/7 users tend to use it more as the car for weekend leisure for longer-distance trips. However, this does not mean that the users of each system do not use the car for the other purposes and other distance range. Certain numbers of trips are made with the car-sharing vehicles for business, private and shopping trips, and travel distances of course vary among the trips.

The users appear to be motivated, in terms of mobility-related aspects, mainly by the high cost of having their own cars, regarding both purchase and maintenance, and the occasional need for a car (this applies especially to the Carsharing 24/7 users), as well as the overall convenience of car sharing. In addition, many users are motivated by the thoughts for the environment. Special types of vehicles such as EV or van can play an important role as a motivation; this is more significant among CARUSO users, where such special vehicles are offered..

The two ICT-based solutions surveyed through this research are fairly similar in that the web-based and/or smartphone interfaces enable peer-to-peer car sharing without any large companies offering vehicles to be shared. However, the two systems are fairly different regarding the formation of user groups. CARUSO is a closed-group system where non-members do not have an access to the car designated for the group, while Carsharing 24/7 is an open system and everyone can theoretically use the memberø car once a person is registered to the system. Although the direct effect with/without the formation of group cannot be observed through this online survey, the formation of the group may enable the users to take the car-sharing vehicle with fewer barriers compared to the open system. This aspect has to be studied more precisely to reveal the effect of the group formation.

One major finding of the **telephone survey** is the fact that the term ócar sharingô has very high recognition even in rural areas where there are no such offers. Nevertheless most of the people surveyed have not used a car-sharing offer as of yet. The main reason for not using car sharing is the non-availability of such offers in smaller cities and rural areas. In light of the high publicity of the term car sharing, a higher number of car-sharing offers and locations in rural areas could attract more users. Considering the fact that CARUSO attracts many users attention to substitute the second car in the rural area with a special type of vehicles such as EV and/or van, such grass-root car sharing still appears to have much potential.

Information received from other surveys for this case study

There was no information derived from other surveys.

10.4 Assessment of the Solution - Grass-Root Cooperative Smartphone-Based Car-Sharing in Austria

10.4.1 Specific Description of the Solution

There is only one solution addressed in this case study, the grass-roots car sharing scheme as described in the previous subchapters.

10.4.2 Assessment of Applicability

Investment costs

The CARUSO platform, which is still in an experimental phase, receives public funding as a research project. At a group set-up, each group has to bear about ú 500 to purchase the CARUSO box that is installed in the shared car. This must be different in the older version of CARUSO that employs smartphones for the same purpose, while no concrete price was available during the survey. No further information in detail about financing is available.

Operation and maintenance costs

The CARUSO box costs ú 21 monthly including communication cost via the mobile network. Needless to mention, the fuel and maintenance cost has to be paid by each group. The operation and maintenance cost of the CARUSO platform is not disclosed.

Financial viability

As stated above, there is not much information available about the cost incurred by the system developer. The actual operating cost of the shared car and the cost to obtain and own the shared car, which is supposed to be the largest part of the cost, are paid by the users, and the system typically reduces the cost that the user would have to bear to own a car for his or her own. Thus, in general, users pay most of the cost incurred by the grass-root car-sharing. This implies that, although the cost associated to the platform is not much known, the system seems financially viable.

Technical feasibility

In the older version using an on-board smartphone for logging, the phone had to have a wake-up function that the smartphone automatically starts up when the vehicle's engine is turned on. Among smartphones available in Austria, ones with such function were fairly limited and practically only one model from a Finnish manufacturer was available; however, the production of this model was discontinued and thus there were no smartphones available to be used as an on-board device. This was a barrier once, while this problem was solved with a development of the aforementioned CARUSO-Box.

Organisational feasibility

The CARUSO booking system is fully online and the reservation data are stored at the system developer. This can help to minimise the organisational complexity for administrations. Municipalities which offer car-sharing for their citizens have only low effort because the users can easily book the cars by themselves. Due to the automatic on-board recording, the organisational complexity of cost calculation for each user can also be kept on a minimum.

Complexity could increase with a growing number of group members. Someone in the group should take care of the condition of the car in terms of fuelling or cleanliness which is made difficult by an increasing number of car users. The sharing of electric vehicles can also lead to a higher complexity. Due to the limited driving range of electric vehicles, the charging time and available locations of charging stations have to be planned in advance.

Administrative burden

As already mentioned, this type of a booking system can assist to minimise the organisational complexity for administrations. It would also be difficult if no insurance company offered the dedicated insurance as stated below.

Legal feasibility

The largest problem is probably the vehicle insurance. Although CARUSO offers a special insurance package with the support of a regional insurance company, problems can occur when shared cars are seriously damaged and the question of responsibility in such case is unsolved.

Another important aspect is the national legal framework for renting a car which varies from country to country. For example, in Austria, car-sharing is seen as a commercial activity if it is considered as profit-generating (e.g. if the price for car-sharing is equal or higher than the government-set travel cost per kilometre). Thus, as far as CARUSO remains non-profitable, this problem does not arise, while once it becomes profitable, much complexity is foreseen in this term.

User acceptance

The user acceptance is very high due to the simplicity of the booking system. Even people with limited experience with the Internet are able to manage their online booking. The acceptance by the public for the concept of forming a group for a car-sharing, however, is unknown as of yet.

Public acceptance

The general public image of car sharing is a positive one.

10.4.3 Assessment of Interest for Travellers

Door to door travel time

Private car-sharing can reduce the door-to-door travel time especially in remote rural areas with scarce public transport for those who do not have access to cars. One important factor is the location of the shared car as the matter of the access time to the shared car. In rural municipalities which offer the grass-root car-sharing, the car is mostly in close proximity to the town hall, which is often centrally located in the town.

Door to door travel costs

The costs for car-sharing differ in each CARUSO group as every group can choose the price model the best suitable for their members and their car usage. Thus it is difficult to generalise the travel cost although cost per-km tend to be set lower than the actual per-km user cost. Rather, CARUSO reduces the travel costs in terms of the fixed cost related to car ownership. Approximately 80% of the conventional car costs are estimated to be fixed costs that the owner has to pay even if the car is unused most of the day. With the grass-root car-sharing, such fixed costs can be shared among the group members. Sharing a car on a private basis is thus cheaper than owning a car and is even cheaper than conventional car-sharing.

Comfort and convenience

Grass-root cooperative car-sharing platforms are increasing the comfort for people who want to share a car, even in remote rural areas with scarce public transport and where no other car-sharing offers are provided. People can be independently mobile without owning a (second) car. The ease of using the CARUSO booking system offers a high convenience even for people with less experience with the Internet. One future development will be the function to offer ridesharing.

Safety

It is possible that members of the private car-sharing groups drive more cautiously when they drive the shared cars. In contrast to conventional car-sharing schemes, in private car-sharing groups like CARUSO, the people know and trust each other and thus they tend to feel more responsible for the other group members and the cars. Some participants in the focus group interviews pointed this out.

Security

No impact expected in this rural setting where people know each other anyhow.

Accessibility for mobility impaired passengers

At the moment, no particular platform for the mobility-impaired is provided, while the system can be easily adapted for some of the mobility impaired passengers. Should this be used to share a special vehicle for the mobility-impaired people, accessibility for them will be increased in some case. However, in such case, the user interface has to be updated to suit it.

10.4.4 Assessment of Modal Change

Car usage

For people not owing a private car alternatively to car sharing, this means of transport could mean a shift towards car usage. On the other hand, people, who replaced their owned car with car sharing, definitely change modal behaviour towards other means of transport in particular public transport. Furthermore, the availability of car sharing will prevent many young people from buying a car in the first place. So, on balance, a shift from car use to the use of buses and train can be expected.

Bus and coach usage

The same arguments as for car usage apply.

Rail usage

The same arguments as for car usage apply.

Ferry usage

There is no impact on ferry usage.

Aeroplane usage

There is no impact on aeroplane usage.

10.4.5 Assessment of Other Impacts

Increased mobility

The availability of a car on 24/7 basis definitely improves mobility for people not owing a private car, while for people formerly owing a private car, mobility is almost constant.

Congestion

The number of the car-sharers using the grass-root cooperative car-sharing is small and the users are typically in the remote rural areas. Thus, it is unlikely that the grass-root cooperative car-sharing has any recognisable effect on congestion.

CO2 emissions

Since car sharing supports a modal shift towards public transport, this will make also a contribution towards CO2 reductions.

Contribution to user pays principle

The car sharing scheme does not contribute to paying towards the external costs of travel, unless the charge contain an automatic charge of a carbon offset..

European economic progress

There is no significant impact implied on European economic progress.

Territorial cohesion

There is no significant impact on territorial cohesion.

10.4.6 Assessment against Main Criteria – Summary

Table 10-3 Grass-root cooperative smartphone-based car sharing - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	€
Financial viability	✓
Technical feasibility	0
Organisational feasibility	0
Administrative burden	0
Legal feasibility	0
User acceptance	✓
Public acceptance	✓
D2D travel time	(✓)
D2D travel costs	✓
Comfort and convenience	✓
Safety	(✓)
Security	0
Accessibility for mobility impaired passengers	0
Car usage	(-)
Bus and coach usage	(+)
Rail usage	(+)
Ferry usage	0
Aeroplane usage	0
Mobility	✓
Congestion in overcrowded corridors	0
CO2 emissions	✓
Contribution to user pays principle	0
European economic progress	0
Territorial cohesion	0

11 CASE STUDY 10 - SANT CUGAT INTELLIGENT MOTORWAY TOLL SYSTEM

11.1 EXECUTIVE SUMMARY OF THE CASE STUDY

The Sant Cugat motorway, a toll highway in service since 1991, has been a pioneer in equipping the motorway with systems of management supported by ITS technologies.

The Sant Cugat motorway links Barcelona with Sant Cugat del Vallès, through the Tibidabo hills. The Sant Cugat Motorway is 13 km long and 42% of this is made up of tunnels, the longest being the 2.5 km-long Vallvidrera Tunnel .

Before the Sant Cugat motorway came into service, a regular trip from Barcelona to Sant Cugat took more than 30 minutes. Now a regular trip has been reduced to 20 minutes during peak hours. Sant Cugat and Barcelona are also linked by train. A regular trip from Barcelona Plaça Catalunya (city centre) to Sant Cugat takes 25 minutes.

In the beginning of the 1990s young couples were settled in Sant Cugat looking for a better quality of life and affordable house prices, close to Barcelona. Due to its proximity to Barcelona and the improvements on transport infrastructures, the population of Sant Cugat has grown by 60% since 2000 and almost doubled during the last 20 years.

Tabasa is the operator of the Sant Cugat motorway (also called Vallvidrera Tunnels). Until 2012, TABASA was a public operator owned by the Catalan Government. In 2012, TABASA was privatised and is now owned by ABERTIS.

11.2 THE BACKGROUND OF THE CASE STUDY

11.2.1 Motivation for this Case Study

Sant Cugat Motorway has pioneered the implementation of smart infrastructure equipment, enabling semi-automatic free-flow toll payment already in the 90s, then introducing automatic incident detection systems inside the tunnel, environmental toll reductions for clean vehicles linked to OBU devices, and more recently a computer based HOV recognition system at tolls allowing for automatic vehicle occupancy detection and fare reduction. This case study analyses technological solutions implemented at Sant Cugat Motorway in order to improve safety, reduce congestion and promote environment protection policies.

11.2.2 General Description of the Region

The Sant Cugat motorway was opened in 1991. It is a motorway which links Barcelona with Sant Cugat del Vallès, a municipality located 20 km from Barcelona, in the Tibidabo Hills, in Vallès County.

Source: Google Maps, 2013

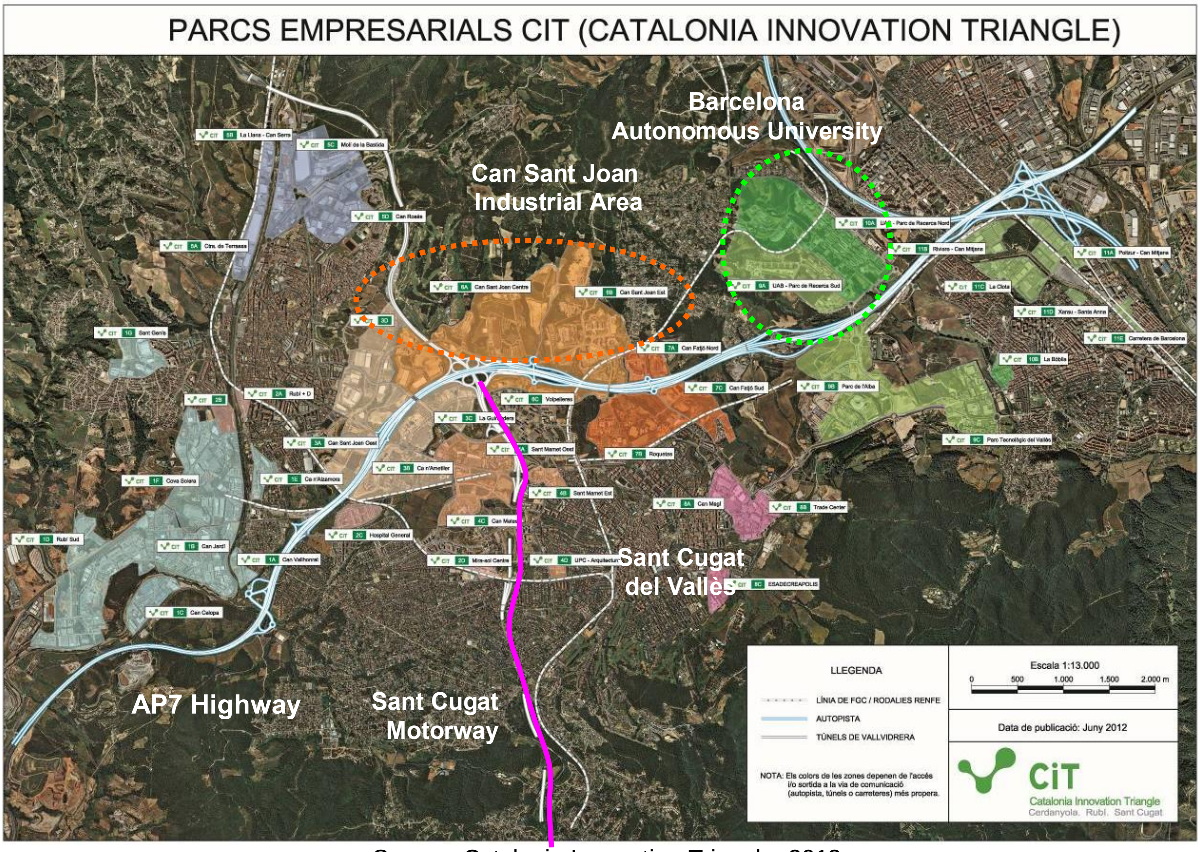
Figure 11-1 Location of Sant Cugat del Vallès and Barcelona

The Sant Cugat motorway links Sarria, a Barcelona neighbourhood with high income per capita, with several towns north of Barcelona - La Floresta, Valldoreix and Sant Cugat.

Source: Google Maps, 2013

Figure 11-2 View of a Sant Cugat street in a new residential area (left) and the Sarrià neighbourhood in Barcelona (right)

The improvements in transport infrastructures (AP7, Sant Cugat motorway and Barcelona regional train), and the proximity to the city of Barcelona and the Barcelona Autonomous University have encouraged the development of large industrial areas around Sant Cugat during the last 20 years. Multinational enterprises such as Deutsche Bank, Roche Diagnostics, and Hewlett Packard are located in the Can Sant Joan industrial area, next to Sant Cugat.

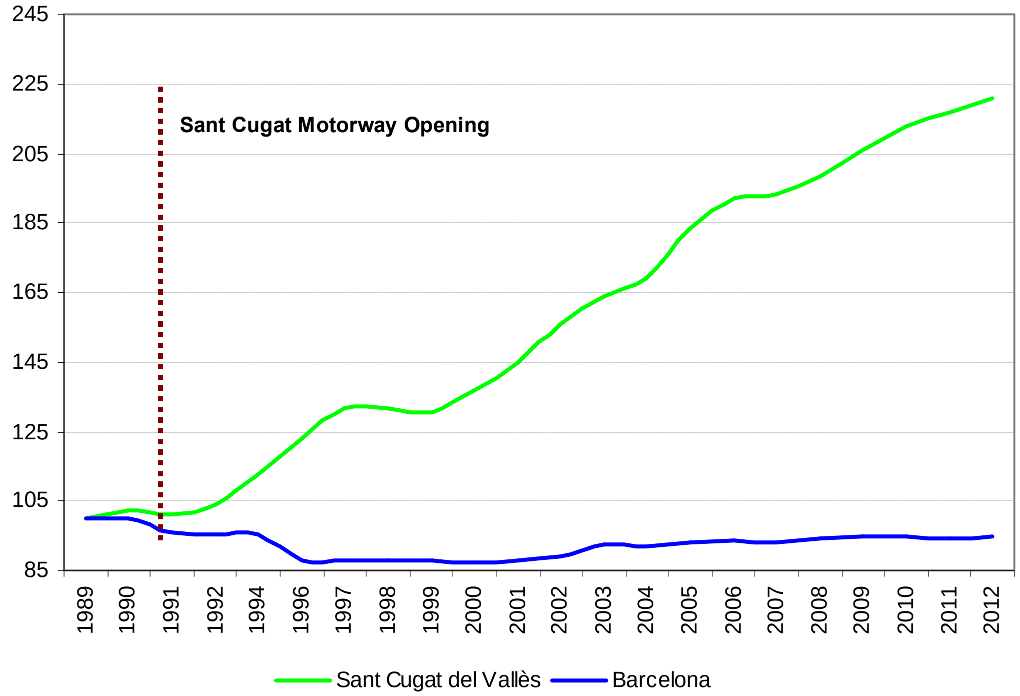


Source: Catalonia Innovation Triangle, 2013

Figure 11-3 Business areas near Sant Cugat del Vallès

Before the opening of the Sant Cugat motorway a trip from Barcelona to Sant Cugat took more than 30 minutes by road; this is now reduced to 20 minutes during peak hours. Sant Cugat and Barcelona are also linked by train. A regular trip from Barcelona Plaça Catalunya (city centre) and Sant Cugat takes 25 minutes.

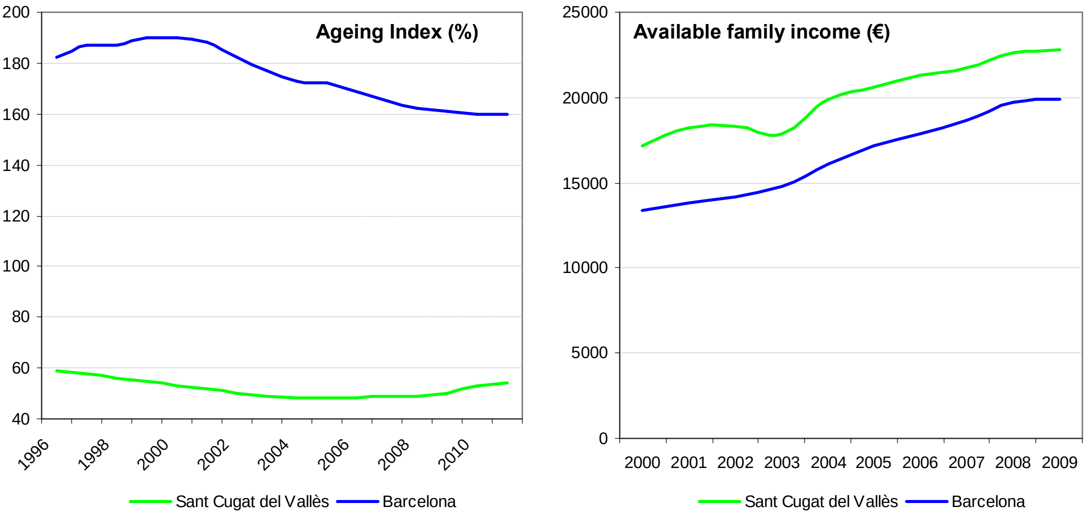
The population of Sant Cugat has increased from 39,000 inhabitants in 1990 to 85,000 inhabitants in 2012. The annual population growth rate in Sant Cugat has been around 5% from 2000 to 2012. During the same period of time, annual population growth rate in Barcelona has been around 0.7%.



Source: Catalonia Statistic Institute, 2013

Figure 11-4 Sant Cugat population growth and Barcelona population growth, 1998 – 2012

Sant Cugat has become a residential city with a young population and high disposable family income, compared to Barcelona. The Sant Cugat population is younger than Barcelonaȇs population: the ageing index[27] is 54% in Sant Cugat and around 160% in Barcelona.



Source: Catalonia Statistic Institute, 2013

Figure 11-5 Ageing index (%) 1996 – 2011 (left side) and available family income (€) 2000 – 2009 (right side)

[27] Ageing index is calculated such as population older than 65 divided population younger than 16.

11.2.3 Stakeholders Involved

Tabasa Infraestructres i Serveis a la Mobilitat SA (TABASA), a public company owned by the Generalitat de Catalunya (Catalan Government), constructed the Sant Cugat motorway. Currently, it manages the maintenance and operation of the infrastructure under toll for 50 years pursuant to a Decree of 1987.

The stockholders of Tabasa are:

- Generalitat de Catalunya (Catalan Government) owns 38% of TABASA;
- GISA (Gestió d'Infaestructures SA), a public Catalan enterprise owned by the Catalan Government, which manages Catalan Infrastructures, owns 53% of TABASA;
- Consell Comarcal del Barcelonès, a local authority, owns 3.5% of TABASA;
- Barcelona Serveis Municipals, Barcelona City Council, owns 3% of TABASA;
- Diputació de Barcelona, a local authority, owns 2% of TABASA;
- Ajuntament de Sant Cugat del Vallès, Sant Cugat City Council, owns 0.5% of TABASA.

The maintenance and operations of the Sant Cugat Motorway were privatised in December 2012 for 25 years. Abertis Infraestrucutras SA bought TABASA for ú 430 million.

Abertis compra Tabasa y Túnel del Cadí a la Generalitat por 430 millones

Los trabajadores de ambas concesionarias celebran el miércoles una jornada de huelga en protesta por el proceso de privatización

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MÁS INFORMACIÓN

- El Govern confía en las privatizaciones para cerrar el año presupuestario
- Abertis lanzará una OPA sin prima por el 40% de OHL Brasil valorada en unos 900 millones
- Abertis compra el 60% de OHL Brasil y lanza una OPA sin prima por el otro 40%
- Fainé: "España se recuperará pronto de la crisis"
- Abertis apunta hacia México y Estados Unidos tras entrar en Brasil

Barcelona. (EFE).- La **Generalitat** ha cerrado un acuerdo con el grupo de infraestructuras **Abertis** para **privatizar** la gestión de los **túneles de Vallvidrera** y del **Cadí**, que operan **Tabasa** y **Túneles del Cadí**, han informado fuentes conocedoras de la operación.

De esta manera, Abertis, en alianza con el banco brasileño BTG Pactual, se hará cargo de la gestión de estos dos túneles, que dependen de las empresas públicas Tabasa y Túnel del Cadí, durante un período de 25 años.
La Generalitat licitó hace más de seis meses el contrato de gestión en la modalidad de concesión de estos dos peajes por un precio de salida de 430 millones de euros.

Sin embargo, Abertis fue la única empresa en presentar una oferta de carácter no vinculante en la fase del concurso, que finalmente acabó declarándose desierto.

Ante esta situación, la Generalitat decidió abrir un proceso negociado con Abertis y otras empresas que manifestaron interés por el concurso para intentar salvar esta privatización. La intención de la Generalitat era mantener en este nuevo proceso las condiciones esenciales del concurso anterior, entre ellas el precio de salida.

Source: La Vanguardia Newspaper, 2012

Figure 11-6 Privatisation of TABASA in the media

11.2.4 Methodology of the Case Study

The methodology followed for this case study is the following:

- Desk work, literature research and press research;
- Analysis of public data available:
  - Annual Report activity of Tunels de Vallvidrera;
  - Annual Report activity of TABASA;
  - Annual budgets of Catalan Government;
  - Website of Tunels de Vallvidrera (http://www.tunelsdevallvidrera.cat);
  - Website of TABASA (http://www.tabasa.cat/);
  - Catalan Statistical Office website (www.idescat.cat).

11.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

11.3.1 General Description of the Case Study

The Sant Cugat Motorway (also known as Tunels de Vallidrera) is a toll highway that came into service in 1991. It links Barcelona and Sant Cugat through the Tibidabo hills. The Sant Cugat motorway is 13 km long and 42% of the motorway is made up of tunnels, the longest of which are listed below.

- Vallvidrera Tunnel: 2.517 m;
- La Floresta Tunnel: 440 m;
- Can Llobet Tunnel: 391 m;
- Valldoreix Tunnel: 857 m;
- Can Rabella Tunnel: 389 m.

Source: TABASA, 2013

Figure 11-7 Sant Cugat Motorway in Barcelona (left picture) and crossing Tibidabo Hills (right picture)

Since 1991 Tabasa and the Sant Cugat motorway have pioneered the introduction of technology for the management of the infrastructure in order to improve safety, reduce congestion and to be environmental friendly. These technological innovations are described below.

Automatic detection of high occupancy vehicles and applications of discounts

Sant Cugat motorway has implemented discounts for vehicles with 3 or more occupants. The discount is applied for users of ViaT. The client must go through the toll lane signalled as VAO3+. The user stops the car in the toll and pushes the button to apply for the discount. The plate and the occupants are photographed. The camera recognises automatically the number of occupants. If the car has 3 or more occupants, the car can go on. The picture is validated manually and the discount is applied at the end of the month by ViaT. This is described in chapter 11.4 below.

Environmental discounts for ecological vehicles

Sant Cugat motorway has implemented discounts for low emissions cars. Drivers with an environmentally-friendly car must be registered on the website www.ecoviat.com, where they need to enter their personal details and their car registration details. Once the service documentation has been completed by a client, the users receive an SMS indicating the date the discount is activated. Having authorised the registration, the next time the vehicle passes through the toll a camera system reads the vehicle registration number and the ViaT number (electronic toll), which enables the registration data to be checked in the management systems. This is described in chapter 11.5 below.

ViaT: Electronic Toll System

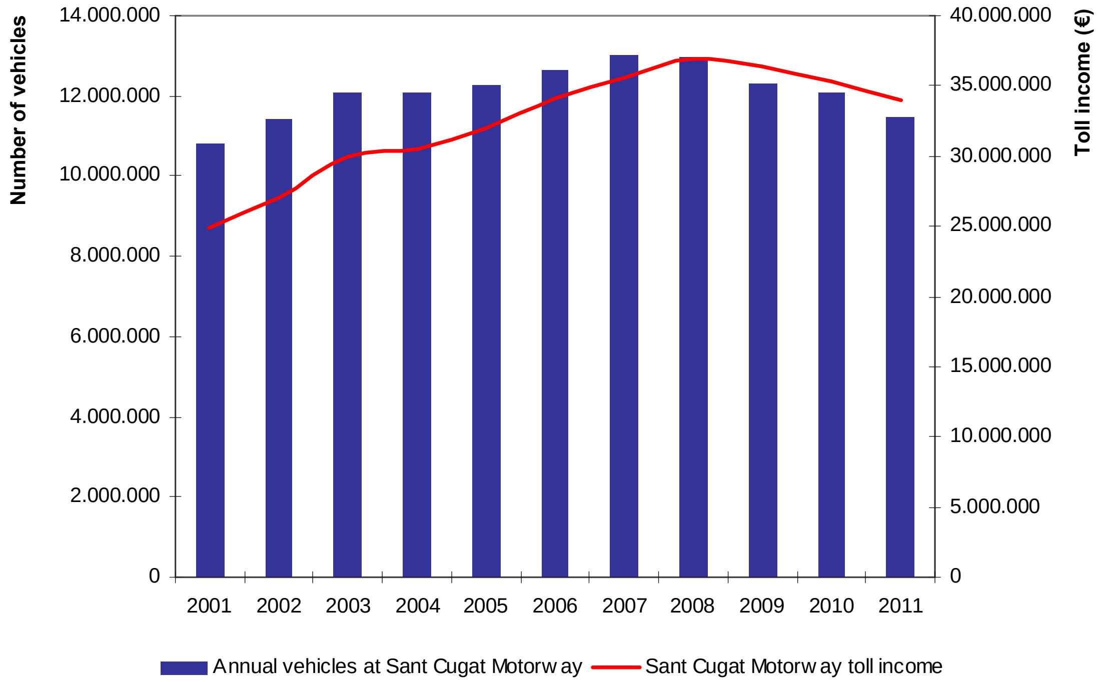
Via T enables clients to make toll payments on the Sant Cugat motorway without having to stop. Once installed on the windscreen of a vehicle travelling along an electronic toll lane, the device is read by the antenna on the lane using DSRC (dedicated short-range communication), the transaction is validated and the vehicle is allowed to pass. The system automatically charges the toll to the clientô s account. This is described in chapter 11.6 below.

Automatic Incident Detection System

Sant Cugat motorway is equipped with technology in order to manage safety inside the tunnels. Each tunnel is equipped with several cameras. When congestion or dangerous situations are detected, a traffic signal located at the entrance of the tunnel manages the traffic. This is described in chapter 11.7 below.

11.3.2 Motorway Traffic and Toll Fees

Annually, 11 million vehicles use the Sant Cugat motorway (39,000 vehicles per day). According to Tabasa, 80% of total traffic uses the motorway during the working day and traffic is concentrated at the peak hour (52%). 95% of total traffic is made up of passenger cars. In 2011, annual toll income was ú 42 million.



Source: TABASA, 2013

Figure 11-8 Annual vehicles and toll income at Sant Cugat Motorway

A regular trip from Barcelona to Sant Cugat del Vallès costs ú 4.20 at peak times and ú 3.73 at off-peak times. A discount for high frequency at off-peak hours is applied for drivers with ViaT. The rebate goes up to 20% of the toll fee (when there are more than 31 trips per month in off-peak hours). Additionally, rebates of 40% of the toll fee for high-occupancy vehicles (HOV) and of 30% for low-emission vehicles (LEV) are available for drivers with ViaT.

Table 11-1 Sant Cugat Motorway fee and discounts available

	Timetable	Fee	High frequency (HF)	HOV	LEV	HOV+ LEV	HOV+LEV+ HF
Peak hour (Working days)	From 7.00am to 10.30pm From 5.00pm to 9.00pm	€ 4.25	-	€ 2.57	€ 2.99	€ 1.31	-
Off-peak hour (Working days)	From midnight to 7.30am From 10.30am to 5.00pm From 9.00pm to midnight	€ 3.73	€ 3.04	€ 2.57	€ 2.99	€ 1.31	€ 0.43
Weekend	All day	€ 3.73	€ 3.04	-	-	-	-

Note: the fee provided includes the maintenance cost of ViaT, estimated in 0.05 per trip

Source: TABASA, 2013

11.4 ASSESSMENT OF THE SOLUTION - AUTOMATIC DETECTION OF HIGH OCCUPANCY VEHICLES AND APPLICATION OF DISCOUNTS

11.4.1 Specific Description of the Solution

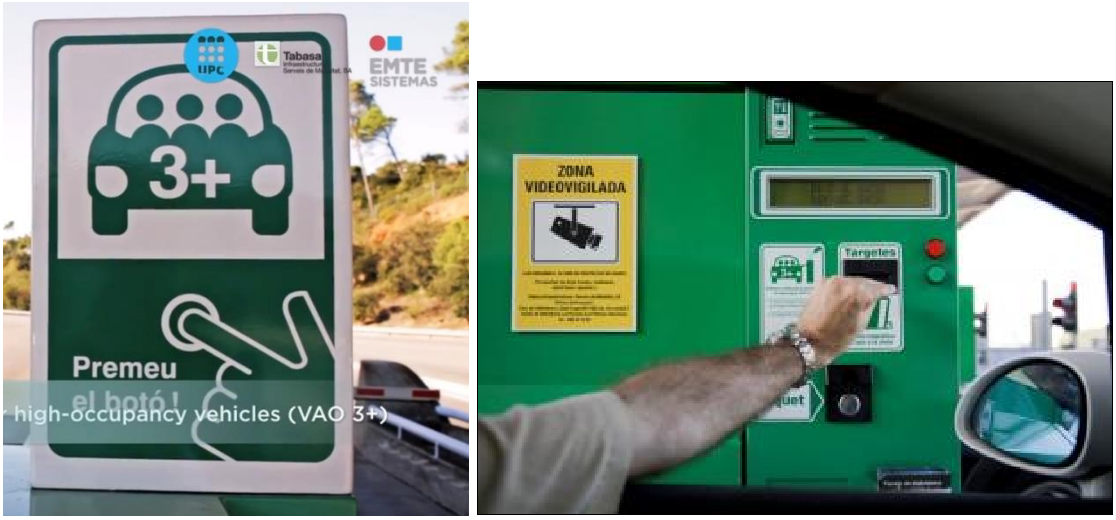
In order to reduce releasing polluting gas emissions into the atmosphere, to reduce congestion of traffic at the entrance to the city of Barcelona and to promote rational use of private vehicles, Sant Cugat Motorway implemented in 2010 a 40% rebate on the toll fee for vehicles with three or more occupants. The HOV discount is applied from Monday to Friday.

The automatic detection of High Occupancy Vehicles (HOV) detects the number of occupants of the vehicle, and if the system counts three or more passengers, the toll fee will be reduced. The HOV discount can only be applied for owners of ViaT (Electronic Toll Payment System). To apply for the HOV discount, the vehicle must pass through the lane toll signalised as VAO3+.

Source: TABASA, 2013

Figure 11-9 View of HOV lane at Sant Cugat Motorway

Then, the vehicle has to stop at signalised toll plaza and the driver has to press a button to apply for the discount. When an HOV driver presses this button, he accepts to be recorded by the cameras. The process of validation takes 3 seconds.



Source: TABASA, 2013

Figure 11-10 View of toll area

An automatic detection system has been designed by TABASA, Technical University of Catalonia (UPC) and EMTE (Private Company). The system for automatic detection of HOV is composed of optical cameras and the software.

Optical cameras

Two optical cameras are placed at the toll area, one on the left side and the other one on the right side, both in front of the car. These cameras register the images of the inside of the vehicle from different angles. The multiplicity of viewpoints eliminates errors caused by reflections and refines the detection of faces. This innovative system avoids recognition errors and it is able to distinguish between human bodies and mannequins.

Source: TABASA, 2013

Figure 11-11 View of the cameras installed at toll area

The software

The cameras are linked to software developed specially to detect faces automatically. The software processes automatically the images taken and counts the number of faces. If the system detects three or more passengers, the toll barrier is opened. However, the discount is not applied at that moment because the automatic detection system is supported by manual checking to ensure complete reliability. When the image has been validated, the discount is applied. All the accumulated discounts are applied once at the end of the month.

Source: TABASA, UPC, COMSA, 2013

Figure 11-12 Automatic image processing to detect the number of occupants in each vehicle

In order to avoid privacy issues, the images taken at the toll plaza and validated manually by TABASA personnel will be deleted after six months. It is expected that the manual checking process will be used in coming years only when a driver applies for a discount and the software rejects it.

11.4.2 Assessment of Applicability

Investment costs

According to the Activity Report of TABASA 2010, the development of the automatic detection system for vehicles occupied by three or more persons at the toll plaza is estimated to be ú 116,000. This cost includes the development of technology. The automatic face recognition system has been developed partly by the Technical University of Catalonia.

Operation and maintenance costs

Once the recognition face software has been developed, the maintenance cost is expected to be low.

Financial viability

When TABASA introduced HOV discounts at Sant Cugat Motorway was a public operator, and the pay back was expected in term of the saving in social costs for congestion. After the privatisation of the operator no changes have been made.

Technical feasibility

Faces are complex objects and detecting them remains a challenging task for computer vision systems, despite the relative ease with which humans are able to do so. The principal problems in this system are occlusions, illumination changes and false positives. It is very normal to find occluded faces in this system since both front seat and rear passengers can be partially occluded by many parts of the vehicle or their body position. Sunlight reflections produce many illumination changes that lead to shifts in the location and shape of shadows, changes in highlights and reversal of contrast gradients, complicating face detection.

Organisational feasibility

No problems involved.

Administrative burden

The manual checking of all images is a major administrative burden. This burden will be reduced once when the checks are only made if a driver applies for a discount and the software rejects it, but it will remain substantial.

Legal feasibility

The main concerns with this technology are the issues related to user privacy. The technology developed avoids recognising faces and images taken at toll plaza. The images are deleted after six months. However, when the driver presses the button to apply for HOV discount at toll plaza, he accepts to be recorded.

User acceptance

In 2011, 5.74% of total Sant Cugat Motorways private cars could apply for the discount. According to a TABASA Survey and due to complex procedures for obtaining HOV discount,, just the 36% of drivers have applied for the HOV discount, and there 36% are certainly very satisfied users. The fact is that HOV discount can only be applied to users engaged in the ViaT program. ViaT has a yearly cost of 12 euros plus a one-time payment of 34 euros for the acquisition of OBU receptor.

Public acceptance

Public acceptance should be high, because HOVs reduce congestion on the road for other users.

11.4.3 Assessment of Interest for Travellers

Door to door travel time

The needs to stop until the picture is validated will very slightly increase travel time.

Door to door travel costs

A regular fee for a car at the Sant Cugat Motorway is ú 4.20 (ú 4.25 including ViaT). A high occupancy vehicle saves ú 1.68 (40%) per trip. HOV discounts can be accumulated with other discounts for low emissions vehicles or high frequency drivers.

Comfort and convenience

No impacts expected on comfort and convenience.

Safety

No impacts expected on safety.

Security

No impacts expected on security.

Accessibility for mobility impaired passengers

No impacts expected on accessibility.

11.4.4 Assessment of Modal Change

Car usage

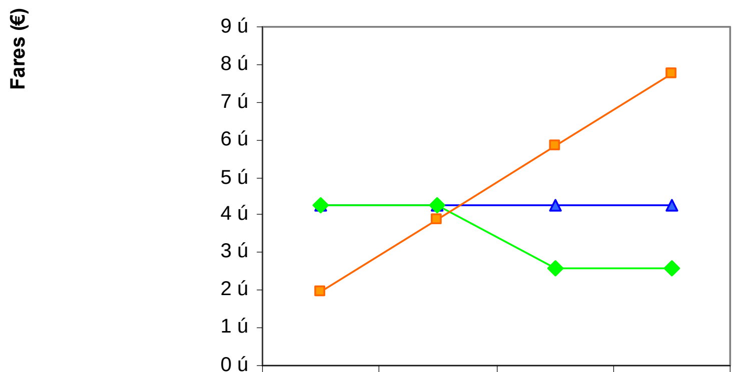
This measure is not designed to induce modal change. The aim of this measure is to reduce the use of private car and CO_2 emissions at Barcelona main entry roads, but with the HOV discount the private car could for 3 passengers or more become financially even more attractive than the train (see below).

Bus and coach usage

No impacts expected.

Rail usage

The cost of 3 train tickets from Barcelona to Sant Cugat del Vallès is ú 5.82. The toll fee at Sant Cugat Motorway is ú 4.25, and for an HOV even only ú 2.57 including the cost of ViaT, estimated at ú 0.05 per trip. Therefore using the toll road is financially more attractive than train use, and the HOV discount even increases this discrepancy.



	1	2	3	4
Regular toll fare	4,25 ú	4,25 ú	4,25 ú	4,25 ú
HOV fare	4,25 ú	4,25 ú	2,57 ú	2,57 ú
FGC	1,94 ú	3,88 ú	5,82 ú	7,76 ú

Vehicle occupancy (number)

Regular toll fare — HOV fare — FGC

Source: TABASA and FGC, 2013.

Figure 11-13 Regular toll fare, HOV toll fare and cost of a trip by train

Ferry usage

No impacts expected.

Aeroplane usage

No impacts expected.

11.4.5 Assessment of Other Impacts

Increased mobility

No significant impact expected.

Congestion

No data exists to determine where the balance lies between the reduced car usage because more people share one car on the one side and how many more people use the car than the train because of the financial incentive.

CO2 emissions

HOV policies will trend to reduce CO2 emissions as long as they do not attract passengers from public transport nodes to use the car instead. The balance of impacts of the HOV discounts at the Sant Cugat Motorway is unknown.

Contribution to user pays principle

No impact expected.

European economic progress

No impact expected.

Territorial cohesion

No impact expected.

11.4.6 Assessment against Main Criteria – Summary

Table 11-2 Sant Cugat Automatic Detection of High Occupancy Vehicles and Applications of Discounts - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	€
Financial viability	(✓)
Technical feasibility	(X)
Organisational feasibility	*0*
Administrative burden	X
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	(X)
D2D travel costs	✓
Comfort and convenience	*0*
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	*0*
Bus and coach usage	*0*
Rail usage	-
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	*0*
CO2 emissions	*0*
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

11.5 Assessment of the Solution - Environmental Discounts for Ecological Vehicles

11.5.1 Specific Description of the Solution

In order to promote the use of energy efficient vehicles, the Sant Cugat Motorway has implemented in 2012 a 30% discount on the toll fee for low polluting vehicles. The aim of introducing discounted fees for Low Emissions Vehicles (LEV) is to compensate vehicles that pollute less in order to promote sustainable mobility and thus attain the levels of air quality set by current European legislation.

The drivers who want to apply for an LEV discount must fulfil the following conditions:

- Be owner of a passenger vehicle;
- The vehicle must be registered on EU Member State;
- LEV discount is only applied for owners of VIA T (electronic toll system);
- The user must apply for the discount when he goes through the toll plaza.
- Technical requirements to be classified as Low Emission Vehicle:
    - All LPG, natural gas, hydrogen and electric vehicles;
    - Diesel and biodiesel vehicles: CO_2 emissions below 108 g/km;
    - Petrol vehicles and other fuels: CO_2 emissions below 120 g/km.

The technological components of low emissions vehicles discounts are presented below.

Website Portal EcoViaT

An owner of a low emission vehicle, who wants to apply for LEV toll discount at the Sant Cugat Motorway, must be registered on the website www.ecoviat.com. The driver must provide his personal details and fill in the vehicle details.

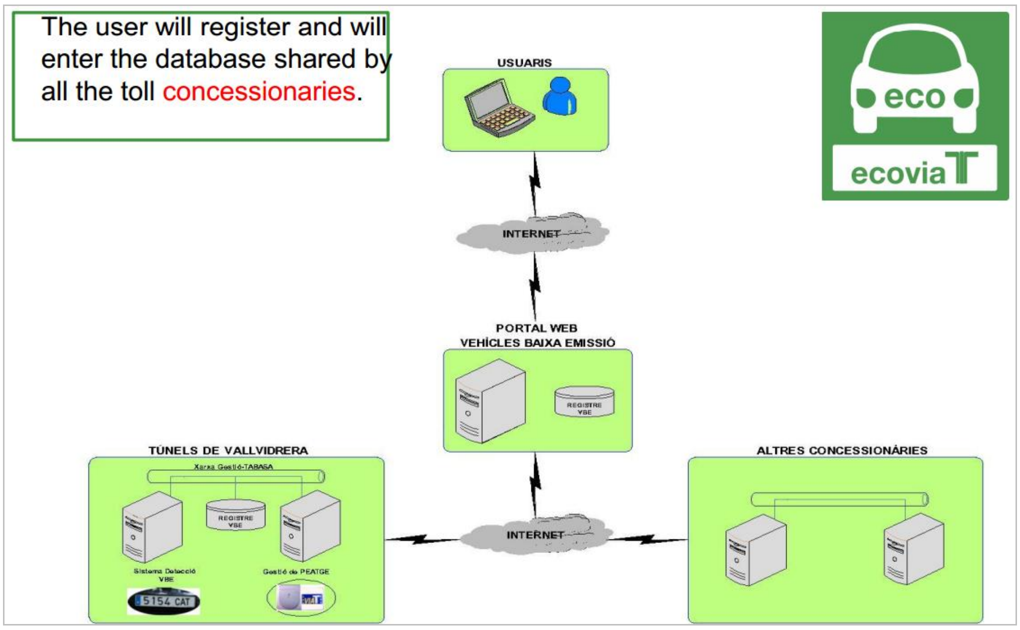
The official documents that attest compliance with the conditions to be classified as LEV must be presented in person at the customer services department of Tabasa:

- Vehicle specification sheet or an official certificate published by the manufacturer indicating the level of emissions;
- Vehicle registration certificate; and
- MOT (technical inspection of vehicle).

Figure 11-14 Homepage of EcoviaT website (www.ecoviat.com)

LEV Database

When the driver is registered at the EcoviaT website and he has provided the official vehicle documentation, the vehicle is registered at the LEV database. The LEV database is shared with other Catalan highway concessions, which also offer discounts for low emissions vehicles. At this point, the registry process is complete. The driver receives an SMS indicating the date when the discount is activated.

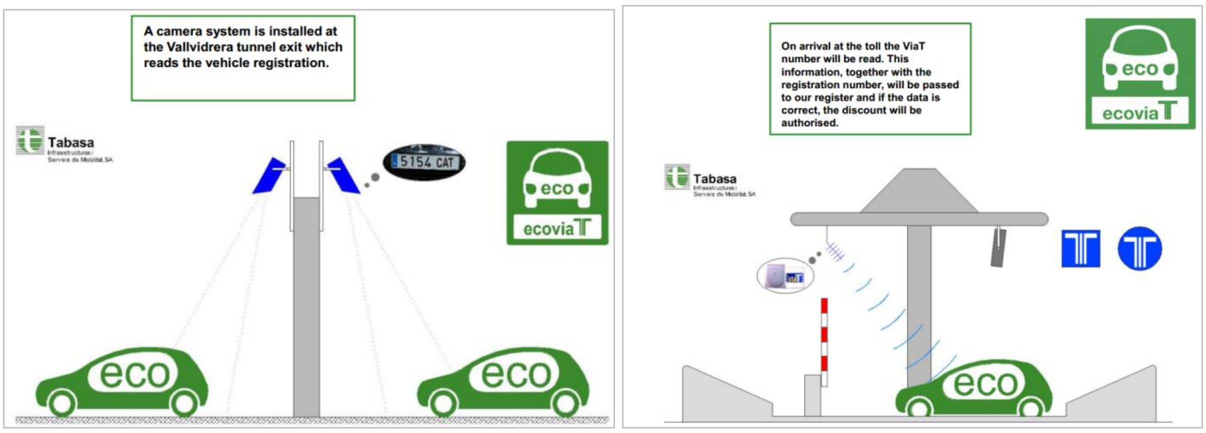


Source: TABASA, 2013

Figure 11-15 Technological components of LEV discounts: database, LEV web portal, automatic detection system of LEV and ViaT

Automatic cameras at the toll area

When the vehicle passes through the toll, a camera system reads the vehicle license number and a radio system reads the ViaT number (electronic toll payment system). Both data are checked in the management systems (ViaT register and LEV database). When the data matches, the LEV discount is applied, pursuant to the conditions of each concession.



Source: TABASA, 2012

Figure 11-16 Automatic cameras system at toll plaza

11.5.2 Assessment of Applicability

Investment costs

According to Activity Report of TABASA 2011, the development of a system to implement the discounts for low emission vehicles at the toll plaza is estimated in ú306,800. This cost includes the update of the TABASA network (software and servers), the automatic detection system of low emissions vehicles (optical cameras) and finally the cost of setting up of the ecological vehicles database and web portal EcoviaT.

Operation and maintenance costs

The main maintenance cost is the update of low emissions vehicles database and the management system, which is relatively low.

Financial viability

The setting up of the ecological vehicle database and the portal web EcoviaT has been financed by TABASA. When TABASA introduced LEV discounts at the Sant Cugat Motorway was a public operator, and therefore the payback was expected in terms of the social benefits of reduced emissions. After privatisation of operator no changes have been performed.

Technical feasibility

It was straightforward to implement the system.

Organisational feasibility

No problems organisational envisage because Catalan Government manages a single database with all low emissions vehicles registered which is consultable for different concessionaries that operate within the Catalan Highways.

Administrative burden

There is some administrative burden through the fact that drivers have to appear in person at the operatorsôoffices with the vehicle registration documents, but this burden is not at a significant level.

Legal feasibility

The main concern with this system is the issues related to private data provided by the owner of LEV to TABASA. When a driver registers to LEV database accepts that their personal details are transferred to other highway operators.

User acceptance

It is estimated that 4.7% of total vehicles of Sant Cugat Motorway are ecological. The discount was set up in 2012. So far only 10% of these vehicles are registered on the website, and these 10% will be very satisfied users. Furthermore, there is no reason to believe that those who have not registered yet are doing so because they have any objections against the system, but more likely out of lack of awareness, lack of access to the internet and similar reasons, and it is expected that the user acceptance and knowledge of the LEV discount will increase in the coming years.

Public acceptance

Public acceptance is high, since everybody benefits from the incentive to drivers to buy green cars.

11.5.3 Assessment of Interest for Travellers

Door to door travel time

No impact expected.

Door to door travel costs

A regular fare for a car at Sant Cugat Motorway is ú 4.20 (ú4.25 including ViaT). The discount system has reduced the regular fare by 30%, and a low emissions vehicle saves ú 1.26 per trip.

Comfort and convenience

No impacts expected on comfort and convenience.

Safety

No impacts expected on safety.

Security

No impacts expected on security.

Accessibility for mobility impaired passengers

No impacts expected on accessibility.

11.5.4 Assessment of Modal Change

Car usage

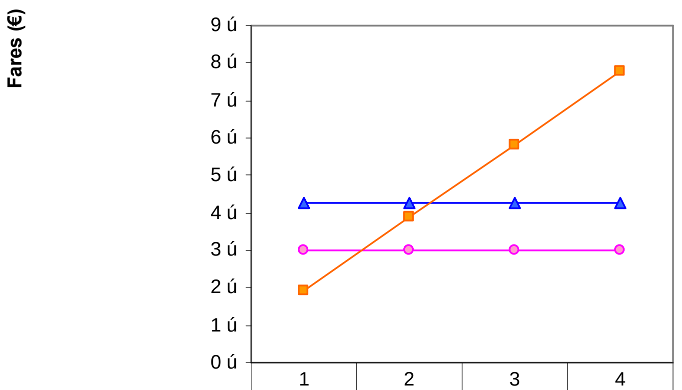
This measure is not designed to induce modal change. The aim of this measure is to reduce the CO_2 emissions at Barcelona entry main roads. However, the private car could become more attractive than train.

Bus and coach usage

No impacts expected.

Rail usage

This measure could increase the attractiveness of the private car in front of train (FGC) because the cost of 2 train tickets from Barcelona to Sant Cugat del Vallès is ú 3.88. The toll fee at Sant Cugat Motorway for LEV is ú 2.99, including cost of ViaT estimated in ú 0.05 per trip.



	1	2	3	4
Regular toll fare	4,25 ú	4,25 ú	4,25 ú	4,25 ú
LEV fare	2,99 ú	2,99 ú	2,99 ú	2,99 ú
FGC	1,94 ú	3,88 ú	5,82 ú	7,76 ú

Vehicle occupancy (number)

Regular toll fare — LEV fare — FGC

Source: TABASA and FGC, 2013

Figure 11-17 Regular toll fare, LEV toll fare and cost of a trip by train

Ferry usage

No impacts expected.

Aeroplane usage

No impacts expected.

11.5.5 Assessment of Other Impacts

Increased mobility

No impacts expected.

Congestion

No significant impacts expected.

CO2 emissions

LEV discount policies are an incentive for regular motorway users to buy a green car and is therefore likely reduce CO_2 emissions, Even if some travellers may change from train to car use, they either have to have an LEV already or, in the best case, may be induced to buy one instead of their high polluting old car.

Contribution to user pays principle

No impacts expected.

European economic progress

No impacts expected.

Territorial cohesion

No impacts expected.

11.5.6 Assessment against Main Criteria – Summary

Table 11-3 Sant Cugat environmental discounts for ecological vehicles - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	€
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	*0*
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	*0*
D2D travel costs	✓
Comfort and convenience	*0*
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	(+)
Bus and coach usage	*0*
Rail usage	(-)
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	*0*
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

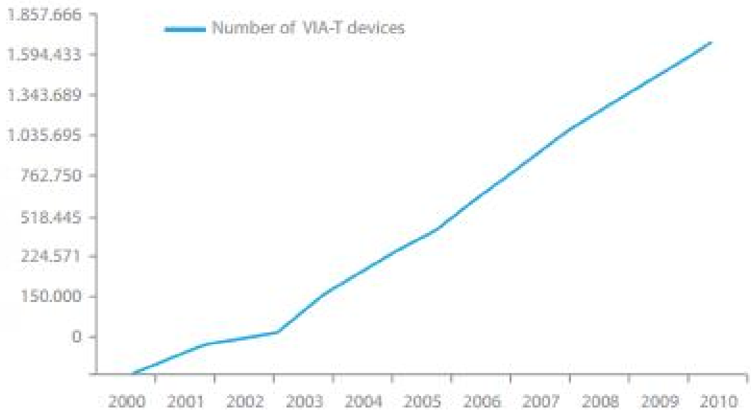
11.6 Assessment of the Solution - Via T: Electronic Toll System

11.6.1 Specific Description of the Solution

In Spain there is an interoperable electronic toll system called VIA-T that has been designed and developed by concessionaires themselves in collaboration with issuing companies. VIA-T has been operational since 2003 and enables clients to make toll payments on all motorways in the Iberian Peninsula without having to stop. Some car parks also operate using VIA-T. Clients can get their electronic toll device from many financial institutionsôbranch offices as well as from companies offering payment and management services to freight firms.

The electronic system implementation was a great success. According to *Toll Motorways in Spain* (ATESA, 2011), nearly 2 million on-board devices have been already distributed and almost 200 million transactions are processed every year.

It is currently the most commonly used means of payment on motorways, together with credit and debit cards.



Source: *Toll Motorways in Spain 2011*, ACESA, 2011

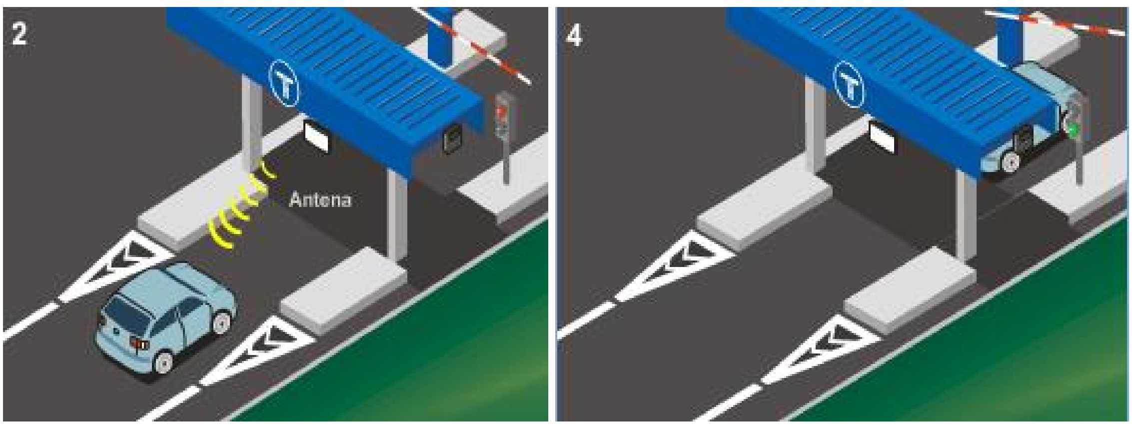
Figure 11-18 Number of Via-T devices 2000 - 2010

To become operational, the electronic device of ViaT has to be installed on the windscreen of the vehicle. The ViaT is linked to the driver's bank account.

Source: TABASA, 2013

Figure 11-19 Electronic device of ViaT

When the vehicle equipped with ViaT is approaching a toll plaza, it has to reduce the speed to 20 km/h. An antenna, which uses a DSRC System (Dedicated Short Range Communication), located at toll plaza reads the ViaT electronic device. The system validates the operation and the vehicle is allowed to pass. The system automatically charges the toll fare to the driver's account.



Source: ViaT, 2012 (http://viat.es/)

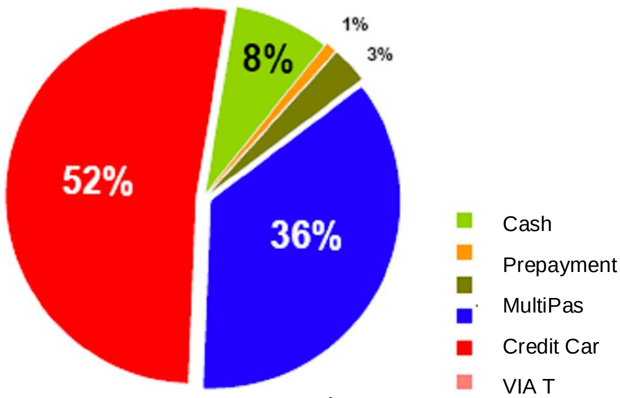
Figure 11-20 Via T: electronic toll system

The lanes where ViaT is operable are signalised with a white T on blue background.

Source: Google Maps

Figure 11-21 View of ViaT exclusive lanes at the Sant Cugat Motorway

When the Sant Cugat motorway was opening in 1991, an electronic system based on radio waves and linked to client bank account was implemented in order to pay the toll without stop on it and reduce travel time. The system has been improved and in 2003, TABASA introduced the current electronic toll system (VIA-T), which is interoperable at European level. Since then, the use of VIA-T has steadily increased (in 2011 by 6%) and currently almost 50% of total traffic pays with VIA-T, while only 36% of users pay by credit card and just 8% pay in cash.



Source: Tabasa, 2012

Figure 11-22 Distribution of traffic in by type of payment during January 2012

The registration fee of VIA-T is ú 34. Every five years the electronic device of VIA-T must be renewed. The annual bank management fee is ú 12. The estimated cost of ViaT per trip is ú 0.05 under the hypothesis of two trips taken per day (only school days).

TABASA applies special discounts for high frequency drivers and owners of VIA-T at off peak-hours and at week-end as stated before. High frequency drivers with ViaT can apply for combined discounts to save up to 90% per trip: 40% of discount for high occupancy vehicles (3+), 30% of discount for low emissions car and 20% of discount for all users who do at least 31 trips per month.

The discounts available are presented in the table below.

Table 11-4 Discounts for regular users and owners of Via-T (including cost of Via-T)

	Discount for regular users	Cost per trip (off peak hours and weekends)
Up to 10 trips per month	0%	ú 3.78
From 11 trips per month to 20 trips per month	10%	ú 3.41
From 21 trips per month to 30 trips per month	15%	ú 3.22
More than 31 trips per month	20%	ú 3.04

Source: TABASA, 2013

11.6.2 Assessment of Applicability

Investment costs

Although no data is available, the investment cost of ETC systems such as ViaT is not expected to be an important barrier because it has been spread out to more than 30 countries.

Operation and maintenance costs

Based on other experiences, ETC system enables decreases down to 1/3 of the transaction costs, when compared to manual toll collection.

Financial viability

The strong decrease in transaction costs makes the system clearly very viable.

Technical feasibility

ViaT has been in operation since 2003 and no technical barriers have been identified.

Organisational feasibility

No organisational barriers found.

Administrative burden

The system reduces the administrative burden of processing toll payments.

Legal feasibility

No legal barriers.

User acceptance

The ViaT (Electronic toll payment system) is highly accepted by road users. More than a half of the Sant Cugat Motorway drivers pay with ViaT.

Public acceptance

Non-users should welcome the system, since it reduces queues at conventional toll booths.

11.6.3 Assessment of Interest for Travellers

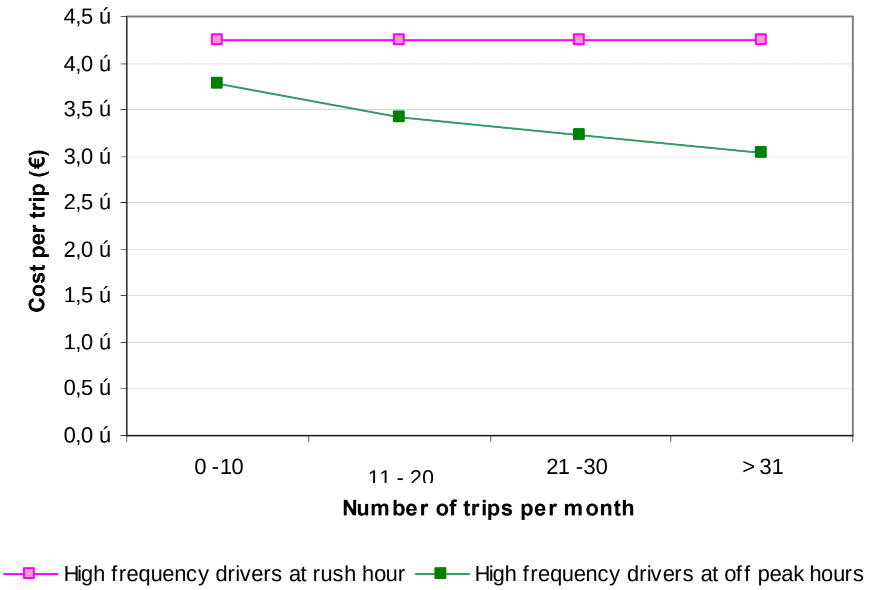
Door to door travel time

The application of ViaT saves time waiting at toll gates.

Door to door travel costs

Depending on the time of the day, drivers with ViaT can apply for high frequency (HF) discounts:

- At rush hour (from Monday to Friday from 7.30h to 10.30h and from 17.00h to 21.00h), HF discounts are not available: the cost per trip for drivers with ViaT is ú 4.25.
- At off-peak hours (from Monday to Friday from 0.00h to 7.30h, from 10.30 h to 17.00h and from 21h to 0.00h and week-ends day), drivers can apply for discounts depending on the frequency of their travel.



Source: TABASA, 2013

Figure 11-23 Cost per trip with ViaT at rush hour and off peak hours

Comfort and convenience

It is a convenient system to pay with because drivers do not need to stop at the toll plaza.

Safety

No impacts expected on safety.

Security

No impacts expected on security.

Accessibility for mobility impaired passengers

No impacts expected on accessibility.

11.6.4 Assessment of Modal Change

Car usage

No impacts expected.

Bus and coach usage

No impacts expected.

Rail usage

No impacts expected.

Ferry usage

No impacts expected.

Aeroplane usage

No impacts expected.

11.6.5 Assessment of Other Impacts

Increased mobility

No impacts expected.

Congestion

ViaT enables to reduce congestion at toll the plaza because cars pass through toll plaza at 20 km/ h without stopping.

CO2 emissions

Due to reduced congestion, ViaT system can contribute to decrease fuel consumption and carbon emissions.

Contribution to user pays principle

No impacts expected.

European economic progress

No impacts expected.

Territorial cohesion

No impacts expected.

11.6.6 Assessment against Main Criteria – Summary

Table 11-5 Sant Cugat Via T: electronic toll system - Point score for the criteria

	Score
Investment costs	€
Operation and maintenance costs	€
Financial viability	✓
Technical feasibility	*0*
Organisational feasibility	*0*
Administrative burden	✓
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	✓
Comfort and convenience	✓
Safety	*0*
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	*0*
Bus and coach usage	*0*
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

11.7 Assessment of the Solution - Automatic Incident Detection System

11.7.1 Specific Description of the Solution

The Sant Cugat motorway is 13 km long and 42% of the motorway is made up of tunnels, the longest of which are listed below.

- Vallvidrera Tunnel: 2.517 m;
- La Floresta Tunnel: 440 m;
- Can Llobet Tunnel: 391 m;
- Valldoreix Tunnel: 857 m;
- Can Rabella Tunnel: 389 m.

In order to prevent incidents within tunnels of the Sant Cugat Motorway, an automatic incident detection system (AID System) has been installed within the limits of the concession area. The components of the AID system are presented below.

Automatic real time traffic data collection system

This system provides real-time information on traffic situation in the tunnel to the operator in order to identify dangerous situations:

- *Closed Circuit TV (CCTV) system*: a set of fixed cameras is installed inside the tunnels and mobile cameras outside. The closed circuit system collects real-time information within the concession area and especially inside the tunnels. The software analyses the images recorded by the CCTV system automatically. This system is able to detect automatically and in few seconds if an accident or other incident occurs. This might include a slow-moving vehicle, stopped or reversing vehicles, pedestrians, debris or fires. When an incident is detected an alarm is activated automatically.
- *Automatic traffic counters.* In order to provide real-time data about the traffic, over the entire concession several traffic counters are available reporting to the operator the number of vehicles in the tunnel, average speed, vehicle type and traffic density. With this data the operator is able to manage the traffic and prevent traffic congestion, especially inside the tunnels.

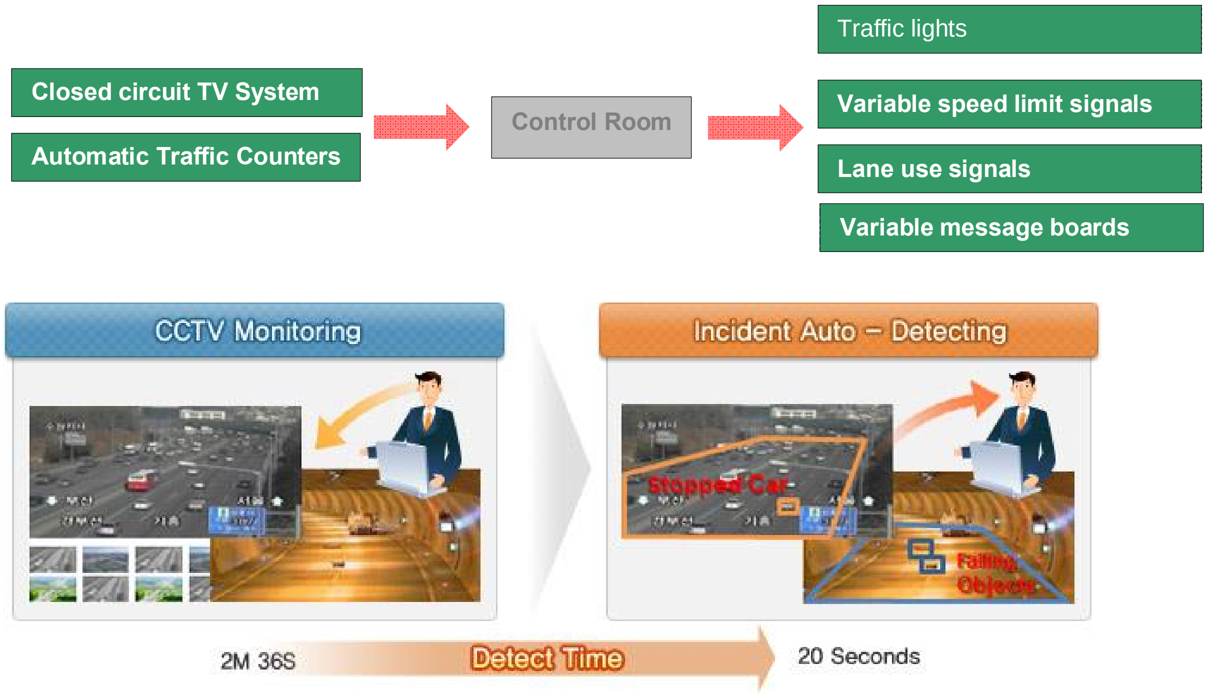


Figure 11-24 Components of the AID system

Control room

The operator's control room allows controlling and managing the facilities of the Sant Cugat Motorway Concession. The control room is under operation 24 hours a day, 365 day a year. Depending of the hour and traffic congestion, one or two persons are working at the control room. The staff supervises the systems that manage the operation of the tunnel (lighting, ventilation, signalising, communication, fire extinction, AID).

When an alarm of the automatic incident detection system is activated, the control room activates the security protocols, informs the users of the incident and manages the traffic flow with the signalling system.

Automatic information system

In order to manage the traffic flow and prevent incidents, the operator informs to drivers through the signalling system that is presented below:

- *The traffic lights.* At the entrance of the tunnels traffic lights are installed in order to manage the traffic flow, to prevent incidents and traffic hold-ups inside the tunnels. When the AID detects some irregularities inside the tunnels or dense traffic flow, the red traffic light is activated from the Control Room.
- *Variable speed limit signals.* Several variable speed limit signals are installed at the entrance of each tunnel and inside the Vallvidrera tunnel (the longest tunnel).

- *Lane use signals.* The central lane in the Vallvidrera tunnel is reversible. Thanks to set of signals installed inside the tunnel, the operator manages the direction of the flow, depending on the density of traffic in each direction. A green arrow indicates that the lane is open and a red cross indicates that the lane is closed.
- *Variable Message Signs (VMS)*. In order to improve the communication between the operator and the drivers, a set of VMSs are installed within the concession. Weather messages, traffic messages and incidents are displayed on the VMS.

Communication system

A communication system based on radiating cable is installed in Vallvidrera Tunnels. This system allows the reception of radio broadcast inside the tunnel. The most important aspect concerned to safety is that, when an incident is detected, the system allows cutting off the radio broadcast in order to transmit safety instructions to drivers.

Source: Mcrit, 2013

Figure 11-25 View of signalling system at Vallvidrera Tunnel

11.7.2 Assessment of Applicability

Investment costs

Automatic incident detection (AID) presents a high investment due to the complexity and scope of implementing the system (optical cameras, traffic counters, and signalling system). According to the TABASA Annual Activity Report:

- The cost of installing VMS system at different access was ú 1.2 million
- The cost of the renewal of the lane use signals at tunnels was ú 250,000;
- The cost of installing a new VMS server was ú 70.000.

Operation and maintenance costs

The operation and maintenance are high due to the complexity of the system.

Financial viability

When TABASA introduced AID system at Sant Cugat Motorway was a public operator, and the pay-back was expected in terms of social gains through reduced accidents and reduced congestion. After privatisation of the operator no changes have been made.

Technical feasibility

The major challenges related to technical barriers can be attributed to the limitations of the existing automatic detection devices. Those limitations presently prevent such systems from a full automation of the overall system and so require constant human monitoring of data and events.

Organisational feasibility

No problems envisaged.

Administrative burden

The need for human monitoring is an administrative burden, but human intervention is mainly needed to check whether any alarm raised may be a false alarm, while without the AID system the burden of monitoring the tunnels and adjacent motorway network would be much bigger.

Legal feasibility

The main concerns with this system are the issues related to user privacy due to cameras can record the license plate, but there are no serious legal issues.

User acceptance

There is high acceptance of the system by the motorway operator because the AID system improves system performance.

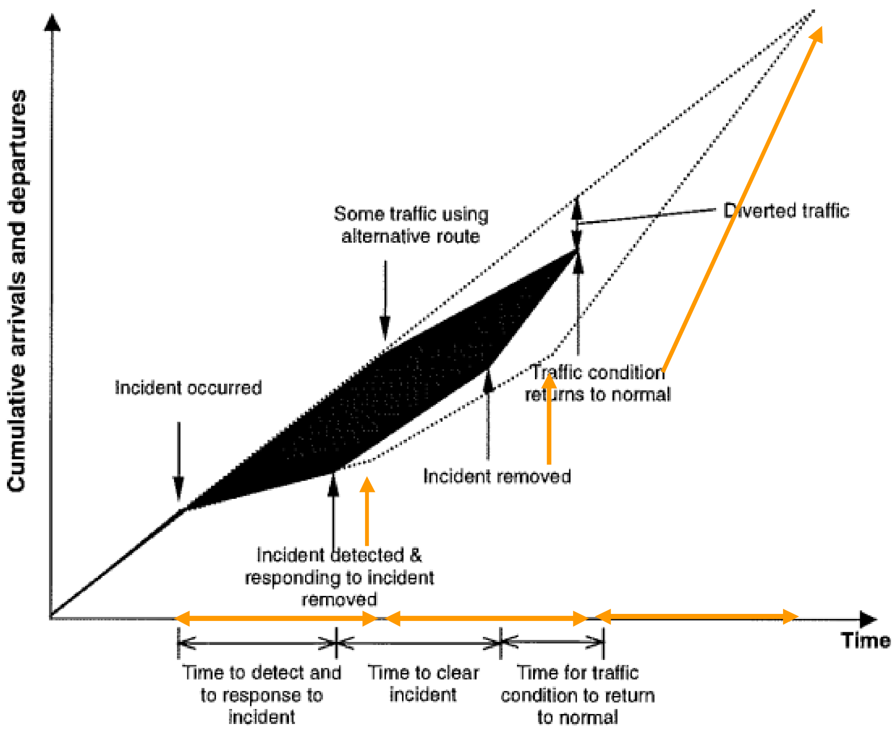
Public acceptance

The travelling public may be aware of the CCTV cameras, even without knowing their precise function, and will know that the traffic monitoring they imply increases the level of information they receive and the comfort and the safety during the trip.

11.7.3 Assessment of Interest for Travellers

Door to door travel time

In case of an incident occurs, the Automatic Incident Detection system reduces the time of detection of the incident, the response time of the personnel and the time to remove the incident. The effect of implementing an AID system is evident in the reduction of delays to traffic, as shown in the figure below.



Source: *Effective incident detection and management on freeways.* Edward Chung and Natalia Rosalion, ARRB Transport Research, 1999

Figure 11-26 Time to remove an incident with and automatic detections system (black) and without AID system (orange)

Door to door travel costs

The AID system has no direct impact on travel costs.

Comfort and convenience

In the case of an incident, the convenience increases because TABASA can provide timely and accurate information to the road users and they can decide whether they continue their journey on the Sant Cugat Motorway or they chose an alternative route.

Safety

Safety increases because the operator is able to manage the infrastructure with real time data provided by the AID system. Through signalling and communication system the operator can prevent secondary accidents, especially inside the tunnels.

Security

No particular impact is expected.

Accessibility for mobility impaired passengers

No impacts expected on accessibility.

11.7.4 Assessment of Modal Change

Car usage

No impacts expected.

Bus and coach usage

No impacts expected.

Rail usage

No impacts expected.

Ferry usage

No impacts expected.

Aeroplane usage

No impacts expected.

11.7.5 Assessment of Other Impacts

Increased mobility

No impacts expected.

Congestion

The system collects real time information about the level of occupancy of the road and the operator can adopt measures to prevent congestion. In case of high traffic volumes, the operator can reduce the speed limit with variable speed signals and thereby reduce the accident risk.

CO2 emissions

Due to reduced congestion, the AID system can contribute to decrease fuel consumption and carbon emissions.

Contribution to user pays principle

No impacts expected.

European economic progress

No impacts expected.

Territorial cohesion

No impacts expected.

11.7.6 Assessment against Main Criteria – Summary

Table 11-6 Sant Cugat automatic incident detection system - Point score for the criteria

	Score
Investment costs	úúú
Operation and maintenance costs	úú
Financial viability	✓
Technical feasibility	(X)
Organisational feasibility	*0*
Administrative burden	✓
Legal feasibility	*0*
User acceptance	✓
Public acceptance	✓
D2D travel time	✓
D2D travel costs	*0*
Comfort and convenience	✓
Safety	✓
Security	*0*
Accessibility for mobility impaired passengers	*0*
Car usage	*0*
Bus and coach usage	*0*
Rail usage	*0*
Ferry usage	*0*
Aeroplane usage	*0*
Mobility	*0*
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	*0*
European economic progress	*0*
Territorial cohesion	*0*

12 CASE STUDY 11 - LATIS: ICT MODELLING IN SCOTLAND REGION 2007 TO 2027

12.1 EXECUTIVE SUMMARY OF THE CASE STUDY

This case study uses the existing Transport Model for Scotland which is owned by Transport Scotland (The Scottish Government) to produce quantitative estimates for traffic and emissions reductions resulting from the potential implementation of two general ICT solutions.

The first solution assesses the impact of a reduction in In-Vehicle travel time on road-based public transport which may be the result of smart ticketing measures. (Other ICT measures such as improved traveller information and bus signal priority may also contribute to the reduction in overall/in-vehicle public transport journey time).

The second solution assesses the impact of increased car occupancy levels which may be achieved by lift-sharing initiatives.

Generally, the impacts of each of the tests is relatively marginal (when compared to major schemes such as infrastructure schemes), but some of the measures do start to take an impact with the higher-end assumptions in place. The relatively marginal impacts are likely to stem from some of the test assumptions, whereby the aspects that are changed/appraised here only make up one specific component of travel time. This illustrates some of the challenges of encouraging greater use of public transport or car sharing, but whilst reductions are not large relative to major strategic assessment, the carbon reductions are apparent and in some cases could be quite significant.

The change to in-vehicle time (IVT) for urban buses to represent smart ticketing has little effect at a 5% level, and is a little drowned out by the scale of the model / model noise effects. The public transport matrices have however shown a slight increase in trip making across the PT model, but due to the scale of the road model this increase is not reflected in vehicle kilometre and carbon emissions levels. The trend associated with decreasing IVT becomes more apparent in the 10% test where small but apparent reductions are observed across the network.

The change to car occupancy levels to represent increased lift-sharing presents much more promising results in terms of quantifiable carbon reduction. If average car occupancy levels were increased from 1.03 to 1.08 across the entire Scotland region, an annualised equivalent CO_2 saving of 17,897 tonnes could be made. The modelling suggests that regional effects would produce regional benefits and that the percentage benefits are slightly more favourable in Interurban/rural regions than in urban regions, which supports the introduction of lift-sharing schemes in rural areas.

12.2 THE BACKGROUND OF THE CASE STUDY

12.2.1 Motivation for this Case Study

The ICT measures assessed in the case studies generally have a broad range of impacts, the relative impacts of which have been assessed against the COMPASS assessment matrix. This case study aims to quantify some of the potential impacts relative to reduction in CO_2 emissions and traffic congestion levels. This quantification is made feasible by the existence of the LATIS model (Land Use and Transport Integration in Scotland) which is an integrated Land-use and Transport model for strategic assessment across the full Scotland Region. The nature of the model is such that the relative impact of possible ICT scenario effects could be assessed across different sub-regions; specifically Urban regions, inter-urban and rural.

This case study relates to ICT solutions discussed in COMPASS fact sheets and other case studies, and presents specific measurable impacts of these potential solutions.

12.2.2 General Description of the Region

The region for this model is the whole of Scotland, one of the constituent countries of the United Kingdom. Scotland occupies the northern third of the island of Great Britain; it shares a land border with England to the south and is otherwise bounded by sea. The population of Scotland is 5.3 million, which is highly concentrated in urban and interurban regions. The total land area is 78.4 sqkm and overall population density is 67.5/sqkm. Scotland is governed locally by Local Authority regions as shown in Figure 12-1. Whilst the Local Authority region does not correspond directly to population density, it was the most convenient metric to use in relation to the LATIS model.

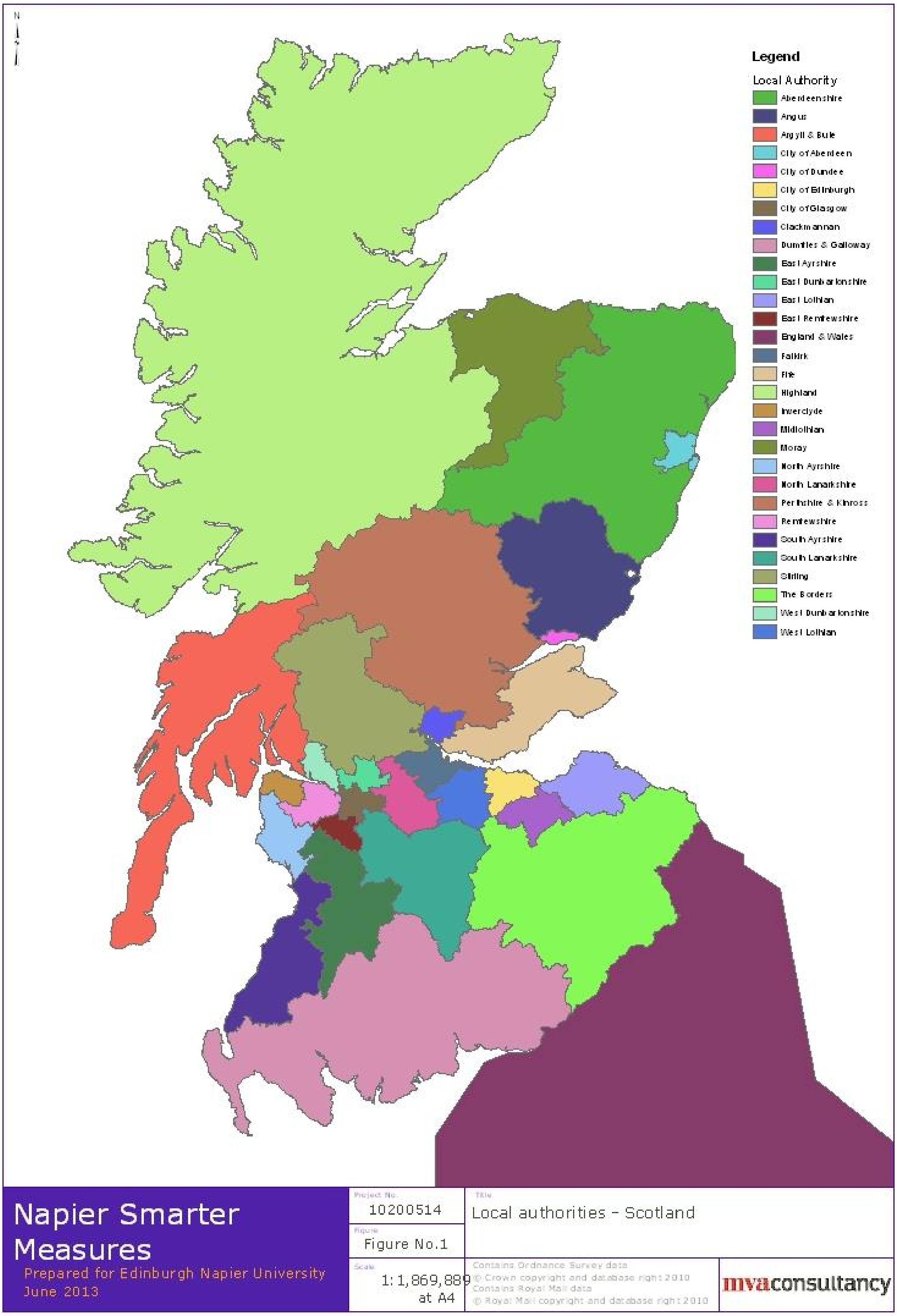


Figure 12-1 Scotland region by local authority

The Local Authority Regions may be classified as follows:

- **Urban** (City Regions)- City of Edinburgh, City of Glasgow, City of Dundee, City of Aberdeen
- **Interurban-** East Lothian, Midlothian, West Lothian, South Lanarkshire, East Renfrewshire, North Lanarkshire, East Dunbartonshire, Renfrewshire, West Dunbartonshire, Aberdeenshire
- **Rural**- Dumfries & Galloway, The Borders, East Ayrshire, South Ayrshire, North Ayrshire, Falkirk, Inverclyde, Stirling, Clackmannan, Fife, Perthshire & Kinross, Angus, Moray, Argyll & Bute, Highland

Population density by region type:

- Urban Regions 1224-3390/sqkm
- Interurban Regions 150-710/sqkm
- Rural 8-96/sq/km

It was not possible for the purpose of this case study to separate the Rural category into PRC (Predominately Rural Connected) and PRR (predominately Rural Remote). The GDP/capita for Scotland is around ú 33,300, which is around 30% above the EU average[1].

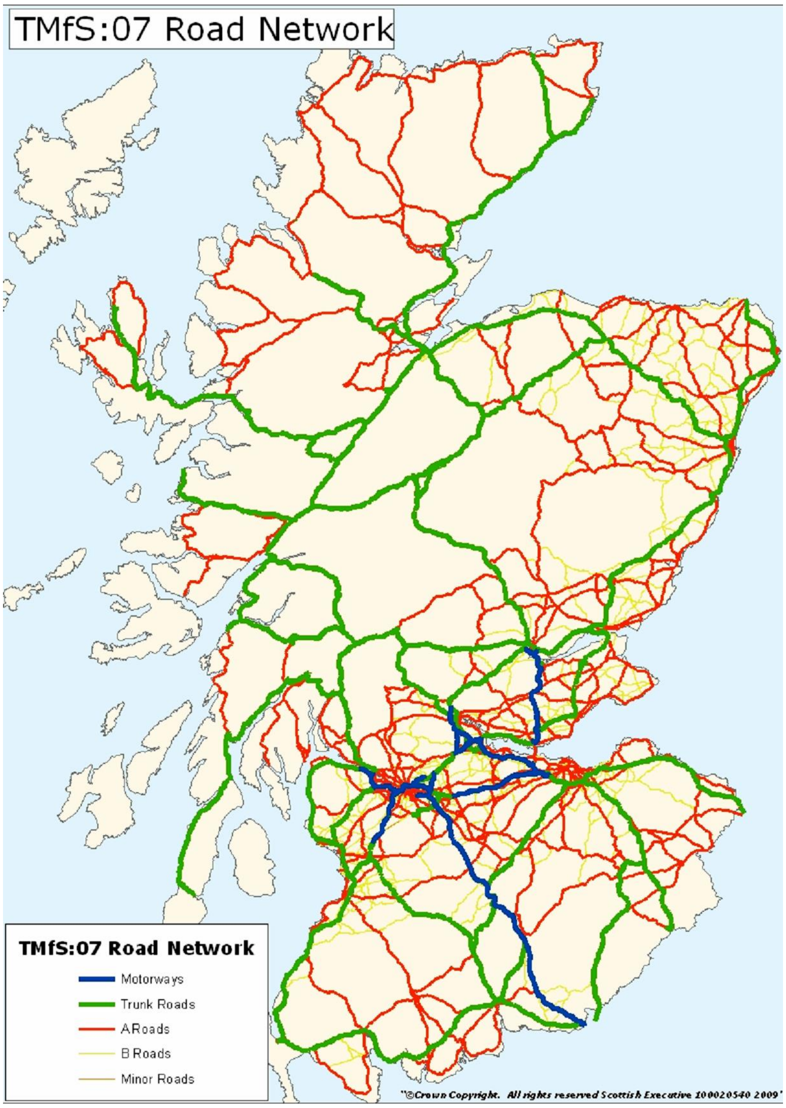


Figure 12-2 Scotland region road network[2]

The region is directly accessible to Europe predominately by air. There are two major airports serving City regions of Edinburgh (Edinburgh International) and Glasgow (Glasgow International), and Glasgow Prestwick airport (Ayrshire) which also serves central Scotland. International flights are also available directly to Aberdeen (Aberdeen Dyce Airport|). Sea Freight services also provide EU connections although passenger ferry services direct to EU are currently not available.

Further EU connectivity is via the trunk road network through England to various ferry ports and the channel tunnel. There are no through rail services to continental Europe, but rail connections may be made via London (St. Pancras).

The main internal transport connections are road, rail, internal ferry services and internal air services. The LATIS model uses trunk road network (including road based public transport provision) and rail services.

12.2.3 Stakeholders Involved

The LATIS model is owned by Transport Scotland (a body of The Scottish Government), and this case study was approved for modelling by Transport Scotland. The model runs and analysis were prepared by MVA consultancy, one of the Transport Scotland approved bodies.

12.2.4 Methodology of the Case Study

The case study applied the Transport Model for Scotland 07 (TMfS07) which is a part of the LATIS model to understand changes to traffic levels and road-traffic related carbon emissions (tail-pipe) from the introduction and/or wider delivery of ICT related transport measures.

Appraisal Test Specification

The case study considered two main test scenarios with additional test variants. The first test was public transport related and used to investigate the potential impact of the wider adoption of smart ticketing. This assumed a certain reduction in bus vehicle travel times to represent a reduction in bus boarding times within urban areas.

The second test scenario was car travel related and considered the use of mobile technology to encourage car sharing. The test assumed an increase in vehicle occupancy and subsequent reduction in overall commuter trip making due to the wider take up of car sharing (i.e. more people lift sharing - which would be assumed to switch from car to higher occupancy vehicles).

The latest version of the TMfS07 model (V2.1) was used to appraise all test options. This model includes the impact of forecast population changes over time along with the introduction of planned transport investments.

Model data outputs were extracted from the TMfS07 2007 Base Year, 2027 Do Minimum Forecast year scenario and each 2027 Option Test scenario. The following scenarios were appraised and analysed:

- 2007 Base year scenario: used for comparison purposes;
- 2027 Do Minimum Scenario: used for comparison purposes;
- Test 1 PT: 5% reduction in urban bus journey times (Glasgow, Edinburgh, Aberdeen & Dundee) ï all journey purposes and time periods. The in-vehicle time (IVT) factor for urban buses was reduced from 1.2 to 1.15;
- Test 2 PT: 10% reduction in urban bus journey times (Glasgow, Edinburgh, Aberdeen & Dundee) - all journey purposes and time periods. The in-vehicle time (IVT) factor for urban buses was reduced from 1.2 to 1.1;
- Test 3 Car: 5% increase in car occupancy - subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08);
- Test 4 Car: 5% increase in car occupancy for ćityô origins ï subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08);

- Test 5 Car: 5% increase in car occupancy for ‘non-city’ origins – subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08)

Appraisal Test Assumptions & Data

Within the public transport related appraisal tests, the 5% and 10% reduction to IVT will reduce the overall travel time for relevant urban bus-based public transport movements. However, as public transport travel time consists of a number of individual elements, the actual reduction in total PT time would be considerably lower than 5% and 10%. For example, the total PT travel time consists of a walk time, fare and waiting time which have remained constant. Depending on the journey characteristic a 5% reduction in IVT would likely be closer to 1-2% of total PT time and 10% reduction maybe closer to 4-5% of total PT time.

Full detail of the LATIS modelling suite may be found at http://www.transportscotland.gov.uk/latis

12.3 SPECIFIC CHARACTERISTICS OF THE CASE STUDY

12.3.1 General Description of the Case Study

This case study utilises an existing regional multimodal transport model to produce quantitative estimates for emissions reductions and for reduction in road congestion based on ICT solutions. The approach used is scenario based and aims to illustrate the effect on congestion and emissions that could result from ICT solutions where the solutions result in possible travel time reductions or vehicle occupancy figures.

The test year chosen was 2027 (model base year in 2007), as a future year where such ICT solutions may be assumed to have been implemented. All comparisons given relate the test scenarios to the 2027-Do nothing scenario.

Two sets of ICT solutions are tested. The first is to test the effect of reducing IVT bus journey times in Urban regions by the introduction of smart ticketing. 5% and 10% possible reductions in IVT were tested. This case study relates primarily to the COMPASS-factsheet smart-ticketing-and-tolling, but reduction in IVT journey time may also result from lower passenger confusion (hence fewer questions to drivers) from ICT-passenger information measures, and certainly from Signal priority for bus measures. Some of these measures may eventually reduce journey times in Interurban and Rural regions, however in-line with current implementation of these technologies this case study proposes the reductions to apply to Urban bus journeys only.

The second set of tests considers change in car occupancy levels from ICT-lift sharing technologies. A 5% increase in car occupancy levels is tested for all areas, and then separately for city origins and non-city origins separately.

12.3.2 Data Used

Data used is that which supplies the LATIS model and the sub-model TMfS07. The LATIS database includes; The LATIS database includes: road traffic counts, public transport passenger counts, roadside interviews, public transport surveys, car and bus journey time surveys, park and ride, car occupancy surveys, park and ride origin - destination surveys, surveys on people's attitudes towards travel and car use, concessionary fares data – http://www.transportscotland.gov.uk/analysis/LATIS/data/Observed-Data

Results of the specific survey

No specific survey was completed for this case study.

Information received from other surveys for this case study

Indicative values were considered from results of surveys fort Case studies 5 and 9, which informed the modelling scenario choices determined in discussion with also determining 5 change values which could be feasible, if possibly aspirational and those which would produce measurable changes for emissions and congestion levels.

12.4 Assessment of the Solution - Reduction in Urban Bus Journey Times as a Result of ICT

12.4.1 Specific Description of the Solution

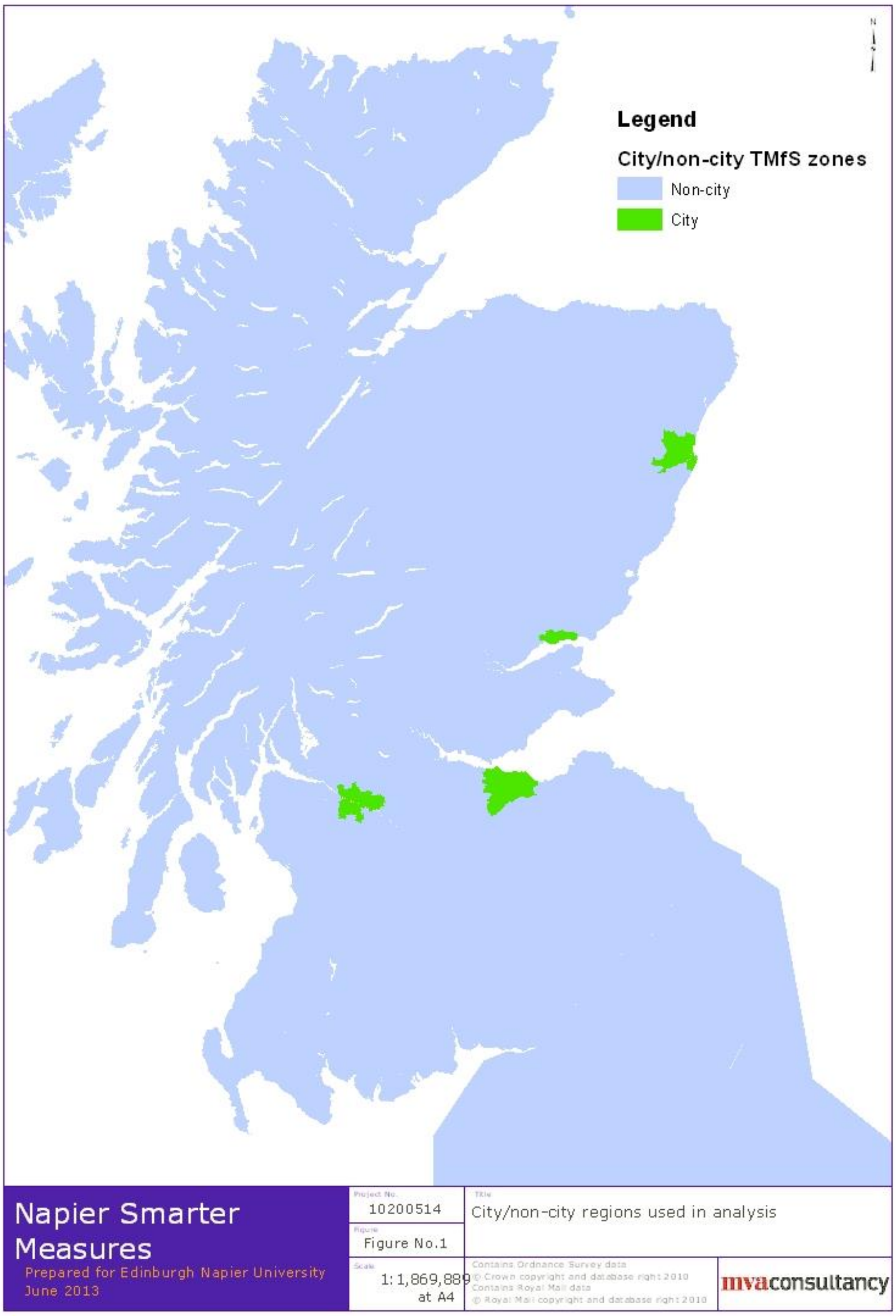


Figure 12-3 Scotland city regions

The urban regions within the Scotland region are the City regions of Edinburgh, Glasgow, Dundee and Aberdeen.

	2027 Ref			IVT-5%			IVT -10%		
	TOTAL CARBON	TOTAL CO2[E]	TOTALVeh Kms	TOTAL CARBON	TOTAL CO2[E]	TOTAL Veh Kms	TOTAL CARBON	TOTAL CO2[E]	TOTAL Veh Kms
City of Edinburgh	203,372	745,687	3,258,783,960	0.04%	0.05%	0.04%	0.00%	0.00%	-0.02%
City of Glasgow	198,040	726,147	3,902,193,378	0.02%	0.02%	0.01%	-0.01%	-0.01%	-0.03%
City of Dundee	25,215	92,457	578,263,832	0.00%	0.00%	-0.01%	0.00%	-0.04%	-0.02%
City of Aberdeen	54,360	199,348	1,161,840,344	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.02%
East Lothian	41,024	150,418	772,457,350	-0.02%	0.00%	-0.01%	-0.02%	-0.01%	-0.02%
Midlothian	33,210	121,790	651,208,005	0.02%	0.03%	0.02%	0.00%	-0.02%	-0.02%
West Lothian	111,874	410,221	1,858,126,221	0.00%	-0.01%	0.00%	0.00%	0.00%	-0.01%
South Lanarkshire	188,468	691,045	3,017,076,132	0.00%	0.01%	0.02%	0.00%	0.00%	0.00%
East Renfrewshire	25,836	94,715	533,542,751	0.00%	-0.04%	-0.02%	-0.03%	-0.06%	-0.06%
North Lanarkshire	175,138	642,167	3,022,147,482	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
East Dunbartonshire	18,804	68,948	492,289,243	-0.03%	-0.01%	0.00%	-0.03%	-0.03%	-0.03%
Renfrewshire	72,491	265,841	1,464,272,778	-0.01%	-0.02%	0.00%	-0.01%	-0.01%	0.00%
West Dunbartonshire	20,762	76,182	493,877,491	0.00%	0.00%	-0.01%	0.00%	0.00%	-0.02%
Aberdeenshire	125,729	460,940	2,776,633,075	-0.01%	0.00%	0.00%	-0.01%	0.00%	0.00%
Dumfries & Galloway	160,619	588,978	2,293,348,989	0.00%	-0.01%	0.00%	0.00%	-0.01%	0.00%
The Borders	71,488	262,060	1,392,620,634	-0.05%	0.00%	0.00%	0.00%	0.00%	0.00%
East Ayrshire	66,008	242,042	1,198,644,216	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
South Ayrshire	46,610	170,857	932,349,277	-0.01%	0.00%	-0.01%	-0.01%	0.00%	0.00%
North Ayrshire	52,864	193,824	1,007,902,669	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
Falkirk	88,529	324,544	1,481,488,281	0.00%	0.01%	0.00%	-0.04%	0.00%	-0.01%
Inverclyde	18,887	69,250	383,657,729	0.00%	-0.01%	0.00%	0.00%	-0.01%	0.00%
Stirling	65,387	239,781	1,216,748,224	0.01%	0.00%	0.00%	0.01%	0.00%	0.00%
Clackmannan	17,695	64,945	329,968,388	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Fife	147,516	540,862	3,046,110,032	-0.01%	0.00%	0.00%	-0.01%	0.00%	0.00%
Perthshire & Kinross	149,953	549,884	2,623,686,380	0.03%	0.02%	0.00%	0.00%	0.00%	0.00%
Angus	46,845	171,806	967,947,824	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%
Moray	33,729	123,699	777,253,371	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Argyll & Bute	35,309	129,466	803,277,753	0.02%	-0.03%	0.00%	0.02%	0.00%	0.00%
Highland	142,039	520,792	2,764,673,689	0.00%	-0.01%	0.00%	0.00%	0.00%	0.00%

Figure 12-4 Public transport IVT reductions

The change to in-vehicle time (IVT) for urban buses to represent smart ticketing has little effect at a 5% level, and is a little drowned out by the scale of the model / model noise effects. The public transport matrices have shown a slight increase in trip making across the PT model, but due to the scale of the road model this increase is not reflected in vehicle kilometre and carbon emissions levels. The trend associated with decreasing IVT becomes more apparent in the 10% test, where small but consistent percentage decreases may be observed across Carbon and CO2 emissions (tonnes) and total v-km.

As might be expected the effects of reduction in PT journey times in the urban regions shows some spill over into the adjacent interurban regions and negligible impact into the rural regions. The city of Glasgow would benefit most from a 10% decrease in PT-IVT with a reduction of 108 tonnes of CO2 (equivalent per annum) and a reduction in 1.06 million veh-kms (per annum).

By region the reductions in annualised CO2-equivalent and million-v-kms are;

- Urban(City) 38 0.48
- Interurban 18 0.15
- Rural 4 0.05

Emission/Congestion maps (from the model-base year 2007) show that the rural areas are generally uncongested and that reductions are most beneficial within the central belt.

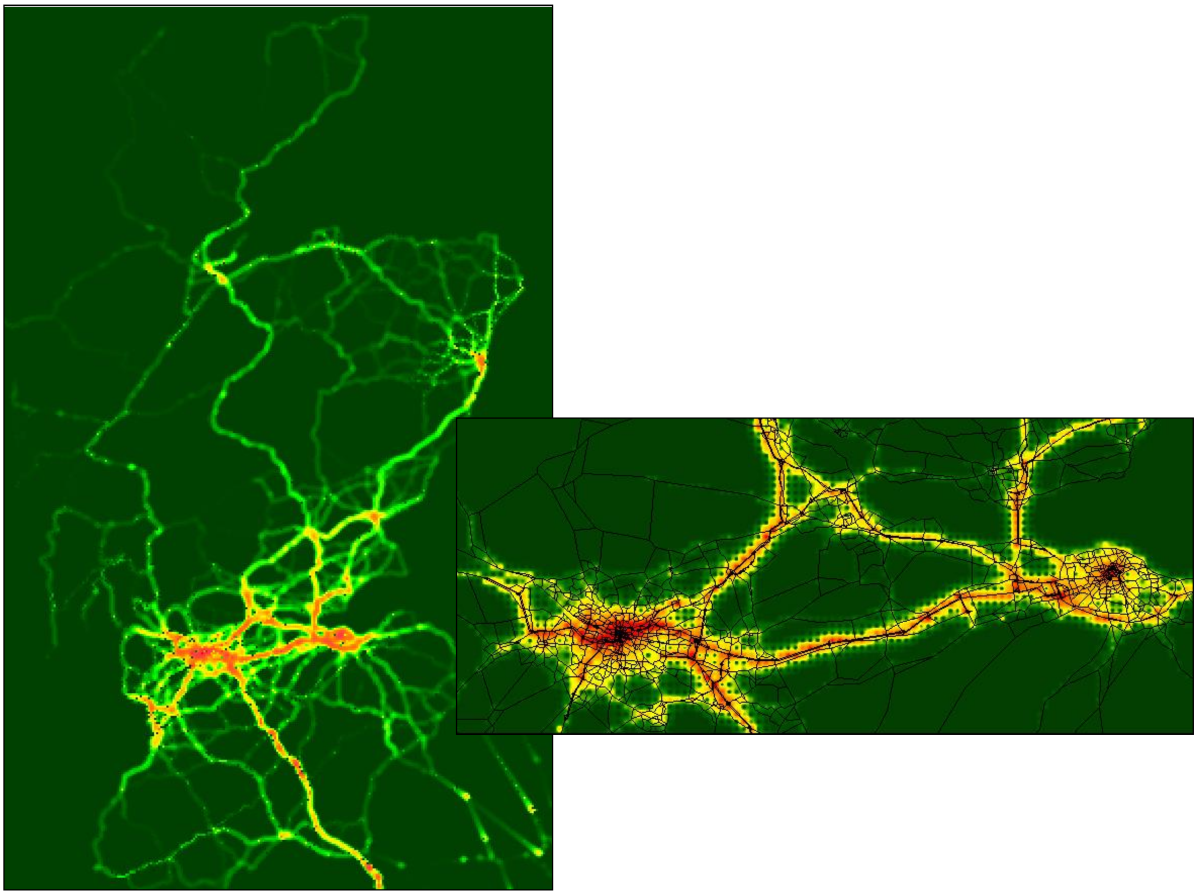


Figure 12-5 Emissions hotspots-Scotland and central belt

12.4.2 Assessment of Applicability

This case study models the reductions in emissions and congestion due to a feasible reduction in PT travel time consistent with a range of possible ICT solutions (as per relevant COMPASS factsheets). This case study does not analyse a specific example of smart ticketing (or other IVT reducing measure) in practice, so the below are not assessed.

Investment costs

Not assessed

Operation and maintenance costs

Not assessed

Financial viability

Not assessed

Technical feasibility

Not assessed.

Organisational feasibility

Not assessed.

Administrative burden

Not assessed.

User acceptance

Not assessed.

Legal feasibility

Not assessed.

12.4.3 Assessment of Interest for Travellers

Door to door travel time

Any ICT solution which reduces IVT on public transport, will act to reduce door to door travel time. The reduction in road veh-km resulting from the 10% reduction in PT-IVT in City regions implies that door to door travel time will reduce for road users as well as PT users.

Door to door travel costs

Reduced for car users due to reduction in congestion. PT cost may reduce as a result of smart ticketing.

Comfort and convenience

Shorter IVT on public transport will increase convenience of the mode, and smart ticketing in general supports increased convenience for the user.

Safety

No impact.

Security

Cashless payment may improve personal security.

Accessibility for mobility impaired passengers

No impact.

12.4.4 Assessment of Modal Change

Car usage

The model suggests an increase in PT mode share and a decrease in car-trips (and veh-km driven)

Bus and coach usage

An increase in PT (bus) usage is forecast.

Rail usage

No impact assessed.

Ferry usage

No impact.

Aeroplane usage

No impact.

12.4.5 Assessment of Other Impacts

Increased mobility

No impact.

Congestion

For a 10% decrease in PT-IVT in city regions, veh-km driven reduce across all regions ranging from 0% to 0.06% reduction. This gives an average reduction by region of:

- Urban(City) 0.48 mill-v-km/annum;
- Interurban 0.15 mill-v-km/annum;
- Rural 0.05 mill-v-km/annum.

The maximum reduction is seen in the City of Glasgow (1.06 mill-veh-km/annum)

CO2 emissions

For 10% decrease in PT-IVT in city regions the annualised CO2 (equivalent) emissions reduce across all regions ranging from 0% to 0.06% reduction. This gives average reduction by region of:

- Urban(City) 38 tonnes;
- Interurban 18 tonnes;
- Rural 4 tonnes.

The maximum reduction is seen in the City of Glasgow (108 tonnes/annum).

Contribution to user pays principle

No Impact

European economic progress

No Impact

Territorial cohesion

No Impact

12.4.6 Assessment against Main Criteria – Summary

Table 12-1 Reduction in urban bus journey times as a result of ICT - Point score for the criteria

	Score
Investment costs	-
Operation and maintenance costs	-
Financial viability	-
Technical feasibility	-
Organisational feasibility	-
Administrative burden	-
Legal feasibility	-
User acceptance	-
Public acceptance	-
D2D travel time	✓
D2D travel costs	✓
Comfort and convenience	✓
Safety	0
Security	0
Accessibility for mobility impaired passengers	0
Car usage	-
Bus and coach usage	+
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	0
Congestion in overcrowded corridors	✓
CO2 emissions	✓
Contribution to user pays principle	-
European economic progress	-
Territorial cohesion	-

12.5 ASSESSMENT OF THE SOLUTION - MOBILE TECHNOLOGY TO ENCOURAGE CAR SHARING

The second test scenario was car travel related and considered the use of mobile technology to encourage car sharing. The test assumed an increase in vehicle occupancy and subsequent reduction in overall commuter trip making due to the wider take up of car sharing (i.e. more people lift sharing - which would be assumed to switch from car to a higher occupancy vehicles).

There were three modelling scenarios undertaken, all assuming a 5% increase in lift sharing (hence increasing the car occupancy levels in the model from 1.03 to 1.08). The first test assumed uniform increase in car-occupancy across all regions, the second assumed the increase applied only to journeys with a city origin in AM and PM peak commuter trip matrices and the third assumed non-city origins. Hence the second test would relate to a urban city based lift-sharing scheme and the third to an interurban/rural scheme (such as might be promoted to improve accessibility in areas of poor public transport).

The change in both congestion and emissions for a 5% increase in vehicle occupancy caused by lift-sharing is much more significant than for reducing public transport in-vehicle journey time. For emissions the average CO2 equivalent reductions for urban (city), interurban and rural are shown in Table 12-2.

Table 12-2 CO reductions

CO2 (tonnes)	All	Urban-origins	Non-urban origins
Urban	-552	-444	-97
Interurban	-660	-179	-470
Rural	-606	-57	-550

And for reduction in network road vehicle-km driven are shown in Table 12-3.

Table 12-3 Reduction in vehicle kilometres

v-km (10^6)	All	Urban-origins	Non-urban origins
Urban	-5.00	-3.82	-1.27
Interurban	-5.20	-1.21	-3.94
Rural	-5.13	-0.45	-4.65

For either CO2 emissions or congestion it is clear that if the vehicle occupancy increases unevenly by region (such as for a region specific targeted scheme) then that region will benefit most from the measure. The relative benefit in interurban and rural areas is slightly greater than when the same measure is applied to only city origins. Increasing vehicle occupancies (by 5%) results in reductions in emissions and congestion of an order of magnitude greater than the reduction of public transport travel time by 10%.

	Lift-share ALL			Lift-share URBAN (city)			Lift-share Interurban/rural		
	TOTAL CARBON	TOTAL CO2[E]	TOTAL Veh Kms	TOTAL CARBON	TOTAL CO2[E]	TOTAL Veh Kms	TOTAL CARBON	TOTAL CO2[E]	TOTAL Veh Kms
City of Edinburgh	-0.01%	-0.02%	-0.08%	-0.04%	-0.04%	-0.09%	0.03%	0.03%	0.00%
City of Glasgow	-0.16%	-0.15%	-0.24%	-0.11%	-0.11%	-0.17%	-0.05%	-0.05%	-0.08%
City of Dundee	-0.26%	-0.25%	-0.36%	-0.17%	-0.16%	-0.25%	-0.07%	-0.08%	-0.09%
City of Aberdeen	-0.35%	-0.38%	-0.51%	-0.24%	-0.27%	-0.39%	-0.10%	-0.09%	-0.12%
East Lothian	-0.22%	-0.20%	-0.33%	-0.06%	-0.06%	-0.08%	-0.16%	-0.16%	-0.27%
Midlothian	-0.32%	-0.34%	-0.43%	-0.13%	-0.15%	-0.18%	-0.23%	-0.24%	-0.31%
West Lothian	-0.17%	-0.17%	-0.34%	-0.04%	-0.03%	-0.05%	-0.12%	-0.13%	-0.28%
South Lanarkshire	-0.23%	-0.23%	-0.34%	-0.05%	-0.05%	-0.06%	-0.16%	-0.16%	-0.25%
East Renfrewshire	-0.24%	-0.23%	-0.35%	-0.08%	-0.11%	-0.09%	-0.16%	-0.16%	-0.27%
North Lanarkshire	-0.17%	-0.17%	-0.29%	-0.03%	-0.04%	-0.06%	-0.13%	-0.13%	-0.23%
East Dunbartonshire	-0.48%	-0.44%	-0.54%	-0.20%	-0.22%	-0.19%	-0.28%	-0.28%	-0.33%
Renfrewshire	-0.17%	-0.20%	-0.28%	-0.02%	-0.05%	-0.06%	-0.12%	-0.13%	-0.21%
West Dunbartonshire	-0.09%	-0.25%	-0.36%	-0.06%	-0.08%	-0.10%	-0.17%	-0.17%	-0.25%
Aberdeenshire	-0.29%	-0.28%	-0.40%	-0.09%	-0.08%	-0.11%	-0.23%	-0.20%	-0.29%
Dumfries & Galloway	-0.08%	-0.08%	-0.19%	0.02%	0.00%	0.01%	-0.08%	-0.08%	-0.19%
The Borders	-0.23%	-0.20%	-0.32%	-0.07%	-0.03%	-0.06%	-0.22%	-0.17%	-0.26%
East Ayrshire	-0.24%	-0.22%	-0.36%	-0.02%	-0.02%	-0.03%	-0.21%	-0.20%	-0.33%
South Ayrshire	-0.28%	-0.27%	-0.41%	-0.03%	-0.01%	-0.02%	-0.27%	-0.26%	-0.39%
North Ayrshire	-0.24%	-0.23%	-0.38%	-0.02%	-0.03%	-0.04%	-0.23%	-0.20%	-0.34%
Falkirk	-0.23%	-0.22%	-0.37%	-0.02%	-0.03%	-0.04%	-0.19%	-0.19%	-0.33%
Inverclyde	-0.32%	-0.32%	-0.46%	0.00%	-0.03%	-0.03%	-0.32%	-0.31%	-0.43%
Stirling	-0.27%	-0.31%	-0.49%	-0.04%	-0.04%	-0.06%	-0.24%	-0.27%	-0.42%
Clackmannan	-0.20%	-0.23%	-0.36%	-0.04%	-0.02%	-0.03%	-0.20%	-0.20%	-0.33%
Fife	-0.23%	-0.23%	-0.38%	-0.03%	-0.04%	-0.04%	-0.20%	-0.20%	-0.34%
Perthshire & Kinross	-0.25%	-0.26%	-0.38%	-0.02%	-0.02%	-0.05%	-0.22%	-0.22%	-0.33%
Angus	-0.19%	-0.22%	-0.35%	-0.04%	-0.04%	-0.07%	-0.16%	-0.18%	-0.28%
Moray	-0.22%	-0.22%	-0.36%	0.00%	-0.01%	-0.02%	-0.22%	-0.21%	-0.34%
Argyll & Bute	-0.26%	-0.21%	-0.34%	0.02%	-0.02%	-0.02%	-0.24%	-0.21%	-0.31%
Highland	-0.26%	-0.25%	-0.42%	0.00%	-0.01%	-0.01%	-0.23%	-0.24%	-0.40%

Figure 12-6 Increase in vehicle occupancy of 5%

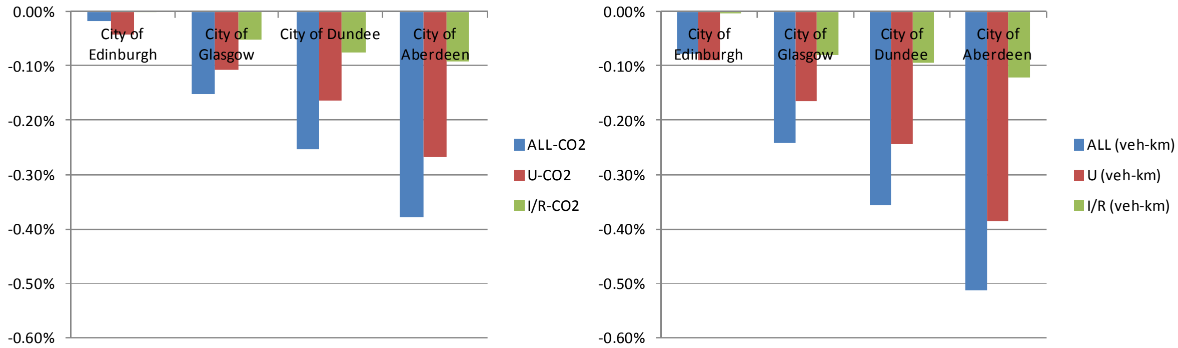


Figure 12-7 Increase in vehicle occupancy of 5% - urban (city) regions

The pattern of traffic/emissions reductions within the urban (city) regions is similar, with the City of Edinburgh experiencing little benefit if the scheme is targeted outwith the city region. This may be due to the relative compactness of Edinburgh and local commuting patterns.

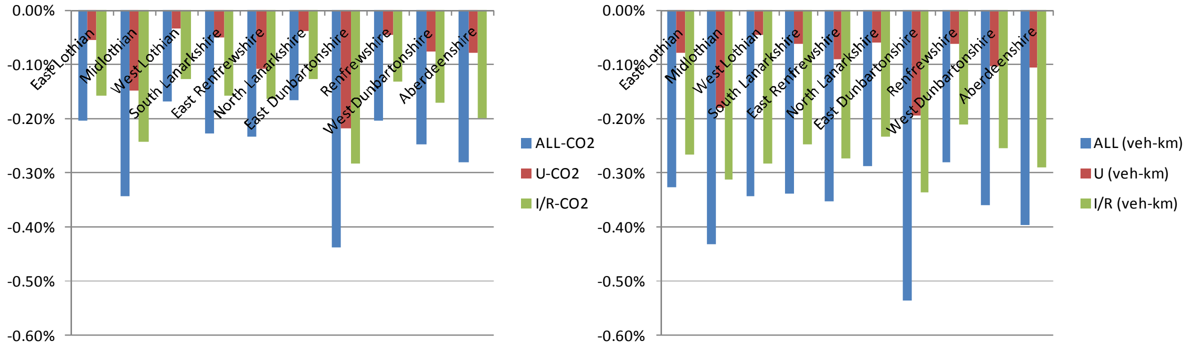


Figure 12-8 Increase in vehicle occupancy of 5% - interurban regions

As would be expected, interurban regions benefit from schemes which target urban residents and non-urban residents, and locally based lift sharing schemes would be expected to benefit the local area most significantly with some significant overspill into surrounding areas.

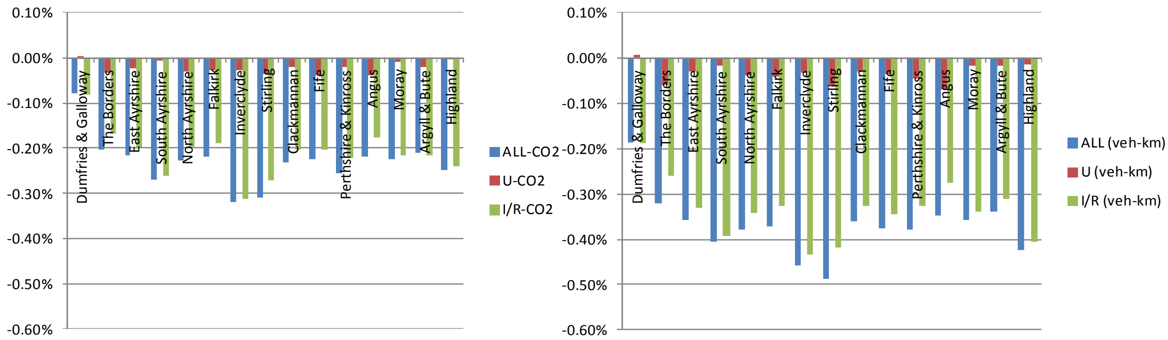


Figure 12-9 Increase in vehicle occupancy of 5% - rural regions

The most rural areas would only benefit slightly from lift-sharing schemes that were targeted specifically to city residents, but at a rural level encouraging local lift sharing schemes would appear to offer favourable carbon reductions if sufficient usage is achieved. Whilst a 5% increase might be considered aspirational, within more rural areas (due to smaller populations) and possibly a greater propensity to consider lift-sharing, it may be seen that the local effects could be relatively significant.

12.5.1 Assessment of Applicability

This case study models the reductions in emissions and congestion due to a feasible reduction in vehicle occupancies resulting from ICT measures to promote and arrange lift-sharing (as per relevant COMPASS factsheets). This case study does not analyse a specific example of a lift-sharing scheme, so the below are not assessed.

Investment costs

Not assessed.

Operation and maintenance costs

Not assessed

Financial viability

Not assessed.

Technical feasibility

Not assessed.

Organisational feasibility

Not assessed.

Administrative burden

Not assessed.

User acceptance

Not assessed.

Legal feasibility

Not assessed.

12.5.2 Assessment of Interest for Travellers

Door to door travel time

Lift sharing may increase door-to-door travel times due to potentially longer journeys to collect a lift sharing partner, or for a lift-sharer to walk to a specified location to be collected. The magnitude of this has not been assessed, but would be expected to be negligible.

Door to door travel costs

Costs would reduce due to journeys being shared (fuel/parking costs split).

Comfort and convenience

Comfort and convenience would be expected to decrease due to having less individual flexibility once a lift share is agreed.

Safety

No impact.

Security

Agreeing a lift-share with strangers introduces possible personal security issues. These may be reduced dependent on how the system is organised.

Accessibility for mobility impaired passengers

If a lift-share is available instead of a public transport journey, the mobility impaired lift-sharer could potentially have increased accessibility.

12.5.3 Assessment of Modal Change

Car usage

Overall car usage would decrease due to higher overall occupancy levels.

Bus and coach usage

Lift-share may cause model shift away from bus, if a user is able to find a compatible lift share partner.

Rail usage

As for bus, but in many of the rural areas of Scotland, train as an option is unavailable so any rail usage reduction would be dependent on the specific geographic of the scheme. It is likely that a rural lift-sharing scheme would be promoted where there is no rail service (or if it is very infrequent), hence any reduction of this factor, depending on scheme, would be overall quite negligible.

Ferry usage

No impact

Aeroplane usage

No impact

12.5.4 Assessment of Other Impacts

Increased mobility

Lift-sharing schemes would expect to increase mobility, particularly in very rural remote areas.

Congestion

v-km (10^6)	All	Urban-origins	Non-urban origins
Urban	-5.00	-3.82	-1.27
Interurban	-5.20	-1.21	-3.94
Rural	-5.13	-0.45	-4.65

Increase in vehicle occupancy from 1.03 to 1.08 due to an increased use of lift-sharing (5%) would produce significant reduction in v-kms driven. This effect would be strongly linked to the geographical location of the lift-sharing scheme.

CO2 emissions

CO2 (tonnes)	All	Urban-origins	Non-urban origins
Urban	-552	-444	-97
Interurban	-660	-179	-470
Rural	-606	-57	-550

Significant reductions in overall CO2 emissions could be achieved if national car occupancy increases could be made. Any scheme to promote this objective would be expected to perform well on emission reduction measures. Local schemes however would be expected to benefit the local area and whilst detailed local schemes have not been specifically tested it is clear that the location of the origin where the increase in occupancy occurs will produce a strong local effect.

Contribution to user pays principle

No Impact

European economic progress

No Impact

Territorial cohesion

No Impact

12.5.5 Assessment against Main Criteria – Summary

Table 12-4 Mobile technology to encourage car sharing - Point score for the criteria

	Score
Investment costs	-
Operation and maintenance costs	-
Financial viability	-
Technical feasibility	-
Organisational feasibility	--
Administrative burden	-
Legal feasibility	
User acceptance	-
Public acceptance	-
D2D travel time	X
D2D travel costs	✓
Comfort and convenience	X
Safety	X
Security	0
Accessibility for mobility impaired passengers	✓
Car usage	-
Bus and coach usage	-
Rail usage	0
Ferry usage	0
Aeroplane usage	0
Mobility	✓
Congestion in overcrowded corridors	✓
CO2 emissions	✓✓
Contribution to user pays principle	-
European economic progress	-
Territorial cohesion	-

13 TRANSFERABILITY OF CASE STUDY SOLUTIONS

13.1 METHODOLOGY

13.1.1 Approach

In this section a transferability assessment of each solution analysed within case studies is performed in order to inform on the transferability potential of the experiences investigated as well as to provide a basis for the discussion on the potential barriers which might hamper the diffusion of such kind of solutions at a European level.

The definition of COMPASS transferability criteria started with a review of transferability approaches recently developed in other European research projects. Amongst these projects, ORIGAMI[28] proposes a methodology to assess transferability of solution embedded on the INTERCONNECT[29] evaluation framework and on the evaluation criteria proposed by the European Bank of Investment.

In ORIGAMI the transferability of solutions is evaluated on the basis of complementary criteria reflecting six (not always conciliated) dimensions in the transport market:

- The user dimension (traveller);
- The operator dimension;
- The government dimension;
- The regulator dimension;
- The technological dimension;
- The external dimension or the vision of non-users.

Each of these dimensions responds to different specific issues, reflecting the variety of interests of involved stakeholders, as shown in Table 13-1.

Table 13-1 ORIGAMI assumptions for transferability

	Stakeholder	Criterion	Elements to consider *(indicative)*
INTEREST	USERS *(Fast, cheap and comfortable travel)*	Is the solution interesting enough to be useful for other users in a different context?	*What is the overall magnitude of benefits to users? (e.g. decreased travel times and travel costs, increased reliability, comfort, convenience...)*
INTEREST	OPERATORS *(Commercial profit)*	Is the solution attractive enough for other operators to consider?	*To what extent benefits to operators outweigh difficulties to implement? (e.g. decrease operating costs, increase profit opportunities for operator...)? Is it simple enough in terms of organisation?*
INTEREST	GOVERNMENT *(social profitability)*	Is the solution strategic enough for other governments to consider?	*How large is the set of benefited users in relation to the cost of the solution? Cost-Benefit ratios*
FEASIBILITY	REGULATOR *(legal framework)*	Is the regulatory framework simple enough to allow straightforward implementation of solution in other countries?	*What are the legal constraints constraining the solution? Are there any barriers likely to be insurmountable in a different country, region?*
FEASIBILITY	TECHNOLOGY *(ad hoc approach)*	To what extent can the solution be implemented in other geographic contexts or in other modes?	*Is it an ad hoc solution for a specific problem, transport mode or transport technology?*
FEASIBILITY	NON-USERS *(externalities)*	Are there any externalitites or/and side effects linked to the solution affecting third parties other than users?	*Is the solution environmentally acceptable? What are the impacts at local or regional scale for not users? (increased noise, pollution, congestion, visual intrussion...)*

Source: ORIGAMI (2012) - http://81.47.175.201/origami/index.php?option=com_content&view=article&id=475&Itemid=90)

[28] INTERCONNECT project (Interconnection between short and long-distance transport networks) examined the role of local and regional interconnections in the context of longer distance passenger journeys in Europe, in order to address the potential for greater economic efficiency and reduced environmental impact (http://www.interconnect-project.eu/).

[29] ORIGAMI project (Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces) was concerned with improvements in long-distance door-to-door passenger transport chains through improved co-modality and intermodality (http://www.origami-project.eu/).

Starting from the general conceptual framework adopted in ORIGAMI an effort was made to enrich it with other potential aspects of interest for the evaluation of transferability derived by other relevant projects (e.g. NICHE+[30]) dealing with transferability assessment of transport solutions.

Following this tradition, in the approach proposed by COMPASS, three main dimensions are finally considered for the transferability assessment:

- the applicability of the solution;
- the interest for the solution;
- the feasibility of the solution.

1-. APPLICABILITY dimension

Within the dimension of ***applicability***, the spatial area and the demand segment addressed by the solution are the two main components to be investigated. Co-modality refers to solutions that can be implemented in an urban area, in a rural one or at a regional or corridor level and that can intercept different demand segments (i.e. short-distance or long-distance, the latter being also national or international).

2-. INTEREST dimension

Within the dimension of ***interest*** three different groups of stakeholders are considered: the *traveller,* the *operator* and the *government*.

Interest for travellers

Referring to ***travellers*** the variables to be investigated are their potential *interest* for the solution and the expected *benefits* they might achieve in exploiting it.

In order to assess the different level of *interest* that diverse person groups might have towards the solution travellers are grouped in several categories (e.g. general public, business travellers, leisure travellers/tourists, commuters/students, PT users, car drivers) and further investigated according to their specific peculiarities / socio-economic attributes (e.g. in relation to their age, gender, disability, education and income level).

Travellersô *benefits* are instead declined in terms of decrease of travel time and of travel costs, increase in reliability, comfort, frequency of public services, quality of information delivered to travellers, safety/security and territorial accessibility

It should be noted that in the context of this assessment the potential benefits of increased reliability are evaluated in relation to the potentiality of the solutions in helping travellers planning the trip by fixing convenient departure and arrival times *before* the trip starts. All the solutions which are mainly targeted to inform the user *during* the trip are not considered to increase the reliability of travellers. Under this assumption it is considered that travel planners can increase reliability for travellers, while live travel time information inside vehicles (which are supposed to inform travellers when the trip is already in progress) are rated as not contributing to increased reliability.

Interest for operators

The level of interest that ***operators*** might have for the solution is assessed in term of its potential *attractiveness* to them, of the *benefits* that might derive from its implementation and of the organizational *requirements* needed. The solution is therefore measured in terms of its attractiveness for a set of generic transport operators (e.g. local authorities/district planning managers, PT operators, taxi operators, rail operators, road managers, air traffic operators, bike sharing operators, car clubs operators etc.).

[30] The mission of NICHES+ was to promote innovative measures for making urban transport more efficient and sustainable and to move them from their current "niche" position into a mainstream urban transport application. This project looked into the details of 12 innovative measures, structured in 4 thematic areas (http://www.niches-transport.org/).

Benefits to operators are instead assessed in terms of optimized routes, optimized use of capacity (of both vehicles and roads), optimized frequency, increased sales / number of customers and decreasing operating costs.

Organizational requirements for operators are measured in terms to staff number, specific skills and training, space (dedicated areas/warehouses/garages etc.) and administrative structure needs for the implementation of the solution.

Interest for government

The other relevant stakeholder to be considered for the transferability assessment is ***government*** (at various levels) whose interest in ICTs applied to transport systems is measured in terms of the contribution ICTs might provide in supporting the policy strategies that it has envisaged or planned for the sector (e.g. accessibility policies, PT policies, traffic management policies, pollution reduction policies, sustainability/modal shift policies, etc.).

Itĝs worthwhile to mention that in the context of this assessment, *accessibility* is investigated mainly in terms of ICTs potential in increasing *territorial accessibility* and not in terms of its potential to increase accessibility of travellers to specific services since all ICTs are in principle focused on improving information and access to services. Furthermore territorial accessibility is supposed to be increased to a greater extent whether ICTs are applied to a greater geographic area or to a rural area (where the supply of services and routes is generally less known) than in urban areas. It is for example the case for the co-modal travel planners whose contribution in terms of increased accessibility is higher when covering regional or rural areas and is considered less relevant when applied in the urban context.

3-. FEASABILITY dimension

The ***dimension of feasibility*** is investigated in relation to the following set of stakeholders: *financier*, *regulator*, *technology supplier* and *non-users*.

Feasibility for financier

The assessment of the transferability of an ICT solution from the **financier** perspective has to consider *costs* and *profitability* variables (e.g. capital costs of design/planning/implementation, running costs, whole-life costs and revenues). In the COMPASS transferability framework a specific assessment for financier is made since it might be that in some cases the solution is funded by the transport operator while in other cases it might be the government to provide the capital for its implementation.

Feasibility for regulator

Towards **regulator** the variable to be assessed for transferability purpose is the requirement in terms of legal constraints (e.g. partnership agreements, licenses, contracts, privacy protection laws, copyright issues etc.) or other possible barriers which might be hard to overcome (e.g. lobbies interests).

Feasibility for technology supplier

From the point of view of the **technology supplier**, the variable of *requirement* has to be considered from two different perspectives: from the *user* and from the *operator*.

From the *user* perspective while the use of some specific technological devices is well-known and established (i.e. mobile phones or smartcards), other devices are not yet fully widespread (smart-phones, internet access or on-board units) while others are not common for all citizens (i.e. PCs or laptops). Transferability requirements may be assessed in relation to the specific technological supply needed which might be considered lower for applications accessible by mobile phones and smartcards, or higher for those requiring an internet connection and smartphones, PCs, laptops etc.

From the *operator* perspective there are two variables which are considered relevant for feasibility: the technological *requirement* and *specificity* of the solution. Operatorĝs technical requirement is evaluated in relation to the different resources involved in the solution: equipment and tools, software, information/data processing, booking system, ticketing/paying system, communication system and infrastructure system. The specificity of the solution has also to be considered: it can be rated from a higher to a lower score in relation to the presence (or not) of a specific design of the solution for addressing a specific problem or a specific transport mode.

Requirement is also assessed in relation to the *maturity* of the technology underlying the solution. Mature technologies are in general less problematic in implementation and more transferable than new ones.

Feasibility for non-users

In the sphere of the feasibility dimension the last section of investigation is related to *non-users*: it should be considered whether there any negative externalities or side effects linked to the solution affecting non-users. Any potential side-effects and/or externalities in terms of economic, environmental and societal impacts have to be carefully considered in order to avoid (or at least limit) the negative influences of unexpected reactions.

Table 13-2 provides with an overview of the COMPASS transferability framework in terms of domains, stakeholders, research questions and variables to be investigated. To these variables a qualitative score (none, low, medium and high) is assigned and contribute to the final overall assessment of transferability.

Table 13-2 COMPASS transferability framework

APPLICABILITY		
Stakeholder: All ***Research question: Is the solution applicable in a different context?***		**VARIABLE**
What is the area of applicability?	Urban areas	APPLICABILITY
	Rural areas	APPLICABILITY
	Regions	APPLICABILITY
	Corridors	APPLICABILITY
What is the demand segment of applicability?	Short distance travel	APPLICABILITY
	Long distance travel/National	APPLICABILITY
	Long distance travel/International	APPLICABILITY
INTEREST		
Stakeholder: Travellers ***Research question: Is the solution interesting enough to be useful for other users in a different context?***		
What is the targeted user?	General Public	INTEREST
	Business travellers	INTEREST
	Leisure travellers/Tourists	INTEREST
	Commuter/Students	INTEREST
	Users of Public Transport	INTEREST
	Car drivers	INTEREST
	Younger people (< 50 years old)	INTEREST
	Senior people (> 50 years old)	INTEREST
	Male	INTEREST
	Female	INTEREST
	Disabled	INTEREST
	Low to medium education (below secondary school)	INTEREST
	High education (above secondary education)	INTEREST
	Low income level	INTEREST
	Medium income level	INTEREST
	High income level	INTEREST
	People with specific interests/preferences/values (environment-friendly thinking people, people with cooperative values, etc)	INTEREST
What is the overall magnitude of benefits to users?	Decreased travel time	BENEFIT
	Decreased travel costs	BENEFIT
	Increased reliability	BENEFIT
	Increased comfort	BENEFIT
	Increased frequency	BENEFIT
	Increased quality of information	BENEFIT
	Improved personal carbon footprint	BENEFIT
	Increased safety/security	BENEFIT
	Increased accessibility	BENEFIT
Stakeholder: Operators ***Research question: Is the solution attractive enough for other operators to consider in another context?***		
What is the targeted operator?	Local authorities/district planning managers	ATTRACTIVENESS
	PT operators	ATTRACTIVENESS
	Taxi operators	ATTRACTIVENESS
	Rail operators	ATTRACTIVENESS
	Road managers	ATTRACTIVENESS
	Air traffic operators	ATTRACTIVENESS

	Bike sharing operators Departments of travel (at companies/institutions) Tourist boards / organisations (online) Travel agencies Car clubs operators	ATTRACTIVENESS ATTRACTIVENESS ATTRACTIVENESS ATTRACTIVENESS ATTRACTIVENESS
What is the overall magnitude of benefits to operators?	Optimised routes Optimised use of capacity (vehicles and roads) Optimised frequency Increase sales / revenues / number of customersé Decrease operating costs	BENEFIT BENEFIT BENEFIT BENEFIT BENEFIT
What is the organisational requirement?	Staff number Skills and training Space (dedicated areas/warehouses/garages etc.) Administrative structure	REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT
Stakeholder: Government ***Is the solution strategic enough for other governments to consider?***		
What are the policies targeted by the solution?	Accessibility policies Public Transport policies Traffic management policies Pollution reduction policies Sustainability (modal shift) policies	INTEREST INTEREST INTEREST INTEREST INTEREST
FEASIBILITY		
Stakeholder: Financier ***Research question: Is the solution financially viable in another context?***		
What is the overall magnitude of costs for the implementation of the solution?	Capital costs of design, planning, implementation Running costs Whole life costs	COST COST COST
What is the overall magnitude of profitability from the implementation of the solution?	Revenues	REVENUE
Are there possibilities to benefit from external financing / co-financing?	International/EU funds National funds	PROBABILITY PROBABILITY
Stakeholder: Regulator ***Research question: Is the regulatory framework simple enough to allow straightforward implementation?***		
What are the legal constraints underlying the solution?	Partnership agreements required Licenses required Contracts Privacy protection laws Copyright issues Non-compliance with the current legislative framework	LEGAL CONSTRAINT LEGAL CONSTRAINT LEGAL CONSTRAINT LEGAL CONSTRAINT LEGAL CONSTRAINT LEGAL CONSTRAINT
Are there any barriers likely to be insurmountable in a different context?	Lobbies interests	BARRIER
Stakeholder: Technology supplier ***Research question: To what extent the solution can be implemented in other contexts?***		
What is the technical requirement for the user?	(Mobile) phone Smartphone/PC/Laptop Internet access Smartcard On board unit	REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT
What is the technical requirement for the operator?	Equipment and tools Software Information gathering Data processing Booking system Ticketing/paying system Communication system Infrastructure system	REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT REQUIREMENT
Is it an ad hoc solution for a specific problem, transport mode?	Problem solution specificity Transport mode specificity	SPECIFICITY SPECIFICITY
Is the solution based on a mature technology?	Technology maturity	REQUIREMENT
Stakeholder: Non-users ***Research question: Are there any externalities or side effects linked to the solution affecting third parties other than users?***		
What are the impacts for non users?	Economic impacts Environmental impacts Social impacts	IMPACTS IMPACTS IMPACTS

13.1.2 Clusters of Solutions

The 21 solutions analysed by the 11 Compass Case Studies contained in this report are quite different in nature; some of them have been investigated within different contexts (e.g. urban/metropolitan areas, rural areas); some others cover different scales (European scale, regional scale etc.).

In order to make a cross-cutting of these solutions, they have been clustered according to the categories of ICTs solutions identified in the COMPASS Handbook (see D5.1 Handbook of ICT solutions for improving co-modality in passenger transport).

Next table provides with an overview of the solutions analysed by the Compass Case Studies that are considered for the transferability assessment.

Table 13-3 Clusters of solutions for transferability analysis

CLUSTER 1 - Passenger orientation and guidance	
Solution: - Augmented reality smartphone apps to locate closest public transport station	*Case Study 4*
- Accessibility applications for disabled people	*Case Study 3*
CLUSTER 2 - Automated fare collection systems (AFC) - Ticketing systems	
Solution: - Ticket purchasing via mobile phones / internet - Rural areas	*Case Study 5*
- Smart ticketing	*Case Study 11*
CLUSTER 3 - Access management	
Solution: - Biometric personal access control	*Case Study 10*
CLUSTER 4 - Shared mobility	
Solution: - Lift Sharing	*Case Study 11*
- Grass-root cooperative car sharing	*Case Study 9*
- Car sharing and car clubs: distribution and booking systems	*Case Study 8*
- Shared bike scheme management system	*Case Study 7*
CLUSTER 5 - Co-modal travel planners	
Solution: - Interurban traveller information system on personal computers (web based)ï EU scale	*Case Study 1*
- Interurban traveller information system on personal computers (web based)ï Regional scale	*Case Study 2*
- Interurban traveller information system on personal computers (web based) ï Rural areas	*Case Study 5*
- Point-to-point traveller information system on mobile device and PC	*Case Study 4*
CLUSTER 6 - Strategic transport management for corridors and network	
Solution: - Automatic incident detection based on CCTV	*Case Study 10*
CLUSTER 7 - Real time travel information services	
Solution: - Live travel time information at local public transport terminals - Bus stops in rural areas	*Case Study 5*
- Live travel time information inside vehicles - Buses in rural areas	*Case Study 5*
- Live travel time information on mobile phone / internet ï Urban / metropolitan areas	*Case Study 4*
- Live travel time information on mobile phones / internet ï Rural areas	*Case Study 5*
CLUSTER 8 - Electronic toll collection	
Solution: - Semi-automated payment at highway toll plazas	*Case Study 10*
CLUSTER 9 - Demand Responsive Transport (DRT)	
Solution: - Demand responsive services in rural areas	*Case Study 5*
CLUSTER 10 - Collective Taxis	
Solution: - Mobile applications for taxi services	*Case Study 6*

13.2 CLUSTER 1 PASSENGER ORIENTATION AND GUIDANCE

13.2.1 Solution: Augmented reality smartphone apps to locate closest public transport station (CS4)

Applicability of solution

The augmented reality for public transport orientation and guidance on smart phones provides information to public transport users about the location of nearby bus stops, metro stops (distance and direction) superimposed on real images taken from the smart phone integrated camera. This technological solution is applicable to public transport systems at urban areas, including bike or car sharing systems.

Interest of solution for travellers

The targeted users of augmented reality on smart phones are users of public transport at urban areas. Tourists and leisure travellers may be more interested on it, provided that they are aware of it existence. Frequent users and commuter are more likely to know their way around the public transport network.

The main benefits for transport public users are the improvement of information provided, which may eventually reduce door to door travel time compared to a situation where the user does not know the location of the closest public transport stop.

Even though this app has a clear potential to improve public transport guidance, the system on its current configuration may be confusing to use at first, discouraging users from repeating. Because the location of stops appears superimposed on real images, the return may be counterintuitive when stops are located behind buildings, but are still shown on the smart phone screen.

Interest of solution for operators

The targeted operators of augmented reality on smart phones are public transport operators. The main interest of operators is better informing users on the availability of nearby services, therefore encouraging the use of public transport. This solution promotes the use of public transport and at mid term, it might slightly increase the number of customers. Eventually, augmented reality may also promote the corporative image of operators associating them with the use of cutting edge or futuristic technologies.

Interest of solution for governments

In urban areas, transferability to local governments is high in order to promote the use of public transport. This solution is most useful when availability of stops is large and guidance is more crucial. Outside of urban environments, with fewer stops on the territory, this app may lose part of its attractiveness.

Feasibility of solution for financiers

The financial aspects do not seem a barrier to transferability of the technology for large public transport operators. However, it needs to be analysed more in depth what is the size of the cost-benefit ratios of such solutions.

Feasibility of solution for regulators

Legal aspects are not involved in the transferability of this solution.

Feasibility of solution for technology supplier

From the user perspective, the transferability is medium for public transport users because a smart phone with internet access is needed to run augmented reality solution.

Feasibility of solution for non-user

No direct impacts can be expected to non-users since no externalities are supposed to affect them.

In principle some environmental benefits might be achieved by non-users in case this solution proved to increase the attractiveness of public transport (more comfortable) to such an extent that it determines an increasing of modal shift from private vehicle to public transport, reducing CO_2 emissions. Nevertheless there is no evidence of such impacts so far and therefore the potential benefits cannot be quantified.

13.2.2 Solution: Accessibility Applications for Disabled People (CS3)

Applicability of solution

Accessibility applications for disabled people provide disabled people with accessibility information and/or access to accessibility-related assistance and support. By doing so, they help to enable the disabled persons to exercise greater choice in their travel decisions, and to travel with greater confidence. Consequently, they can also facilitate increased levels of travel and mode-switching behaviour. They are, in principal, equally applicable in urban or rural areas, though in practice the supporting transport infrastructure tends to be less accessible in rural areas and so their impact, in terms of disabled peopleœ travel, is likely to be greater in urban areas. As they are focused on disabled people, many of whom are older, and as they are provided via smartphones, the costs of owning a smartphone and their usability for older and disabled people is an important factor which, at present, appears to serve as a limitation on transferability. As a greater proportion of the population becomes older and more familiar with technology, one can expect transferability to increase.

Interest of solution for travellers

As mentioned above, these applications are of principal interest to disabled people, many of whom are elderly. Whilst this might, at first, seem like a relatively narrowly-defined user-group, it is estimated that disabled people comprise approximately 15% of the population and it is widely observed that the proportion of older people in society is increasing. The applications target disabled car drivers, disabled car passengers, disabled public transport users and disabled pedestrians, as well as the high proportions of disabled people who travel very little by any mode.
The applications currently have three main functions, and therefore interests, for travellers:

a. Assistance with navigation and way finding, particularly for visually impaired people;
b. Provision of specific and tailored accessibility information, relevant to particular impairments; and
c. Communication assistance between the disabled person and customer-facing transport staff.

Interest of solution for operators

These applications require some technological know-how on the part of the operators to develop, and access to relevant data sources. Nevertheless, the skills required for app-development are becoming more widely disseminated and there are a number of óopen-sourceô and ócrowd-sourcedô data sources becoming available and being used. Some ongoing management and development of the applications is generally required to allow for some monitoring of the information and support being delivered. There seem to be some barriers in the way of developing apps for IOS devices, as compared with development of apps for Android devices.
Currently, there are some applications which are available for free and others that are available at a price. Those which are free rely on advertising to generate their revenue.

Interest of solution for governments

These applications have generally been developed and operate independent of government involvement. However, a small minority have received government support (either in terms of funding or assistance with data).

Insofar as these applications are able to support and facilitate disabled peopleœ mobility, they serve to promote the goals of many governments in this area. In particular, they can be viewed as directly supporting local authoritiesô statutory responsibilities to work with disabled and older people to promote their greater social inclusion. They can also be viewed as contributing to the move toward enabling greater levels of economic participation amongst disabled and older people, to the extent that they alleviate the mobility-related barrier to this participation.

Feasibility of solution for financiers

We are not aware of any serious financial feasibility difficulties with these applications. Applications are being developed and, amongst a relatively niche market segment, they are being taken up and utilized ï both the free applications and those which require payment. The principal financial feasibility issue could be related to take-up of the appropriate devices, which currently involve the user in high one-off or relatively high monthly costs.

Feasibility of solution for regulators

The key issues in this area would seem to be twofold. Firstly, there are legal issues related to sharing of data which might serve to limit the future development of services available via these applications. Secondly, there could be issues of legal liability and/or óduty of careô That is, if a disabled person has been encouraged to use an application, has increased their level of mobility but then been involved in an accident, issues may arise regarding the apportionment of responsibility for that accident. Care needs to be taken to avoid this becoming a limiting factor.

Feasibility of solution for technology supplier

The market for the supply of the technological devices supporting these applications ï i.e. smartphones ï is a competitive one which is developing rapidly. The trend appears to be that the devicesô capabilities are increasing, whilst the cost to the user is stabilising. For these applications to realise their full benefit, the technology suppliers will need to continue their efforts to ensure usability amongst disabled and older people. This is likely to involve maintenance and development of the existing accessibility features of their devices and ongoing liaison with these user groups to understand their changing requirements.

Feasibility of solution for non-user

No negative impacts for non-users are envisaged from the implementation of this solution.

Non-users can be viewed as falling into two generic groups. Firstly, there are disabled and older people who, for whatever reason, do not use these applications. These non-users may find themselves not only experiencing social exclusion but also digital exclusion ï particularly if the accessibility of transport systems comes to rely on these applications and if the technology itself does not move to adapt to the requirements of these groups. Nevertheless, not using these applications is not considered to provide them a damage (i.e. increasing their level of social exclusion), but rather it can be considered an opportunity lost.

The second group of non-users are those who are not disabled or elderly, and therefore who would not be the target audience for these applications. Two issues are relevant to flag here. Firstly, they may be affected if any of their friends or relations are disabled or elderly and, previously, they had provided care or support in connection with their disabled or elderly friendsô or relationsô travel, the need for which is reduced by these applications. This may serve to reduce their travel and, consequently, free-up time. Secondly, becoming disabled or elderly can be viewed as something that most people will encounter, over the course of their life, and so whilst non-disabled, younger people are non-users now, they could be óusersô later in life. On this reasoning, it is argued that people place a value on the option of having these sorts of support mechanisms available to them, as and when they might need them in the future.

13.3 CLUSTER 2 AUTOMATED FARE COLLECTION SYSTEMS (AFC) - TICKETING SYSTEMS

13.3.1 Solution: Ticket purchasing via mobile phones / internet – Rural areas (CS5)

Applicability of solution

The overall applicability can be assessed as high in general terms but might be highly differentiated between different areas and demand segments. Higher acceptance is characteristic for young users travelling for medium and long-distance journeys. For other market segments the testing of the solution in rural area of North-Eastern part of Poland has shown that acceptance might be lower as discussed below.

Interest of solution for travellers

The interest of the solution in rural areas is in principle high since it eliminates problem of ticket sales for rural routes and outside the ticket booth opening hours. Nevertheless some aspects might reduce its attractiveness.

As surveyed in the Polish rural area, for majority of short distance regular travellers this solution might be useless as they might prefer either monthly ticket or find it easier to buy ticket directly on-board. Attractiveness of this solution increases with medium distance travellers and it is even higher with long distance travellers. Travellersô age plays also a significant role. As proved in the survey in North-Eastern part of Poland, highest acceptance levels are expressed by 19-45 year olds. It is a positive pattern which shows that customers which are most sought after from the marketing point of view, people who have some disposable income (students and employees), are more inclined to use electronic tickets.

The serve also disclosed that some passengers are reluctant to purchase tickets via electronic means due to the fear of fraud. That is also especially symptomatic for rural areas due to lack of confidence in validity of electronic ticket as opposed to ñmaterialò printed ticket.

Summing up, this solution is interesting for general public but going into details it can be noticed that mainly business and leisure long-distance public transport users are interested while for commuters and students as well as for older people the interest is lower.

Expected benefits in rural areas are medium or low. Travel time, reliability, comfort, quality of information should be improved.

Interest of solution for operators

The general attractiveness for public transport operators is high. In the case of rural areas no specific barriers of transferability can be envisaged except possible requirement of necessary changes in the first stage of implementation in existing specific traditional style managed companies. If the implementation of the solution requires cooperation between transport operators/managers in the region and mobile phone service providers some barriers at the first stage of introduction can be envisaged. Also if the mobile applications are implemented internally by transport operator it can cause some organisational changes that might represent a barrier in implementing this solution.

Other transport modes operators are not involved in the solution investigated in the Polish rural area. Nevertheless, in general terms, ticket purchasing via mobile phone or internet is considered of high interest also for rail and air transport operators. Local authorities and planning managers could also support this solution.

As far as concerns the organizational aspects of this solution, no specific requirements in terms of staff number and skills are envisaged, even though these requirements might increase with the complexity of the solution to be implemented.

Routes optimisation or better use of capacity is not envisaged as a result of implementation of this solution. Some benefits can be expected resulting from increased sales and revenues due to most feasible way of ticket purchase.

Interest of solution for governments

As far as concerns the interest for government, the solution is of high relevance for public transport policies and it is not targeted to directly address traffic management policies or pollution reduction. The potential of this solution in promoting sustainable mobility is considered low since it enhances the purchase of public transport tickets and thus can somehow encourage its usage.

Feasibility of solution for financiers

The general cost of the solution implementation is variable from medium to high, depending on the extension of the system. Though the solution has a generally high usersô acceptability it does not mean that people are willing to pay for the implementation of the solution. This can be a barrier in low income rural areas especially when predicted revenues and probability of obtaining external funds are low.

Additionally, the survey performed in the Polish rural area showed that willingness to pay decreases with the increasing age. When considering travel distance a huge discrepancy can be noted between local and long distance travellers. For long distance users willingness to pay is at the higher level than for local passengers. Thatǿs due to the fact that majority of frequent local travellers uses monthly or other seasonǿs tickets and they are not interested in changing the method of payment.

Feasibility of solution for regulators

No specific regulatory or legal barriers are envisaged preventing the implementation of ticket purchasing via mobile phones / internet in general terms, but the legal requirements might increase with the coverage of the ticketing system. When the system covers a reduced number of operators, (like in rural areas) the requirement in terms of partnership agreements might be low, but it might be more demanding in case of more operators to be involved (generally in urban or long distance solutions).

Feasibility of solution for technology supplier

Integral element of the solution is the mobile phone ownership or an internet connection. In the case of the mobile phones these devices are commonly widespread and no specific barriers are envisaged. In Poland number of mobile phones per 100 citizens amount to 142 (according Central Statistical Office data for 2013) and in rural areas all people have mobile phones especially since the access to landline phones is limited in this area.

But for internet access since broadband internet service is not developed very well in rural areas, then this could be a barrier for implementing this solution in less developed regions. Thatǿs the reason why older people using mobile phones only for basic needs and not having the access to internet may not be interested in this solution.

Feasibility of solution for non-user

No negative impacts for non-users are envisaged from the implementation of this solution.

Even though it is not predicted that implementation of this solution will significantly change the mobility in rural areas, slight increase might result from stimulating the mobility of young transport users who can feel more free to organise the travel with use of mobile phones.

There is some potential impact on modal shift. In rural areas the only serious competitor of bus transport is personal car. Introduction of ticket purchasing via mobile phones / internet may in principle reduce usage of personal cars to a slight extent with consequent small positive effect on CO_2 emissions. Nevertheless all these impacts can be considered negligible.

13.3.2 Solution: Smart Ticketing (CS11)

Applicability of solution

The solution was assessed in the urban context for short distance travel as this relates most closely to existing smart ticketing systems. There is however potential in the medium to long term to transfer such systems to interurban and rural regions and for medium to long distance journeys. There are no theoretical barriers to prevent regional, national or international smart ticketing schemes, but to date existing schemes operate within specific geographical limits and use bespoke systems such that a different smart ticket is required for a different geographical area. There are legal and operational barriers for cross boundary schemes which have not yet been resolved in practice.

Interest of solution for travellers

Travellers benefit strongly from the increased convenience of smart tickets; they often also benefit in cost terms as ticket tariffs using smart tickets are often priced competitively to encourage uptake of the system (e.g. London Oystercards). The highest interest is for local residents such as commuters, students etc. but schemes can be made attractive to less frequent users if there is a pay-as-you-go facility (such as London Oyster) which makes the scheme attractive to visitors as opposed to smart cards which only permit season ticket type usage (such as Edinburgh Lothian-ridacard). There is much higher transferability where the smart card design allows infrequent as well as frequent use.

Older people may be slightly less likely to opt into smart card technology, but this can again be facilitated by the structure of the scheme and the option to pay for smart-cards at the station rather than using internet top-up options. Smart card schemes which relate to concessionary travel passes for the elderly are likely to have higher take up in these groups. Likewise concessionary smart card tickets for disabled persons imply a high interest level.

At present the interest for smart tickets is highly focused within users of public transport and the interest for car drivers is likely to be low whilst the systems are specific to regional public transport. It is however possible that smart payment methods of the future would not be specific to a particular system and a payment system which was transferable between car charges (such as toll payment systems) and public transport tickets would clearly have high interest across multiple groups.

Interest of solution for operators

Most smart-ticketing systems which are operational are specific to existing public transport systems and require bespoke infrastructure for their implementation. The transferability of operational systems is therefore high for other public transport operators and currently almost null for other operators (taxi, air, bike-share, car-clubs). Transferability to regional rail/light rail is higher than for long distance rail as operational schemes are bounded geographically. Potential transferability in medium to long term would be medium to high however, but would rely on more generic payment systems being developed (such as via personal multi-use card). Smart payment systems are certainly of interest across wider solutions than just transport, but operators would need to invest in generic systems before wide transferability could be achieved.

Local authorities, travel departments, tourist boards and travel agencies have generally lower interest than operators in smart-ticketing systems. Government engagement in promoting generic contactless payment systems may improve the transferability of these solutions so the interest of these groups could become higher in the future.

Interest of solution for governments

Government interest in smart ticketing/contactless payments is high and transferability across policy areas is expected. Increased public transport journey times lead to network efficiencies which positively impact of traffic management policies and increased comfort and convenience levels improve the image of public transport which can help to promote mode shift and hence wider sustainability. Government engagement may be required to promote transferable systems.

Feasibility of solution for financiers

Capital and running costs are relatively medium as are expected revenues with an expected payback period in the order of 3 years. Revenues to be accrued in the longer term would make this of medium interest to potential financiers.

Government revenues may be required to promote the development of interoperable systems which could extend the transferability from local geographic areas. EU funding may be required to promote cross boundary systems.

Contactless payment technologies are of interest generally to financial organizations and multi-national companies. Transportation operators may be able to utilize payment technologies developed by banks or commercial organizations such as supermarkets as a more holistic approach to contactless payment is developed.

Feasibility of solution for regulators

In the UK (for example) ATOC (association of train operating companies) has developed a regulatory framework which allows for transferability of smart ticketing between the various train operating companies within the UK. Regulatory complexity will be lower where a single public authority has responsibility for public transport within a nation or a region and higher where partnerships and contractual agreements are required. Smart ticketing has high feasibility for regulators where there is a single regulator responsible for Public Transport within an area (such as a metropolitan region) but complexity is greater where many operators must agree (inter-regional and international).

A large amount of data is generally collected from smart card readers and the security and ownership of this data would be of concern for regulators particularly for wider geographical operation of smart ticketing. Legal requirements of different EU states would need to be considered for international schemes so that immediate transferability would be low-medium.

Feasibility of solution for technology supplier

As many operational systems exist worldwide this solution is feasible for the technology supplier and potentially widely transferable.

Several options currently exist for ticket purchase and payment top-up, with in person options fully available as well as on-line or mobile methods for payment top-up. There is high scope for transferability to other mechanisms for contactless payment and for ticketing functions to be integrated with mobile phones, credit/debit cards etc.

Feasibility of solution for non-user

No negative impacts for non-users are envisaged from the implementation of this solution.

Non-users might potentially benefit from network benefits due to increased network efficiencies resulting from smart ticketing. Reduced public transport journey times will have positive network benefit in reducing congestion and reducing emissions. Increasing the attractiveness (convenience) of public transport journeys will have positive social benefit and reducing payment complexity (and cash handling) may positively benefit some disabled groups.

13.4 CLUSTER 3 ACCESS MANAGEMENT

13.4.1 Solution: Biometric personal access control (CS10)

Applicability of solution

The main user targeted for the solution is the road transport operator. Applicability of this solution is medium because the system uses simple technical components, although the technology is still under development. Main solutions remain in road corridors or urban areas in order to count the number of vehicleÕs occupants.

Interest of solution for travellers

The main benefit for road users is that the system allows applying for HOV discounts in the semi-automatic lanes of toll-plazas instead of having to use the manual lanes. This may result on a reduction of travel time compared to using a manual count system. The set of cameras installed at toll plaza and the software, specially developed to detect faces automatically, are able to count the number of occupants inside a vehicle. This process takes 3 seconds.

Interest of solution for operators

By implementing an automatic counting system, the operator could in theory reduce the number of staff at the toll plaza. At the current stage of operation however, and with the volumes of users using this service, the impact is not likely to be substantial. Biometric access control has also good potential to be employed in other sectors (e.g. air sector) however it is very mode specific therefore different and rather not comparable technical tools are required outside the road sector discussed in this case study.

Interest of solution for governments

Governments are interested in HOV discounts by operators to promote more sustainable transport. However, the way in which vehicle occupancy is detected and / or enforced is not a direct concern of the public authorities.

Feasibility of solution for financiers

Investments are stated to be relatively low, especially if this system can lower the labour force required at toll plazas. The main investment are the cameras installed at toll plazas and the development of the software able to recognise faces, which was estimated on around ú 120 thousand in the case of Barcelona.

Feasibility of solution for regulators

The main legal concerns with this technology are the issues related to user privacy, because the cameras take photos in order to count the number of occupants. However, this technology avoids recognising faces and images taken at toll plaza.

Feasibility of solution for technology supplier

From the operator perspective, the technical requirements to be considered to transfer this solution are a set of cameras and the software able to recognise faces. Faces are complex objects and detecting them remains a challenging task for computer vision systems, despite the relative ease with which humans are able to do so. The principal problems in this system are occlusions, illumination changes and false positives. It is very normal to find occluded faces in this system since both front seat and rear passengers can be partially occluded by many parts of the vehicle or their body position. Sunlight reflections produce many illumination changes that lead to shifts in the location and shape of shadows, changes in highlights and reversal of contrast gradients, complicating face detection.

Feasibility of solution for non-user

No direct impacts on non-users are expected from this solution but on the society level impacts might actually be significant. There is an on-going discussion in number of countries whether this type of tools based on biometric data collection are not too abusive and are not interfering too much with privacy protection.

13.5 CLUSTER 4 SHARED MOBILITY

13.5.1 Solution: Lift Sharing (CS11)

Applicability of solution

The solution was assessed in the urban and interurban/rural contexts for travel of any distance which exists within the Scotland region (trips as per demand matrices derived from LATIS model). The solution was not applied to metropolitan areas or international trips. Transferability to metropolitan areas should be high, but operational complexity may inhibit transferability to international trips.

In terms of journey length, trip sharing would be most beneficial for short to medium journeys, particularly regular commuting journeys, although a wider range of possible rural trip types would be expected from a rural trip sharing scheme.

Existing company based schemes have high effectiveness as positive incentives are available to promote trip-sharing at this level and transferability to single organisations (as part of a workplace travel plan) is high. A more regional scheme would have operational complexity and a local authority would typically enable transferability to a regional level.

Interest of solution for travellers

Individual travellers are the primary target for lift sharing solutions, both the user who has spare capacity and wishes to drive and the user who wishes to obtain a lift. Highest transferability would be expected within the group of commuters particularly those that share a workplace or who wish to work in a small geographical destination. Commuters will be particularly interested in sharing travel costs and to benefit from any local incentives which exist to promote the use of high occupancy vehicles (existence of HOV lanes to benefit from shorter travel times in peak periods, preferential parking regulations at destination etc.). Transferability to leisure travellers and tourists is likely to be null but it might potentially have some interest in more rural areas.

Interest (and benefiting from concurrent policy measures supporting HOV use) is likely to be high for both genders and all age ranges, although more elderly persons may be less likely to be willing to share travel. All income levels are likely to wish to benefit from the ability to use HOV lanes/preferential parking where they exist, although the higher income levels are less likely to be concerned about sharing fuel costs.

Interest of solution for operators

Lift sharing solutions are focused on private car users and so are not transferable to public transport operators. There may be limited transferability of the concept to taxi operators, but as shared taxi operation is a separate solution transferability of lift sharing per se is null. There is medium transferability for car club operators who may wish to promote lift sharing in addition to car club membership for increased attractiveness of the service to potential members. There is no scope for transferability to bike-sharing schemes.

Touristic organizations and travel agencies are considered to be not interested in lift sharing schemes even though this solution could potential help increase accessibility to sites of touristic interest which are not well served by public transport.

Road managers would be interested in the potential take up of lift sharing when planning the provision of HOV lanes and would benefit from congestion reduction achieved by increased car sharing in peaks.

Interest of solution for governments

Government interest in solutions which can reduce carbon emissions and congestion, particularly in peak periods is high. Government incentives/regulation with regard to enforcement of workplace travel plans can help to encourage the take up of lift sharing, particularly when other supportive policy measures (HOV/parking control) exist.

Local government incentives may be required to set up and operate schemes which are not company/organisation based and these would increase transferability of lift-sharing into rural areas.

Feasibility of solution for financiers

Investment for capital and maintenance costs for lift sharing technology is relatively low cost, however the service is generally offered free to the user at point of use and hence revenues are generally null.

The solution is then of low interest to private financiers and government revenue would generally be required to support a scheme which was not operated by a company/organization. Positive benefit to network congestion and emissions would however make such solutions of interest for government funding (at regional/national/EU levels).

Companies and organizations would expect to benefit from more efficient use of workplace parking and could be incentivized by government regulation relating to the monitoring of workplace travel plans.

Feasibility of solution for regulators

A regulatory framework would be required for schemes with regional scope and legal issues would need to be resolved for any cross boundary schemes to exist. Legal complexity exists in the area of personal identification of the users and personal safety issues and these will affect transnational trips more than those within national boundaries.

Any legal constraints regarding maximum payment to lift share (normally fuel and tolls cost sharing) would need to be assessed and resolved for transnational transferability. Privacy protection legislation will also be pertinent to schemes which are wider than workplace schemes and this complexity is a barrier to transferability generally.

Feasibility of solution for technology supplier

The technology required for a lift-sharing solution is typically web based with a matching algorithm, although manual schemes exist within workplaces. This technology is readily transferable to mobile apps etc.

Feasibility of solution for non-user

Non users are expected to not perceive any negative impact. On the contrary, an increase in average private car occupancy could have significant network benefit depending on the scale of the increased occupancy and the geographical scope of the change. Benefits will be located in the geographical areas where the increase in occupancy occurs. Increase in occupancy will result in reduced carbon emissions and reduced congestion on the network and will therefore benefit non users.

13.5.2 Solution: Grass-root cooperative car sharing (CS9)

Applicability of solution

Applicability is generally high as the system uses fairly mature and simple technical components. The applicability in rural areas is high, while this is also applicable to the urban areas. Various organisation of the car-sharing group is possible. For example, in rural areas, typical organisation is a small municipality (with population up to 1,200 people) sharing its official car(s) with the inhabitants. Another possible organisation is that the users in a housing complex or in a neighbourhood forms a group to share some vehicles. Another possibility, although there is no existing case so far, is that a company (either local company or even a large company having an office or a factory in rural area) shares its cars with local people. This flexibility of the organisation is one of the keys for transferability of this cooperative car-sharing.

This sort of car-sharing is designated to cover the trip associated with daily needs such as shopping or accessing to social services. Thus the covered travel range is limited typically within 50km range and this does not appear to be applicable as a solution for long-distance travels.

Interest of solution for travellers

Travellers who need occasionally a car are the potential users of this type of car-sharing. In rural areas, where two or three cars are typically in households, such second or third car is used less frequently and the travellers who want to complement such cars, or complement public transport in low demand times, are the potential targets. In urban areas potential car-sharing users are people who do not own a private car, but occasionally need a car as an additional alternative to public transport or bicycle. Through car-sharing, such travellers will have more opportunity to travel flexibly in a co-modal manner in that the travellers can better choose an adequate mean of transport based on availability, destination, service hours, and so on.

As the reservation system is fully online, it requires a basic skill to operate the web-based solutions and thus the targeted users tend to be highly educated and young (under 50 year-old) persons; however this is the matter of general usage skills of the Internet and thus it does not limit the users.

It has to be noted that the users in favour of cooperative ideas are likely to get more interested in this type of car-sharing.

Interest of solution for operators

This type of car-sharing does not require a dedicated professional transport operator for it. Rather, as mentioned above, a municipality and a company located in the area can be potential organisers of the car-sharing group. Although it is difficult to generalise their interests, organising this type of car-sharing, provides visibility and might help for the publicity of the organiser group. If the car-sharing is organised by the municipality, the municipality can cover some cost associated with the official car through sharing the car and the cost for it with the citizens.

In addition to these, although the cooperative aspect of this car-sharing is not applied and the usage of the car becomes no longer exclusive among the group members, regional tourist board and hotels can potentially apply this system to their guests using their own cars. This could encourage the tourists to reach a rural destination by public means of transport rather than by cars allowing a flexible availability of car within the destination region. Hotels can save a space for parking and thus the management becomes more efficient.

Interest of solution for governments

In rural areas, transferability is high among the local municipal governments who wish to share its official cars with the inhabitants in order to optimise the vehicle usage. The local government and the inhabitants, who are also taxpayers, can build a win-win relation in that the local government can cover some of the cost associated with its official car with the car-sharing while the inhabitants can reduce the travel cost with it.

Additional potential interest for the local government is that the car-sharing can bring about a good publicity among the neighbouring municipalities. As one of the surveyed local government pointed out, this may be recognised as an advantage for some local governments.

Feasibility of solution for financiers

The solution does not require a large monetary investment. In case a car is newly purchased among the car-sharing group members, the total initial investment can be as high as ú 15,000 to 20,000, while this is normally shared among the users in the group and thus the investment per each individual is 1/10 or 1/20 depending on the number of group members. If the shared car is leased, the initial investment will be lower than this and it is more feasible.

The important aspect related to the financing is the extra insurance for this sort of car-sharing. In the surveyed case, a regional insurance company offers the users a designated package. Such development of an insurance policy for the cooperative car-sharing appears to be simple as far as the company has know-how about automobile-associated insurances and thus transferability in this term is high.

Feasibility of solution for regulators

Regulators are not directly involved in this type of car-sharing and thus this stakeholder does not directly affect to the transferability.

Feasibility of solution for technology supplier

In this term, transferability is high because the system applies fairly mature and ubiquitous ICT architectures such as smartphones (to be used as an on-board system and for communication with the online database via cellular network), online database (to be used for user management, reservation management, and driving log management), and the World Wide Web (to be used as the user interface).

Feasibility of solution for non-user

As the car-sharing group is formed spontaneously by the people who wish to share a car, there is no likely direct impact to the non-users. Indirect impacts include an increase of the people walking in the centre of the town/village to go to the shared car and publicity of car-sharing as well as EV in case an EV is shared.

Other additional peculiar items of relevance for transferability

In case a car-sharing requires a complicated and/or time-consuming process to obtain a license, feasibility becomes extremely low.

13.5.3 Solution: Classical Car sharing by car clubs (CS8)

Applicability of solution

The applicability of classic car sharing (car clubs) with fixed locations for pick up / drop off a car is generally high as the system uses fairly mature and simple technical components. The applicability in urban areas is high, while this is medium in rural areas and low in the countryside as the user figures from the case study show.

This sort of car-sharing is designated to replace own car ownership in cases where mobility patterns of users do not include daily car usage, e.g. for commuting and this type of daily ways can be undertaken by public transport, bike or by foot.

Interest of solution for travellers

Travellers who occasionally need an automobile are the potential users of this type of car-sharing. So core usage is for leisure trips (for both: short trips and longer vacation tours) and (weekly) shopping, i.e. all purposes for which public transport or bike usage is not an option at all or at least inconvenient.

As all maintenance or cleaning is with the operator of the system, car sharing is also interesting for business travel, as an alternative to a company's car (fleet) to be used for this type of trips or the usage of the private car of an employee for such trips.

The solution allows reducing travel costs, when comparing to the full costs of own car ownership in cases where just a small annual mileage applies.

Interest of solution for operators

This type of car-sharing does not require a distinct operator for it. As Karlsruhe case study pointed out, such a system can be run by a private company on an economical viable base. But also a municipality located in the area could be a car sharing provider. The same holds for providers of public transport which could run a car sharing system to complement their bus or tramway system by car sharing to provide mobility for all occasions. Such an approach could lead to an increase in the number of their customers. Also rail operators may be interested in car sharing, to provide a full door-to-door travel-chain for their customers. For example Deutsche Bahn already provides car sharing at more than 800 stations all over Germany for that purpose. Finally larger companies could provide car sharing with their existing fleet of cars used for business travels of their employees, to reduce the costs for this fleet, by providing their cars to the public audience in time periods where these cars are not or just rarely used by the company (evening, weekend).

Interest of solution for governments

For governments car sharing is an interesting option to promote sustainable transport, without the disadvantage of reduced mobility when people would have to rely on public transport solely. As Karlsruhe case study pointed out, the mobility patterns of car sharing users change when getting used more and more to such a system, with a mode shift to public transport, accompanied by a reduction of pollution caused by car usage.

Feasibility of solution for financiers

As Karlsruhe case study pointed out, classic car sharing can be run profitable and this business can be interesting for financiers.

Feasibility of solution for regulators

Regulators are not involved in this type of car-sharing and therefore not affected concerning transferability.

Feasibility of solution for technology supplier

In this term, transferability is high because the system applies fairly mature and ubiquitous ICT architectures such as online databases (to be used for user management, reservation management, and driving log management), the World Wide Web (to be used as the user interface) and also smart phones.

Feasibility of solution for non-user

No negative impacts can be envisaged for non users. In principle, non-users may profit of car sharing schemes indirectly due to the potential decrease of emissions caused by car transport.

13.5.4 Solution: Shared Bike Scheme Management System (CS7)

Applicability of solution

Bike-sharing is a widely applicable solution to provide eco-friendly mobility for short distance travel. Main solution remains in urban areas while recent development enables it to be employed in rural areas, too. As this is based on bicycle, applicability of the bicycle has to be carefully considered. Unfavourable topography such as a number of steep slopes, unfavourable climate such as a number of too hot, cold, rainy or windy days, inappropriate cycling infrastructure such as bicycle path being non-existent, and legal requirements that imposes the users extra efforts such as obligation to wear a helmet, will hinder the applicability greatly.

Interest of solution for travellers

Bike-sharing is of interest to different users groups. The target users are leisure travellers, users of public transport as well as tourists. Car drivers might be less interested to this solution, considering it only as an occasional alternative to their usual travel mode. Commuters and business travellers may get interested in when bike sharing facilities are conveniently located for completing the main leg of their journey. .

In cities, as the first half or hour of every ride is free of charge and the stations are often located at an easily accessible place, and the distance between stations is typically short such as 300m, it complements the public transport (metro, tram, bus) while it decreases the travel cost compared to them.

Seamless trip chains for the public transport passengers can be realised by bike-sharing stations located at public transport stop or rail stations. Such organisation will enable the users to use the bicycle as an access/egress mode. This is applied both in cities and rural areas.

Interest of solution for operators

Bike-sharing scheme requires a dedicated operator specialised in it with good know-how concerning technical implementation (management of IT infrastructure for station, registration and payment systems) and management of the shared bikes (e.g. redistribution of bikes from a station to another). Such operator for urban installation is typically an advertisement company that is in charge of bike-sharing schemes and urban billboards and undertakes the management of bike-sharing in trade. This requires a certain number of advertisement viewers that will enable the operator to generate enough income for the management. In rural areas, operators tend to be specialised companies.

Interest of solution for governments

The interest for the governments mainly lies on the local governments, typically city government, if it is employed in urban area. A group of neighbouring governments in urban area can be a subject of this if they decide to implement in the whole urban area. As it is mentioned below, the investment of bike-sharing is rather high and the system will not be effective in small cities typically less than hundred thousand inhabitants as a stand-alone system. Thus the interest for the city government depends much on the size. In rural areas, prefectural or state government are the main subject as they are often able to organise the system implemented throughout a region.

More use of bicycle in general as an alternative to other motorised mode has a positive impact on energy (fossil fuel) use and carbon footprint from the transport sector. Thus, as far as the government has a policy goal to decrease the carbon footprint, bike-sharing can get interested in by them. Bike-sharing0s important effect is that it makes cycling visible on the street. It will raise awareness of cycling in cities and thus it can at large contribute to the shift of transport modes, although the extent is not clearly known.

Bike sharing-schemes compete for available public space in cities with on-street parking, transport infrastructure area such as lanes for cars and/or bicycles, and areas for pedestrians (sidewalk). The government needs to be actively involved in to organise such scarce public space.

Feasibility of solution for financiers

Launching a bike-sharing scheme requires intensive investment on the infrastructure needed for that. Initial costs for terminal-based scheme are typically between ú 500,000 to 1,000,000 for a medium-sized system with approximately 30 stations. Such large system is only applicable for a large city that can afford such initial investments.

If a less expensive mobile-phone-based system is selected, for the similar scale, the initial investment cost will be around ú 150,000 to 450,000 much depending on the number of the shared bikes in each station. As an implementation of small single station costs approximately ú 5,000, this type can be applied in rural areas as well as in small cities that would not afford the more expensive system.

Feasibility of solution for regulators

Legal and organisational aspects (e.g. zoning of public space) and liability and contractual issues (for details, exit clause etc.) play an important role to this solution. Road traffic regulations need to be well considered so that the installed bike-sharing scheme obeys the rules while the rules do not have any aspect to hinder the usage of shared bicycle.

Feasibility of solution for technology supplier

The hardware (bicycle, renting station terminals, backbone system) as well as software is becoming a fairly mature system. The number of the suppliers appears to be fairly limited because of the specialness of the product and because the product can be installed in limited number while it is used for a long period over a decade once it is installed.

Feasibility of solution for non-user

Impact on non-users is setup dependent. While in most cases they are expected to not perceive any negative impact in places where there is no spare space ï like old or tightly build city areas bike routes could be created only by reduction of other facilities (e.g. division of existing courtyards). It is often perceived by pedestrians as problematic due to reduction of pedestrian space and possibility of accidents involving bikes hitting pedestrians.

Positive impact on environment applies in a direct and indirect manner. Direct impact is that as the bike-sharing scheme brings about more cyclists, it has a positive impact on carbon footprints and energy use. Indirect impacts on environment is associated with the social impact in that the awareness of cycling becomes higher through the stations and bicycles on street and thus it will encourage the inhabitants and visitors to use the bicycle more.

13.6 CLUSTER 5 CO-MODAL TRAVEL PLANNERS

13.6.1 Solution: Interurban traveller information system on Personal Computers (web based) (CS1 – EU wide scale)

Applicability of solution

The transferability of co-modal travel planners in different contexts is generally high. As the unimodal travel-planners from different providers are incorporated, the travel-planner can deal with all types of regions, as long they are covered in a providerõs database.

Although the focus of the travel planner investigated in CS1 is on national and especially international scale, it can also be applied to shorter distances (see also the other solutions documented in 13.6.2, 13.6.3 and 13.6.4).

Interest of solution for travellers

Travellers are the key targets of travel planner solutions. High levels of transferability can be therefore envisaged for most of the usersôcategories.

A different, slight, lower evaluation in transferability can be related to oldest people, due to the likely less inclination to the internet use. Disabled people can also partly benefit from this travel-planner, as filtering options allow a focus on search results on travel itineraries e.g. with minimal change of vehicles etc.

Travel time, costs, information on schedules and comfort aspects of different travel alternatives are among the benefits that are likely to interest the users, for which transferability is high. Travel planners are expected to not provide benefits to users in terms of increased security/safety and increased service frequency.

Interest of solution for operators

The transferability of the solution towards long-distance public transport operators (airplanes, trains, coaches) is high. Costs, booking links, timetables and routes represent the key information delivered by the solution.

Touristic organizations and travel agencies (including departments of travel in larger companies) could be highly interested in this solution. By exploiting the solution the formers are informed on convenient travel opportunities for tourists who like to visit their region, while the latters can improve their service from just selling / ordering tickets to provide full travel solutions city to city (or also door to door), resulting in an optimisation of the routing for the traveller, depending on his/her specific needs, which may cover cost sensitiveness, as well as total travel duration or convenience (i.e. number of necessary changes).

Interest of solution for governments

Concerning the government, the transferability is high: several transport policy domains are interested in a multi-modal travel planner (e.g. accessibility, public transport policies etc.) to the extent that the use of the multi-modal travel planner might foster the modal shift from road to public transport, with a special focus on the complete transport chain.

Feasibility of solution for financiers

The transferability is in general medium: such a system, which in principal has world-wide coverage, already exists and its owner prefers to run it on his own. Setting up a new system requires a serious amount of money, and refinancing that by user fees and income from website advertising may take several years.

Feasibility of solution for regulators

The transferability of the regulatory framework is medium as far as partnerships and contracts are concerned.

Feasibility of solution for technology supplier

Currently, the user is required to get the Internet (via laptop or desk computer). The transferability in such a case is high. For other versions of the solution (e.g. for smart phones is low or medium) the transferability is low, as the tool focuses on travel-planning and booking some days before the trip and its usage is not intended to be on the spot.

Feasibility of solution for non-user

The impacts of these solutions on non-users can be considered null since no negative externalities or side effects are expected from these tools. There may be potential environmental benefits of the multi-modal travel-planner of which even non-users would profit. The impact roots in the slight effect on mode choice from car towards public transport in some cases and as well in the CO_2-compensation for which some of the users of the travel-planner opt, when booking a trip.

13.6.2 Solution: Interurban traveller information system on Personal Computers (web based) (CS2 – regional scale)

Applicability of solution

The potential applicability of travel planners in different contexts is generally high since mapping tools of territorial areas (urban, rural, etc.) are available at affordable costs. Generalization to national or even international scale is not prohibitive but the major complexity of the system due to a higher number of transport operators involved and to the need of merging different databases implies a lower degree of applicability.

In regions with a significant presence of municipalities located in mountainous and remote areas, the existence of a travel planner may assist transport users and citizens to better organize mobility, using transport modes at their best and improving accessibility in general.

Interest of solution for travellers

Travellers are the key target users of travel planner solutions. High levels of interest can be therefore envisaged for the most of usersôcategories (e.g. leisure and touristic travellers, younger people, etc.) travelling either by car or public transport. Travellersô income level, education level or gender is expected to have no influence on the general level of interest of this solution.

A slightly lower interest might be envisaged for senior people, due to a likely lower digital skill and familiarity with internet solutions, or for business travellers segment, which might be more interested to longer distance trips not fully covered by regional scale solutions.

Information on travel time, timetables, service interruptions and accessibility during problematic period, (e.g. extreme weather conditions) is among the most important information that is likely to interest the users, from which potential benefits in terms of reduced travel times and increased reliability can be achieved. Regional travel planners are expected to not provide benefits to users in terms of increased security/safety of transport services and increased service frequency since these aspects lye outside the range of aspects addressed by these solutions.

Interest of solution for operators

The interest of the solution for public transport operators (trains, buses and coaches) is high. Public transport timetables and available routes represent the key information delivered by the solution which can lead to an optimised use of infrastructure capacity by travellers. A lower level of interest can be expected for air and motorway transport operators since the former might be generally not interested (if not marginally) in providing information on regional or short distance trips and the latter often provide information through company web solutions.

Touristic organizations and travel agencies could be particularly interested to the regional solution, due to the importance of touristic and historical sites in regional travel planners, which are designed to take into account also the cultural characteristics of the local area.

Due to the scale of the solution, the interest of bike sharing operators can be considered strictly dependent on local conditions and might be not so high in general, even if, in principle, bike paths could be displayed on the maps.

In terms of organizational requirements, the transferability score is medium. Major requirements can derive from the need to update data and staffôs training for data collection/updating updating (see point 6.2.5 below).

Interest of solution for governments

The interest of governments on this solution is considered to be high: several transport policy domains might be actively supported through the development of regional travel planners, e.g. accessibility, public transport policies, modal shift policies, decarbonisation of transport activities, reduction of congestion levels, etc. To the extent that the usage of the regional travel planner might contribute to the modal shift from road to public transport, a general improvement of sustainability of regional transport systems can also be expected.

A strong commitment of the public sector can be considered a cornerstone for the development of these applications since it may facilitate the process of data collection, favouring the establishment of common standards for data exchange and overcoming administrative barriers, e.g. streamlining the process for the definition of objectives, services and characteristics of the application.

Feasibility of solution for financiers

The feasibility of the solution from a financial point of view can be considered medium since no huge investments are needed: investment costs for data collection and set up of the internet based equipments are about ú 50,000. However, maintenance costs may be higher: up to ú 150,000 per year. The higher costs for maintenance depends on the services for data updating, e.g. hiring dedicated personnel, and ensuring technological upgrade (acquisition of maps, data base, etc).

A medium level of profitability can also be envisaged since internet could be an important source of revenues through subscriptions, banners, etc.

There is a certain possibility to benefit from external funding especially a regional (in particular) and national level.

Feasibility of solution for regulators

As far as concerns the regulatory framework, no relevant obstacles to transferability in other contexts can be envisaged since the main requirement for the implementation of regional transport planner is in terms of partnerships and contracts for data sharing.

Even if much depends on the specific institutional context, e.g. whether there is a public authority in charge for all public transport network data, in general it is likely that several transport operators are in charge for their own data. Therefore, partnerships and contractual agreement are likely to be set up for the diffusion of this information. Copyright issues, if any, could also be solved in the partnership and contractual stage.

Licenses could be required, depending on the type of data, while the restriction due to privacy protection laws is likely to be null: in general regional travel plannersô data (e.g. anonymous origin/destination paths by transport mode) do not incur in privacy law violation.

Lobbying activities (vested interests) are not likely to intervene.

Feasibility of solution for technology supplier

As far as concerns the technology supply, to benefit from the Regione Marche Travel Planner the user is currently required to get an internet connection via laptop or desk computer. Further versions of the application will also allow the user to get mobile applications (e.g. smart phones).

Concerning the operatorọs technical requirement, the transferability of the solution is strictly linked to the type of data that must be shared, to the existence of harmonised database, etc. The Regione Marche Travel Planner case study has stressed how the harmonization of procedures for data collection from different data sets plays an important role in ensuring an efficient service. Thus transferability in this context is ranked at medium level.

The Regione Marche Travel Planner application does not include on-line tickets facilities; then the technical requirements with reference to ticketing and booking systems is null at this stage of its development.

Feasibility of solution for non-user

The impacts of these applications on non-users can be considered null since no negative externalities or side effects are expected from these tools.

In general terms it can be argued that non-users might benefit from a more rationale use of the transport system, from reduced congestion and from a better allocation of infrastructure capacity which might derive from a massive exploitation of the travel planners by users. But these benefits are extremely dependent on local context and are hard to quantify.

Other additional peculiar items of relevance for transferability

Despite increased accessibility may have positive impacts on regional GDP (economic and social impacts), the likely impacts of a regional travel planner are basically to be found on the environmental side (modal shift), for which the potential might be higher (though it may depend on the site-specific substitution between car and public transport).

13.6.3 Solution: Interurban traveller information system on Personal Computers (web based) (CS5 – Rural area)

Applicability of solution

This solution surveyed in rural area of peripheral region of Poland shows relatively good transferability potential. Surveys conducted within the case study prove also higher applicability of the solution for long than for short-distance travels.

Interest of solution for travellers

In the survey conducted in a peripheral region of Poland it has appeared that travel planners are considered useful by majority of users though it is has to be mentioned also that for more than 40% of travellers this solution is useless or its usefulness is considered to be low. The reason for that is a high share of older people (65% above 60 years old) expressing lower interest in the solution. Indeed, older people in rural areas have mainly limited access to internet and fear of using any technology solutions. The increase of distance travelled is accompanied by higher level of interest.

Besides young people travelling for medium to long-distances also the segment of tourists can be indicated as highly interested to the implementation of this solution.

It should be also considered that this solution can have a significant impact on travel time which can be a factor stimulating the interest of travellers for the solution. It is especially important in rural areas for planning a long-distance journey where the regular bus services for access and egress stages are not frequent.

Interest of solution for operators

There are several actors which can be interested in the implementation of the internet based travel planner in rural area, e.g. local authorities, tourism organisations and tourism agencies.

The implementation of the solutions requires efficient cooperation with transport operators and managers in the region. This is crucial for providing and updating data which means that some necessary skills of the operatorӳ staff and the openness to the idea of cooperation are needed. In the first stage of introducing this solution in rural areas significant barrier might be expected.

But generally attractiveness for public transport operators and tourist organisation is high.

Interest of solution for governments

Any interest from the government was not investigated in the survey for the rural area of Poland. But travel planners are in line with several goals of transport policy including improvements of transport accessibility at regional level. Therefore especially in rural areas, which are generally characterized by lower economic potential and peripheral obstacles, travel planners can be considered a way for improving public transport efficiency and hence transferability potential can be assessed as high.

Feasibility of solution for financiers

Capital and running costs are at a medium level with rather low revenues expected in rural areas. Additionally, the survey disclosed that the willingness of users to pay extra for profiting of the solution is rather low and this represents an unfavourable factor for potential financier in economically less-developed rural areas.

Possibilities of obtaining external funds for the development of this solution in rural area are also low.

Feasibility of solution for regulators

Depending on specific local context some barriers can exist at the level of contract arrangements for travel planner operation and copyright issues. These barriers can be even stronger in rural areas where such specific legal skills might be lower.

Feasibility of solution for technology supplier

Technology is available but some barriers concern limited access to broadband internet service in rural areas.

Feasibility of solution for non-user

The impacts of these solutions on non-users can be considered null since no negative externalities or side effects are expected from these tools.

Here the impact on modal change can be analysed. Introduction of internet based travel planners can in principle reduce usage of personal cars in rural areas especially for medium to long-distance young travellers; nevertheless it should be considered that environmental pollution is generally not a main concern in rural settings.

13.6.4 Solution: Point-to-point traveller information system on Mobile Device and PC (CS4)

Applicability of solution

Point-to-point traveller information system is a widely applicable solution for urban and metropolitan travel. Main solution remains in urban areas and covers various models of public transport as well as walking. This solution provides access to internet-based information service at any time and any place, including information on service disruptions. Some transport operators are even attempting to install such Point-to-Point traveller information systems at the public transport stops (e.g. bus stops), to allow for users not owning a smart phone to still be able to plan their trip in an easy and quick way.

Interest of solution for travellers

The main benefit for public transport users is the reduction of travel time because the user can choose the shortest and most efficient route to arrive at destination. Sometime, the solution may return a combination of public transport services the user was not previously aware of. The system proves to be more efficient in urban areas where the different means of transport are integrated in one single ticket, therefore where the user can pick any of the proposed routing alternatives at the same cost. The point-to-point traveller information system on mobile device improves the comfort of the journey if itÕs a dynamic system, considering service frequency and eventual service disruptions. On mobile devices, travel planner allow for on-the-run decision taking, whereas on personal computers, travel planners can mainly offer an itinerary suggestion.

Interest of solution for operators

The main benefit for the operator is the increase of users, as they are now more eager to use public transport being better and more efficiently informed.

Interest of solution for governments

In urban areas, interest is high for local governments, especially for city governments. More use of public transport reduces congestion and CO_2 emissions. If the local government aims to induce modal shift, promote the use of public transport and reduce pollution, point-to-point traveller information system can be interesting to reach these goals. The important effect of this solution is that it makes PT more attractive.

Feasibility of solution for financiers

The travel planner solutions for mobile devices is high applicable because it does not require a large volume of investment. A dynamic system can be more expensive because a significant amount of data must be collected, analysed and disseminated.

Feasibility of solution for regulators

Legal aspects are not a barrier in the transferability of this solution.

Feasibility of solution for technology supplier

From the operator perspective, the technical requirements to be considered are the equipment, manly the software which calculates the routes, and design of the solutions for mobile devices. These systems are relatively mature and well tested.

Feasibility of solution for non-user

Non users are not affected by this solution.

13.7 CLUSTER 6 STRATEGIC TRANSPORT MANAGEMENT FOR CORRIDORS AND NETWORK

13.7.1 Solution: Automatic incident detection based on CCTV (CS10)

Applicability of solution

This solution is widely applicable to road corridors, mainly to long distance travels. Automatic incident detection based on CCTV system is also applicable to tunnels located in urban areas, with high levels of traffic and congestion. This solution is high applicable for increase safety on the road and managing traffic flows.

Interest of solution for travellers

The targeted users of this solution are all car drivers and road users. The main benefit for road users is the increase of the safety because if an accident occurs the drivers are warned by variable message signs quickly. In case of an incident occurs this solution reduces the time of detection of the incident, the response time of the personnel and the time to remove the incident. The effect of implementing an AID system is evident in the reduction of delays to traffic.

Interest of solution for operators

The main target operators of this solution are road managers (public or private companies) and it is widely transferable to other road corridors. The main benefits for the operators lye on the capability to promptly manage traffic flow according to road conditions and on safety improvement on the road.

Interest of solution for governments

Increasing road safety is a primary goal for governments, and a formal European objective considered in the EC Transport White Paper.

Feasibility of solution for financiers

Automatic incident detection system based on CCTV solution requires high level of investment due to the associated equipment required (cameras and software) and drivers communication system (variable speed and message signs and traffic lights). However, part of this cost may be recovered with lower insurance costs for a safer infrastructure.

Feasibility of solution for regulators

Legal aspects are not involved in the transferability of this solution.

Feasibility of solution for technology supplier

From the operator perspective, the technical requirements to be considered to transfer this solution are the equipment (cameras and specialised software to recognise automatically incidents on the road), equipments for gathering information and processing (automatic counters installed in order to provide real time data about traffic flow) and equipment for the communication system (variable speed and message signs). From the user perspective, no technology requirements are needed because the operator provides the information by variable message signs.

Feasibility of solution for non-user

Non-user aspects are not involved in the transferability of this solution.

13.8 CLUSTER 7 REAL TIME TRAVEL INFORMATION SERVICES

13.8.1 Solution: Live Travel Time information at local public transport terminals – Bus Stops in rural areas (CS5)

Applicability of solution

This solution is in general of high applicability in different contexts. In metropolitan and urban areas it is generally very common and several examples are already in place.
Applicability of this solution in rural context is medium (and in some secluded locations it can be considered low) as surveyed in the context of a rural Polish area. Although user acceptance is high and there are no legal or administrative barriers, for its implementations, financial barrier might exist. Moreover there is high risk of vandalism and need for frequent replacement of the displays making all operation costly.

Interest of solution for travellers

Travellers are highly interested to this solution since it eliminates uncertainty on the bus arrival time. On rural bus stops with low frequency it is of utmost importance. If bus is delayed passengers waiting at the bus stop may not fear that it already left.
Secondly if some service disruptions occur the information provided to travellers prevents them from losing more time in useless waiting.
The targets of this measure are all passengers of public transport, for all trip purposes, and it can be considered of general public interest. As surveyed in the context of a rural Polish area there is higher interest among younger users (more ready to accept innovations).
Usersô benefits come mostly from better information; the impact on time savings or travel cost is negligible (unless operator charges extra for availability of this ICT in which case the impact on travel cost is negative). No impact on security or safety is expected from the implementation of this measure.

Interest of solution for operators

As surveyed in the context of the rural Polish area, operators of economically less developed regions might be not very interested to this solution due to financial constraints. The initial cost is high and maintenance costs might be high due to risk of vandalism in secluded bus stops, resulting in need for electronic displays replacement. Administrative or organisational requirements are not expected to create particular barriers.

Interest of solution for governments

Governments might be interested to this solution mainly for its potential to increase the attractiveness of public transport, with consequent modal shift. Nevertheless the potential of this measure by its own is considered negligible.

Feasibility of solution for financiers

As far as concerns the feasibility of this solution from the perspective of the financier, it can be expected a weak transferability in economically less developed rural areas like the surveyed Polish one. Expected financial cost is too high to be compensated by ticket sales and given the very low willingness to pay expressed by users it is not likely to be an optimal solution in regard to economic cost effectiveness. In the long run this situation might change due to much higher willingness to pay for this ICT among younger users.

Feasibility of solution for regulators

No regulatory / legal barriers exist.

Feasibility of solution for technology supplier

Technology is available there are no technical reasons for which it could not be used in rural areas bus transport.

Feasibility of solution for non-user

The impacts of these solutions on non-users can be considered null since no negative externalities or side effects are expected from these tools.

Potential benefits to non users could be noted if modal shift from competitive transport modes (in the analysed case from private car) occurs. Impact on congestion reduction is negligible due to non-existence of congestion in this rural setting. Potential impact on overall CO2 emissions might results from modal shift.

Other additional peculiar items of relevance for transferability

In rural regions one should remember that if average score on feasibility factors is good it does not mean that solution could be introduced in practice. In rural areas one of the predominant features of all ICTs is their high cost which cannot be met by weak (in terms of financial standing) transport companies. This factor alone could be prohibitive even if other factors (no real administrative burden, high acceptance, no organizational barriers etc.) are positive.

13.8.2 Solution: Live Travel time information inside vehicles - Buses in rural areas (CS5)

Applicability of solution

This solution is generally applicable to all areas, distance segments and types of vehicles (bus, train, planes and ferries). Live travel time information inside vehicles is very important especially when the passengers have any transfer during their trips.

The solution in the specific context of the Case Study 5 (rural area in Poland) was assessed in regard to rural (and light urban) areas. For users from those areas in general average transferability is noted.

Interest of solution for travellers

The interest expressed by users is high. Younger users are more interested to this solution than older users. This represents the general pattern in society where younger people are more likely to be interested in innovations.

There is higher acceptance amongst low and medium income users. High income users are not really opponents of the ICT, they are rather not interested in it due to the fact that they do not use public transport (in the tested rural area). For the same reason the interest expressed by businessmen is low while it is a very interesting solution for both leisure and daily commuter travellers as well as for tourists. Education is not a differentiating factor ï all users express high acceptance. Car drivers are not interested to this solution as it does not concern them but there is a segment of car drivers who could be persuaded to switch to bus use if this solution is introduced.

The solution does not have impact on travel time nor travel cost (unless operator decides to increase ticket price in exchange for introduction of this ITC). It increases reliability and comfort of travel (user knows where he/she is and whether will be able to make connection/arrive on time). It does not have impact on security nor safety.

Interest of solution for operators

For operators this system is difficult to introduce in rural areas due to medium expenditure required. On the other hand from all information providing ICTs this one is most easily introducible. The additional benefits for operator may result from better knowledge of every time fleet position shortened reaction to breakdowns delays ï overall better fleet management. Additional positive effects could be increase in ticket sales due to surprisingly high expected modal shift.

Interest of solution for governments

Local governments if burdened with provision of public transport will look in the first place for sufficient frequency of service. Other additional services are for them of secondary importance especially if additional financial expenditure will be required to have the system operational.

Feasibility of solution for financiers

The solution is moderately feasible. From all information providing ICTs this one has the lowest expenditure level and lowest further maintenance cost. Nevertheless given low willingness to pay among users and potential users) this cost will most likely be not recoverable.

Feasibility of solution for regulators

No regulatory or legal barriers exist.

Feasibility of solution for technology supplier

Technology exists and there are no technical barriers preventing its use in rural areas.

Feasibility of solution for non-user

Non-users are not impacted with exception of possible shifters from private car segment. For non-users congestion reduction benefits are not substantial due to little or no congestion in rural areas in the initial situation. Impact of CO_2 is limited to the effect resulting from modal shift from private car.

13.8.3 Solution: Live Travel Time information on mobile phone / internet – Urban / metropolitan areas (CS4)

Applicability of solution

Live travel time information on mobile phone and internet is a widely applicable solution to short distance travel in urban and metropolitan areas. It mostly involves providing users with information on what is the expected time of arrival for the next service on a bus or tramway route, or on a metro or rail line. In areas where service frequency is lower (e.g. in urban peripheries or rural areas) this solution proves to be more useful than in areas where services are more frequent (city centres).
Live travel time information is often also available for long distance journeys provided by railway companies or airlines.

Interest of solution for travellers

For public transport stops and stations this app aims at making the userõs waiting more comfortable and painless. It has been demonstrated that the perception of travel time costs increases with time uncertainty. Better informed passengers are more eager to wait until next service in a calm way, and to accept longer waiting times than non-informed passengers.

At mobile devices and computers, these apps allow users saving time as they can go to the station only when the service is expected to arrive and not before, reducing substantially waiting times. For instance, for a given service frequency of 30 minutes, a non-informed passenger is likely to wait on average for 15 minutes, whereas an informed passenger is not likely to wait for more than a few minutes.

Interest of solution for operators

The main benefit for the operator is being in position to offer a better and more attractive service, therefore setting up the conditions for increasing the numbers of users. Public transport becomes more comfortable and reliable.

Interest of solution for governments

The interest for governments is to make public transport more attractive and operational. More use of public transport reduces congestion and CO_2 emissions.

Feasibility of solution for financiers

To transfer integrated live travel time information requires relatively high levels of investment due to the associated computer technology and strong project of fleet management that is required. If fleets are already monitored real time by a centralised platform, then the problem is only to transfer this information to users, with less associated costs. Equipment at stops and stations to inform users (e.g. screens, signsé .), and the on-board equipment for buses or trams, can have an important cost of implementation and maintenance. Vandalism can suppose an important yearly bill.

Feasibility of solution for regulators

Legal aspects are not involved in the transferability of this solution.

Feasibility of solution for technology supplier

From the operator perspective, the technical requirements to be considered to transfer this solution are the equipment (infrastructure, hardware and software) and design of websites. For users, information can be obtained at stops without any technological requirement or at smart phones if they own one.

Feasibility of solution for non-user

No impact is expected for non-users.

13.8.4 Solution: Live Travel time information on mobile phones / internet – Rural areas (CS5)

Applicability of solution

As already mentioned in 13.8.3, the solution is easily applicable to different areas and travel distances. This section specifically focuses on the applicability to rural areas. For these regions the only serious problem could be financing: for rural area transport companies the implementation of this type of system might represent a relatively high initial investment.

Interest of solution for travellers

This solution does not have a specific user target; it is directed to all current and potential users of public transport. It is not expected that business travellers will use this frequently (few business travellers use public bus) and it is not intended for high income people who are reluctant to use public transport regardless of increased quality, but is met with higher interest by low and even medium income users. For the age differentiation criteria this solution (as results show) attracts much more travellers of younger age groups. For older people significant usability barriers exist (they have no knowledge how to use advanced functions of mobile phones/smartphones).

Travellers are mainly interested due to perceived high time savings (in rural areas it might be up to 20 minutes) resulting from just in time departure from home and reduction of waiting time at bus stops. This solution is not expected to have impact on user costs (unless operators increase ticket price in order to compensate for system investment/maintenance expenditure).

Interest of solution for operators

The operator might be interested in particular solution if it offers additional benefits. Benefits could take a form of optimisation of operations, reduction of operating costs or increase in profitability. If introduction of particular ICT solution into transport system adds to the operator costs without compensating direct benefits this solution will be discarded by operator even if it contributes to more efficient transport system in general.

Interest of solution for governments

The government might be interested if it is local government task to organize transport in rural area. However for government the priority is to have transport operational and ICT improvements might not be of primary concern. On the contrary, if public support is sought by operator, the local governments might resist to the introduction of those ICTs due to financial constraints.

Feasibility of solution for financiers

This solution seems not to be very feasible in rural areas. As already mentioned, rather high initial investments are foreseen, although running costs are low (unless the tool is used also for fleet management and requires additional data/operations centre). The operator (bus companies) most probably lack own funds for development of this type of systems and in rural area, as research shows, there might be strong opposition from users to pay more in exchange for ICTs.

Feasibility of solution for regulators

There are no legal/ regulatory barriers. This ICT could be introduced under the existing legal framework.

Feasibility of solution for technology supplier

Technology exists and there are no technical barriers preventing its use in buses in rural areas.

Feasibility of solution for non-user

The impacts of these solutions on non-users can be considered null since no negative externalities or side effects are expected from these tools.

This solution may in principle induce some modal shift. If modal shift (from private car) takes place than some CO2 emission reductions could be achieved. Impact on congestion might be considered negligible since congestion in rural settings is either non-existent or very low.

13.9 CLUSTER 8 ELECTRONIC TOLL COLLECTION

13.9.1 Solution: Semi-automated payment at highway toll plazas (CS10)

Applicability of solution

Applicability of National Highway Toll Payment at plazas is generally high because the system uses mature technology and simply components. An antenna located at toll plazas reads the electronic device (on board unit), linked to the driver bank account, installed at the windscreen of the vehicle. It is currently the most commonly used means of payment on motorways, together with credit and debit cards. The main applicability is at highways (national and international travels). Nevertheless in case of international travels some interoperability requirements are to be satisfied both in terms of technology implemented (which might be different from country to country) and in terms of revenues distribution between countries.

Interest of solution for travellers

The targeted users of this solution are the car drivers and highway users (occasionally tourist and leisure travellers can be benefited).

The main benefit for road users is the reduction of travel time. When the vehicle is approaching at toll plaza, the system validates the operation and the vehicle is allowed to pass. The system automatically charges the toll fare to the driverôs account. The solution of National Highways toll payment at plazas saves time waiting at toll gates.

Eventually, discounts on the toll fare can be applied to users of the semi-automated toll lanes, as vehicle characteristics and identification can be codified within the OBU devices required for such systems (e.g. ecologic vehicle discounts, recurrent user discounts).

Interest of solution for operators

The main benefit for the operator is the reduction of congestion at toll plazas and the optimisation use of capacity. It also contributes to increase the autoimmunisation of the overall toll system, requiring for less labour force.

Interest of solution for governments

Governments are interested in such solutions mostly because they favour reductions on the overall levels of congestion. Additionally, the OBU devices needed for semi-automated toll payment also allow for the implementation of additional policies based on vehicle characteristics or driving patters, such as discounts for environmentally friendly vehicles or recurrent drivers. Nevertheless this possibility is strictly linked to the data collected by the operator when the OBU is released and it is currently not fully exploited. In some countries, like in Italy, the OBU (Telepass) is released to drivers without collecting any information on the emission class of vehicles, but only requiring information on the driver bank details and on the plate number. This makes impossible to implement tolls differentiation on the basis of vehicle emission classes.

Feasibility of solution for financiers

No financial barriers are expected for this widespread and mature technology.

Feasibility of solution for regulators

Only concerns in relation to driversô privacy may apply, but these have not represented any barriers for wide-spread implementation of these systems in several countries.

Feasibility of solution for technology supplier

This is a well-known and mature technology, where most initial technical problems have been overcome over time.

Feasibility of solution for non-user

No negative impacts to non-users are expected from the implementation of this solution.

On the contrary, non-users should welcome the system, since it reduces queues at conventional toll booths. Impact on the environment is slight due to use of this solution reduce congestion at toll plazas and this reduction contribute to decrease fuel consumption and carbon emissions.

13.10 CLUSTER 9 DEMAND RESPONSIVE TRANSPORT (DRT)

13.10.1 Solution: Demand Responsive Services in rural areas (CS5)

Applicability of solution

Generally it can be expected that the applicability of DRS in rural areas is high. But the case study conducted for North-Eastern rural area in Poland proves that some significant barriers of applicability may exist mainly resulting from low awareness and understanding of the solution in the less developed regions.

Interest of solution for travellers

The results of the survey for the Polish case study proved that the perception of the solution by users is highly dependent on their awareness and acquaintance of the solution. If users do not understand correctly the potential of the solution they suspect that it will be too expensive and not convenient for them. Therefore expected benefits even in the range of increased accessibility are perceived as low.
Positive impact on accessibility for people with reduced mobility can be expected especially in the case of the services being more door to door oriented.

Interest of solution for operators

In case of low organisational potential of transport companies it is expected that serious organisational problems can occur in the implementation of demand responsive services. Focus groupsôinterviewed in the Polish case study proved that both transport users and representatives of transport operators are afraid of possibility of very poor quality of the service in the area. Then the attractiveness for public transport operators can be assessed as medium.

Interest of solution for governments

This solution is in line with some policy objectives as e.g. increase of accessibility, better elasticity of public transport therefore it can be expected that this solution would be of a high interest for governments. Of course again since in rural peripheral areas this solution is not well known the crucial issue is to increase the awareness.

Feasibility of solution for financiers

Costs of implementation are relatively high and profitability is risky. External financing seems to be possible but difficult to achieve.
Then the willingness to pay for demand responsive services in studied area is very low.

Feasibility of solution for regulators

Some legal barriers in rural peripheral areas can be expected especially in the country where such solutions are not popular. They can consist in classification of bus fleet used, revenues allocation etc.

Feasibility of solution for technology supplier

No significant technical barriers exist in regard to equipment since the technology is available. But this system is technically advanced in order to enable flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passengersô needs. The key component of the solution is a computer-aided system assisting the control centre staff in the whole process of meeting userŝ requests, providing dynamic routing and scheduling of vehicles, together with the reporting and accounting operations. The special constraints in the remote rural areas concern low technological development and technological potential of the transport operator that is necessary to implement the solutions efficiently.

Additionally limitation of mobile phones coverage in rural and forestry areas is a constraint of the implementation of the solution.

Feasibility of solution for non-user

Very low impact on modal shift can be expected since car usage is not going to be changed by this solution. No impact for CO2 emissions or congestion reduction is envisaged. There can be expected positive impacts on region accessibility in social terms.

13.11 CLUSTER 10 COLLECTIVE TAXIS

13.11.1 Solution: Mobile Applications For Taxi Services (CS6)

Applicability of solution

The solution assessed was the use of mobile apps in the booking of taxi and taxi-like services. The concept of mobile booking platforms is well advanced across many transport services, and is developing rapidly in terms of its application to taxis. Development is led by a small number of app companies crossing jurisdictions and operating in a number of countries. There is potential for the wider development of the app, mainly oriented around the inclusion of additional facilities, but this is limited by the economics of operation, and the willingness, or otherwise, of the licensing authorities to permit such developments. There are both legal and economic barriers for new schemes which have not yet been resolved in practice.

Interest of solution for travellers

Travellers benefit from an increased accessibility of taxi services, and of services that operate in the same market. The taxi market is distinct, and legislated to include a combination of: Taxis, vehicles able to pick up on street; For Hire vehicles, generally limited to pre-booked trips; limousines, operating under similar conditions to For Hire vehicles; and ridesharing, being a relatively new entrant to the market and often operating outside the current regulatory structure. High levels of interest are noted in terms of the reliability and access afforded by taxi apps, while the underlying architecture, and conflict in regulation are not directly apparent to the user.

Additional benefits arise from the ability to track vehicles and make payment by credit card, a practice that is not universal in the taxi industry. Extensions of the taxi app may encompass additional services and features not available in the current generation of apps; which may include facilities specific to older travellers, shared rides, and the ability to report operating practice to local regulators. Further services, though more distant in application, may include price comparison apps, following recent practice in the airline and hotel industries, allowing for both access and price competition through single apps.

The market for apps and app-based services retain a small proportion of the market share, both as a result of their novelty, and the need to have access to smartphones for their use. The novelty and access to smartphones will alter suggesting a growing market in this sector.

Interest of solution for operators

The interest expressed by the taxi trade for app based booking services is sharply divided between those who see their development as positive to the development of the industry, and those who recognise a more significant underlying impact, threatening the structures of supply that exist at present. A further split exists between the interests of the driver, for whom the availability and access to customers is a priority; and the interests of the taxi company, for whom the app may threaten traditional operating practices.

To date four generations of app based services have developed; ranging from early taxi directories, through app systems offering access to traditional booking services; and more recently direct access to drivers, thus avoiding the taxi companies traditionally involved in the booking process. Fourth-generation apps also provide services across platforms, offering bookings to Taxis, Taxi-like services and, in some, instances to ride share services. The latter offering a distinct challenge to the existing industry, sometimes cited as destructive competition.

A further distinction should be drawn between the interests of operators in the short term, for whom rapid expansion of make up operations may be seen as positive, and services over the longer term, where market instability may be an issue. Examples of this incivility can be seen in the case of the deregulation of services in the United States of America in the 1970s and 1980s.

Interest of solution for governments

Impact of taxi apps on government and licensing authorities may be even more distinct than on the operators themselves. The key element in this instance relates to the licensing and regulation of taxi services themselves, a function typically undertaken at a city or district level. Regulations placing distinct requirements on vehicle type and operation characteristics are challenged and sidestepped by the presence of apps which may reduce the ability to define such characteristics, or sidestep the regulations in place. Example of this relates to the determination of fares, typically expressed as time and distance based charges and limited to define and amounts to avoid market exploitation by operators. Many current app-based services sidestep this distinction by offering distinct and changeable fairs, outside of the defined level. Examples of negative impacts include ‘surge pricing’, being the addition of higher charges beyond those permitted by the licensing authority; and the charging of minimum fares above those permitted by the authority.

Government authorities have responded to the development of apps with a variety of responses ranging from seeking to ban operations, to those that permit, albeit grudgingly, certain service types. The term ‘rogue apps’ is widely used across in the USA in relation to apps that seek to avoid regulatory instruments, while some require the app companies themselves to conform with existing service types. The solution offered by taxi apps has received a very mixed reception across government departments and jurisdictions.

Feasibility of solution for financiers

The taxi app has distinct financial implications on its developers, often not fully understood by nascent app providers. The image of a low cost solution is false, with a significant level of costs related to the operational elements of app provision. A small number of very large providers illustrate the full range of costs that are faced by the developer, but also illustrate the potential financial returns of the app when successful.

Operating costs of the app itself remain a very small element in the total cost of its provision. Design and development costs can be seen as less than 10% of the budgets of existing operating apps, with the remaining costs associated with the development and maintenance of relationships with drivers, and the regulatory authorities; as well as the legal defence costs often associated with the development of the app in the taxi market. The extent of this cost will depend on the choices of the regulating authority in challenging the legality of app provision; a practice that is common in the majority of American cities; with the counter being that cities where an app provider chooses to follow existing regulation require larger investment in physical presence. The examples of Toronto and Chicago illustrate this. In these cities up providers are required to register as taxi companies, with the associated costs.

Financial backing is observed in the instance of large providers, often with large Multi-million dollar investments made by investors in industry who identify the development as having a long-term role and market.

Feasibility of solution for regulators

The feasibility of the taxi app for regulators varies widely between locations, as set out in preceding sections, and offering significant challenges to regulatory continuity. Taxi regulators have not achieved a common position in the development of apps, and this is further hindered by the apparent willingness of some app providers to flout existing regulation. Smaller entrants will often entry market without knowledge of regulation, while larger existing market participants may often seek to apply a single solution across different markets. Regulatory challenges have not been resolved and are likely to increase over time as popularity of the taxi app continues to grow.

Feasibility of solution for technology supplier

The technologies associated with taxi apps are distinct and known. The solution offers limited technical challenges, the technology being a minor part in the application. As a result many small app providers have emerged over time with an equally large number of providers falling out of the market as a result of the wider difficulties in development. Single transferable solutions, offered by some larger companies, particularly those that allow for app ‘portability’ between locations, allow for widespread use of an app increasing the market to the technology supplier.

Feasibility of solution for non-user

A key premise in the development of the smartphone app is the ability of a user to access a smartphone. This is a fundamental barrier to use wear smart phones are not accessible, and will preclude used by a proportion of the population. This said, the number of individuals with access to smartphones is growing at a rapid rate, reducing the impacts of a lack of accessibility. More worrying is the threat of market diminution and declining market stability on taxi users who do not or cannot use the smartphone app. Traditional taxi services are challenged by the presence of app based competition, to the extent that the traditional market has declined and will continue to decline further. Individuals on lower incomes and some social economic groups will be negatively affected by market instability and traditional taxi decline. Evidence of market change can be seen in a number of locations, and should be considered in the continuing determination of licensing and regulation.

13.12 CONCLUSIONS

13.12.1 Transferability potential

Introduction

In the previous sections a detailed assessment of transferability of solutions investigated in case studies was performed. As already mentioned the analysed solutions are quite different in nature and have been tested in specific local contexts all over Europe. Furthermore transferability assessment can be considered a delicate matter which is strongly influenced by subjective perceptions and experiences of all stakeholders involved that might differ quite a lot from country to country and from zone to zone, making it very complex to reach an indisputable point of view.

Given this background the cross-cutting analysis for all 21 solutions investigated by COMPASS case studies revealed to be a challenging task leading to interesting and explorative conclusions to be used as starting point for further discussions and research.

Applicability

ICTs solutions investigated are generally characterised by higher applicability than the one specifically analysed within each case study. Several ICTs can be replicated in different contexts or geographic scales and for some of them the analysis already provided with an evidence of their high transferability, as in the case co-modal travel planners which have been tested from European to urban scales.

It is well-known that the complexity of ICTs architecture inevitably increases with the number of transport modes covered and operators to be integrated thus making high scale applications more challenging and therefore reducing their easiness of transferability. On the other side it should be considered that also the benefits potentially achievable from complex ICTs architectures are higher.

Indeed the analysis performed revealed that the most of investigated ICT solutions can be combined together in order to provide with highly advanced ICT architectures which are capable to combine and amplify the benefits arising from each of them. It is for example the case of Integrated Real Time information systems that can be built upon a bundle of solutions (e.g. Live travel time information at local public transport terminals, Live travel time information inside vehicles, Live travel time information on mobile phone / internet etc.).

This kind of architectures are expected to be highly beneficial to transport systems that operate in a great network synergy since they support the management and distribution of any type of information (schedules, infotainment, security etc.), to any transport mode (metro, rail, trams, ferries, buses) making them truly integrated multi-functional information management platforms.

Thus the increased complexity of ICTs architectures is also accompanied by increased potential benefits and this relationship should be further investigated by research projects and real life applications in order to clearly identify the related cost-benefits dynamics and potentials.

Interest for travellers

As far as concerns the interest for travellers, the analysis showed that some solutions are expected to be of more general interest for travellers than the others.

It is for example the case of co-modal travel planners whose interest is quite widespread among all travellers, regardless of personal peculiarities. The interest for co-modal travel planners appears to be higher when they cover a larger geographic area since they are expected to provide a higher contribution to the planning of the trip than local scale applications. Indeed, the planning of shorter distance trips might require less information needs and information might be also collected from alternative sources (e.g. travellersôinformation points at terminals).

Other solutions instead, appear to be more specifically dedicated to enhance mobility for some transport modes and/or demand segment (e.g. biometric personal access control or mobile applications for taxi services) and therefore their interest to the general public might be lower.

Car sharing and bike sharing schemes perform generally well as far as concerns their interest from travellersô perspective, even though they appear to be of higher relevance for people with specific preference and values (e.g. environment-friendly thinking people, people with cooperative values etc.). In particular it can be expected that some solutions of shared mobility (e.g. lift sharing and grass-root cooperative car sharing schemes) might be more transferable to those environments characterised by persons with higher cooperative values and more oriented to innovative solutions.

When looking at personal peculiarities, the analysis disclosed that gender seems to be not an issue of preferences for ICTs applied to transport. A certain preference might be instead observed towards the different transport modes supported by these ICTs. It is for example the case of bike-sharing which was quoted to have a higher interest for male users, being this preference apparently not linked to the technology behind, but mainly on the specific transport mode covered and on different inclination to sport activities.

As far as concerns the age of users, interests for ICT solutions appears to decrease with increasing age. This evidence is more or less widespread amongst all investigated situations, confirming that the digital divide is a general issue all over European countries and zones. Nevertheless the barrier which prevents elderly people to fruitfully access ICTs applied to transport is expected to gradually being removed in the future where the generation of elderly will be composed by persons with higher digital skills and more used to web services and information.

Generally the benefits for disabled people deriving from ICTs applied to transport are strongly related to the channel of information and to the transport mode supported by the ICTs. It is evident that the nature of impairment plays a fundamental role in both these aspects.

Whether the information is provided only by visual channels (no audio information) the ICT technology would be useless for blind people. On the contrary if it is provided only through audio channels deaf persons would not profit from it.

In the same way, people with mobility impairment might not benefit from ICTs solutions applied to all the schemes of shared mobility which imply sharing a vehicle (and not a trip). It should be considered that persons with this kind of physical impairment might need for specific vehicles customized with equipments able to compensate for their specific impairment. These kinds of vehicles are generally not available in car or bike sharing fleets.

But this evidence is supposed to change in the future. As already pointed out by COMPASS project, the ageing of European population will impose new challenges to the development of the European transport systems and to the future European economy. Supporting the mobility of physically impaired persons is expected to become a cornerstone of future policies at several levels and it can be argued that ICTs applications and transport solutions specifically devoted to this challenge will gain a significant relevance in the next future.

When discussing about solutions and income levels, a distinction should be made about the interest of different income level groups towards ICTs and towards the transport solutions supported by these ICTs. It is obvious that ICTs applied to improve local public transport might be considered of lower relevance for high income people who are generally less interested in public transport (since they might prefer private mobility). But their interest might radically change when the same ICT solution is applied to long-distance transport modes (e.g. high-speed rail services or flights). It is for example the case of "Live travel time information inside vehicles" or "Live travel time information at transport terminals", which might be considered of low relevance for high income people when applied to local PT, but they might be of high relevance when applied to high-speed vehicles and relative terminals. Additionally, it can be argued that high income people might be more demanding on the quality and level of information during their journey than medium-lower income people. Therefore income level appears not to be a discriminating factor for travellers' interest in ICTs.

The level of interest of travellers for ICTs is strongly related to the perceived benefits deriving from their exploitation: the most of them is related to the quality level and to the timing the information is delivered to final users. Indeed, information is a high perishable good that should be provided to travellers at the right time and in the right place otherwise it might be useless. Only information collected before the trip starts can really help improving the planning of the journey (increased reliability of trips by establishing appropriate departure and arrival times). Information received during the journey must be delivered in due time and place to allow travellers to change their journey plan in case of delays or services disruptions. In such a case benefits provided by ICTs are mainly on time savings and they might be perceived not so high.

Interest for operators

The interest of operators towards the diffusion of ICTs applications to transport is strongly influenced by the benefits achievable from their implementation and by the balance between the organizational requirements and the expected benefits. If this balance is not so favourable due to higher organizational requirements it can be expected that ICTs solutions perform poorly in this respect and therefore the potential for transferability is lower.

The analysis performed showed that mobile applications for taxi services might appear of high interest to taxi operators (or at least to the share of them supporting the diffusion of these apps) since they are expected to strongly increase their business with minor organizational requirements.

The analysis also disclosed that, despite the organizational requirement needs, this balance appears to be also favourable for car sharing schemes which might represent an interesting business for dedicated operators as witnessed by the Karlsruhe case, or for DRT in rural areas which is expected to highly reduce operational costs for public transport provision in low density demand zones.

It might be concluded that, under the assumption of reasonable organizational requirements, the higher the benefits in terms of increased revenues, reduction of operational costs, better fleet management and optimized capacity of routes and services, the higher is the interest for operators.

Under the perspective of the balance between benefits and requirements, some ICTs applications might be perceived of less strategic relevance by operators (or at least might be considered not so relevant in all contexts). It might be the case of ICTs applications providing live travel time information to users in those contexts where the information provided has a lower potential to efficiently managing services disruptions (i.e. providing benefits to operators). It is for example the case of live travel time information inside buses or at bus stops in rural areas, where the benefits arising from the delivered live time information to users could be rather limited for operators when no alternative public transport option is in place. In such cases the interest for operators could be mainly justified by the potential of such ICTs in attracting more customers by providing the users with higher quality information. Nevertheless these applications might reveal to not increase per se the number of customers in absence of increased quality of services.

On the contrary live travel time information provided by automatic incident detection might be of high relevance for road transport operators since they could effectively contribute in traffic management and rerouting for avoiding serious services disruptions.

Smart ticketing is another case where the interest for operators might be strongly limited by the organizational requirements needed, whose complexity is expected to increase considerably with the number of modes and operators involved thus reducing the level of perceived benefits.

Interest for government

As far as the general interest of the government is concerned, the analysis of individual solutions disclosed that several of them are supposed contributing to a different degree in fulfilling the most common strategic transport policies. In particular co-modal travel planners and the most common schemes of shared mobility (i.e. car and bike sharing) are supposed to perform better than the other solutions since they are expected to contribute to modal shift policies, to pollution reduction policies as well as to the promotion of public transport services and to increase the territorial accessibility.

The cross-cutting analysis also revealed that investigated ICT solutions have a high potential to operate in a great synergy; therefore for those situations where the contribution in pursuing specific transport policy objective of some of these individual ICT solutions might be not substantial when applied individually, their potential in actively supporting the most common transport strategic objectives exponentially increases when they are framed into a more complete information technology framework for transport systems. It can therefore be argued that the interest of the government towards ICTs deployment in transport might strongly increase in case of more complete technology frameworks.

Feasibility for financiers

From a financing point of view it emerged that the profitability - evaluated in terms of additional revenues compared with the overall magnitude of costs for the implementation of the solution - for the most of investigated ICTs is low and it is further accompanied by a general low potential of benefiting from international and also national funding.

Profitability appears to be higher for some emerging applications (i.e. accessibility applications for disabled people, European co-modal travel planners like Routerank and mobile applications for taxi services) while it is almost null for live travel time information applications and for those applications targeted to improve road traffic access and management (e.g. incident automatic detection and biometric access control).

This evidence seems to confirm that a central role in the deployment of ICTs in the transport sector is played by the benefits achievable by transport operators which make the most of solutions financially viable only if framed into a more general overall framework of network and/or fleet management.

Feasibility for regulator

When looking at the regulatorsôperspective, very different situations emerge from the analysis.

Some emerging applications like the mobile applications for taxi services have a clear high potential to revolutionise traditional transport markets, posing relevant problems with respect to established national legal frameworks and consolidated lobby interests.

In some other cases ICTs solutions might pose problems with respect to privacy protection laws. It is for example the case of applications dealing with biometric access control that can raise serious privacy concerns about the ultimate use of the collected information.

In such complex situations it might be explored the opportunity to assess the compliance (or not) of these applications at a higher level (e.g. European Union) and to establish common guidelines for their diffusion rather than leaving their regulation at Member Statesô level which might determine a patchwork of different situations across the Union.

Besides these particular situations which might deserve more attention, other solutions appear to be generally feasible. Some solutions are considered to be more demanding in terms of partnership agreements especially in those cases involving more operators (e.g. smart ticketing); other solutions are instead more demanding in terms of contracts and licenses (e.g. insurance contracts for shared vehicles); others appear of no general complexity from the regulatorsôperspective. But in all of them no insurmountable barriers are ultimately envisaged.

Feasibility for technology suppliers

As far as concerns the technology supply, the analysis disclosed that the level of technology to be made available by the end-user for investigated solutions is different. Indeed, several solutions are generally accessible through a smartphone or a PC connected with the web; others require the installation of on board units or the possession of smart-cards; some others require no devices from the end-user side (e.g. live travel time information inside vehicles or at transport terminals, biometric personal access control, etc.).

In general terms it can be expected higher transferability potential for those solutions requiring null or limited provision of technology equipments by end-users. Nevertheless the diffusion of smart-phones keeps growing in almost all European countries and their cost is expected to be no-longer a barrier. But the availability of PCs and smart-phones is not a guarantee of accessibility to transport solutions when these devices are not connected to the web.

Solutions requiring the availability of internet connection might be low transferable to those zones where internet coverage is low (e.g. rural areas). Additionally their accessibility might be reduced when a traveller is in a foreign country. Indeed, even though several transport terminals are being more and more equipped with facilities to access the web by mobile devices, in general these services are not provided for free and the accessibility to web by exploiting foreign mobile operators reveals often to be more expensive than the domestic one.

When focusing on the operatorsôperspective, the analysis disclosed that some solutions are more demanding in terms of information to be collected, processed and delivered to end-users. It is for example the case of co-modal travel planners which often require for the combination and harmonization of information provided by different operators.

The quality and nature of existing in-house datasets of different operators might be not compatible as such for a cross-exchange of data and this situation might require for further processing and common standards identification thus limiting the potential of creating multi-modal platforms also in restricted and low budget situations (e.g. rural areas).

Furthermore the analysis disclosed that skills and expertise to develop and/or manage such kind of ICTs applications might be not so commonly available in some zones, thus limiting the transferability potential in these areas.

13.12.2 Barriers for transferability

Introduction

The method of analysing 21 solutions in 10 clusters allows for initial generalisation leading to identification of clusters where some strong implementation barriers can be expected. When taking into consideration COMPASS transferability dimensions different types of barriers and their pressure can be expected. Most significant and difficult to overcome barriers result from low interest for operators and low feasibility for financiers. Then also the lack of interest for travellers generates implementation barriers. Other factors like low interest for government or low feasibility for regulators, technology suppliers or non-users seem to be easier to overcome.

Comparative analysis of transferability dimensions for different clusters allows for developing synthetic and subjective conclusions on potential level of barriers to be expected.

Table 13-4 Potential barriers expected in specific COMPASS clusters

CLUSTER	*MAIN BARRIERS*
CLUSTER 1 - Passenger orientation and guidance	Significant costs of implementation
CLUSTER 2 - Automated fare collection systems (AFC) - Ticketing systems	Significant costs of implementation Low profitability from implementation expected by operators Low interest for senior people
CLUSTER 3 - Access management	Low interest for general public Social impacts expected for non-users
CLUSTER 4 - Shared mobility	High implementation costs Legal constraints Low interest for business travellers, senior people and general public
CLUSTER 5 - Co-modal travel planners	Legal constraints Costs of implementation Implementation of high technology maturity
CLUSTER 6 - Strategic transport management for corridors and network	Low interest for general public High capital costs of implementation High technical requirements for the operator
CLUSTER 7 - Real time travel information services	Relatively high capital costs of design, planning, implementation High technical requirements for the operator Implementation of high technology maturity Low interest for local authorities/district planning managers
CLUSTER 8 - Electronic toll collection	Relatively high capital costs of design, planning, implementation Implementation of high technology maturity Organisational requirements for staff skills and training
CLUSTER 9 - Demand Responsive Transport (DRT)	Relatively high whole life costs High technical requirements for the operator
CLUSTER 10 - Collective Taxis	Low interest for general public High legal constraints Lobbies interests Technical requirements for the operator

Case studies analysis has allowed for identification of certain barriers preventing use of ICTs in different setups at the same time regulators, users, governments and operators in many case studies were able to suggest some tools which could be employed in order to reduce those barriers.

Interest for governments

Case study analysis shows that although ICTs start most often as local initiatives they grow only when there is some support of governments (local or central). One of the barriers identified here is disinterest of governments in supporting ICT development. This could be overcome when ICTs serve as a tool to realize important transport policy goals set by governments. Therefore if complex ICT is introduced it should have functionality which helps to fulfill policy objective (e.g. CO2 emissions decrease) than authorities could be convinced to lend their support.

Interest for operators

Operators have to be interested in ICTs otherwise they will not be implemented (private projects) or introduced half-heartedly (government forcing operators to use ITCs). For operator there must be a clear cost benefit advantage. This could be achieved if ICT are made profitable (through increase in ticket prices or significant direct cost reductions for operators). Another barrier here is of operational nature. Small operators usually lack organizational capacity to run ICTs the solution for this is authorities supportive action (e.g. in organizing and running data processing centers) when needed.

Interest for travellers

Case studies show that ICTs are generally well accepted by users or potential users. For some solutions users are reluctant mainly due to the fear that they will not be able to operate ICT or ICT will not be that useful and expensive. Those barriers could be easily overcome by education and information. It must also be noted that those barriers are more common among older users and are often not even considered by younger users. The natural process of aging of population will have side effect of that in the future technology familiar users will become majority.

Feasibility for financiers

ICT solutions are feasible for financiers only if project net present value is positive. This calls for a need of ICTs to be profitable. The actions which could support this task are either creating payment schemes which include ICT cost or by increasing ticket prices in accordance to the user pay principle. This of course is not welcome by users who are generally as our case studies show unwilling to pay extra for ICTs. The alternative action to make ICTs feasible for financiers are government guarantees. If government guarantees certain interest on particular financial instrument used in order to finance ICT development than the risk on financier part is removed. The negative of this action is that whole risk of lack of financial soundness of ICTs is fully borne by society.

Feasibility for technology suppliers

Case studies have identified that barrier in technology field results from either lack of transport application of ICTs or when particular transport supporting technology exists in insufficiency of information/telecommunication networks. The first problem is fundamental and represents non-existence of technology and could be only amended in time by increased research. The only workable yet still long-term tool here would be an increase in R+D expenditure and direction of research at areas which promise most from the ICT perspective. This could be achieved by special research projects by industry (private financing) or through better education in technical fields or special purpose government programs (public financing). The implementation barrier is often caused by insufficient telecommunications when network cannot handle additional traffic generated by ITCs or user equipment is inadequate to support ICTs. The solution here is only through investments on the communication networks operators and gradual replacement of all phones with new models capable of handling ICT's This could be done more rapidly if users will understand potential of (or when users are offered) new useful ICTs.

Feasibility for non-users

ICTs are generally no issue for non-users. Their existence most often does not impact non-users. It could however have negative impact if additional fees are considered in ticket price for all users of transport regardless of their use of ICTs. Some issues could arise from the takeover of land for new investments but this could often be amended by right information campaign.

Feasibility for regulator

ICT solutions are implemented within existing legal frameworks. No important barriers on the regulator part except for the privacy protection issues have been identified in case studies. In the privacy protection field side effects resulting from ICT use like collection of information about user behaviors and maintenance of databases could be considered an issue. In all those uncertain areas regulation is necessary.

13.12.3 Synthesis of Transferability

APPLICABILITY		CLUSTER 1	CLUSTER 1	CLUSTER 2	CLUSTER 2	CLUSTER 3	CLUSTER 4	CLUSTER 4	CLUSTER 4	CLUSTER 4	CLUSTER 9	CLUSTER 10
Is the solution applicable in a different context? Stakeholder: All		Augmented reality smart phone apps	Accessibility apps for disabled people	Ticket purchase on smart phones in rural areas	Smart ticketing in urban areas	Biometric personal access control	Lift sharing	Grass-root cooperative car sharing	Car clubs: distribution and booking systems	Shared bikes system management	Demand responsive services in rural areas	Mobile applications for taxi services
What is the area of applicability?	Urban areas	HIGH	HIGH	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM	HIGH	HIGH	NONE	HIGH
	Rural areas	LOW	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW
	Regions	NONE	LOW	MEDIUM	MEDIUM	NONE	MEDIUM	NONE	NONE	NONE	MEDIUM	NONE
	Corridors	NONE	LOW	LOW	NONE	HIGH	MEDIUM	NONE	NONE	NONE	NONE	NONE
What is the demand segment of applicability?	Short distance travel	HIGH	HIGH	LOW	HIGH	MEDIUM	HIGH	HIGH	HIGH	HIGH	MEDIUM	HIGH
	Long distance travel/National	NONE	MEDIUM	MEDIUM	NONE	HIGH	LOW	NONE	MEDIUM	NONE	NONE	NONE
	Long distance travel/International	NONE	LOW	NONE	NONE	NONE	LOW	NONE	MEDIUM	NONE		NONE
INTEREST												
Is the solution <u>interesting</u> enough to be useful for other users in a different context? Stakeholder: Travellers												
What is the targeted user?	General Public	MEDIUM	LOW	MEDIUM	HIGH	LOW	MEDIUM	LOW	MEDIUM	MEDIUM	MEDIUM	LOW
	Business travellers	MEDIUM	LOW	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	MEDIUM	LOW	MEDIUM
	Leisure travellers/Tourists	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	HIGH	MEDIUM	MEDIUM
	Commuter/Students	LOW	LOW	LOW	HIGH	MEDIUM	HIGH	LOW	NONE	MEDIUM	LOW	NONE
	Users of Public Transport	HIGH	LOW	MEDIUM	HIGH	NONE	LOW	MEDIUM	MEDIUM	HIGH	MEDIUM	NONE
	Car drivers	NONE	LOW	NONE	NONE	HIGH	MEDIUM	HIGH	HIGH	LOW	NONE	NONE
	Younger people (< 50 years old)	HIGH	LOW	HIGH	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM
	Senior people (> 50 years old)	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Male	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Female	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Disabled	LOW	HIGH	MEDIUM	MEDIUM	LOW	MEDIUM	LOW	LOW	LOW	MEDIUM	LOW
	Low to medium education (below secondary school)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	High education (above secondary education)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM
	Low income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW
	Medium income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	High income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	LOW	LOW	HIGH
	People with specific interests/preferences/values (environment-friendly thinking people, people with cooperative values, etc)	NONE	NONE	NONE	NONE	NONE	HIGH	HIGH	HIGH	HIGH	NONE	NONE
What is the overall magnitude of benefits to users?	Decreased travel time	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Decreased travel costs	NONE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM	NONE
	Increased reliability	NONE	MEDIUM	NONE	NONE	NONE	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	NONE
	Increased comfort	LOW	LOW	LOW	LOW	NONE	MEDIUM	NONE	LOW	NONE	MEDIUM	NONE
	Increased frequency	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Increased quality of information	MEDIUM	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	HIGH
	Improved personal carbon footprint	NONE	NONE	NONE	NONE	NONE	MEDIUM	NONE	LOW	HIGH	NONE	NONE
	Increased safety/security	NONE	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Increased accessibility	NONE	MEDIUM	NONE	NONE	NONE	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	LOW
Is the solution <u>attractive</u> enough for other operators to consider in another context? Stakeholder: Operators												
What is the targeted operator?	Local authorities/district planning managers	LOW	LOW	MEDIUM	MEDIUM	LOW	LOW	HIGH	MEDIUM	MEDIUM	MEDIUM	NONE
	PT operators	HIGH	MEDIUM	HIGH	HIGH	NONE	NONE	NONE	MEDIUM	HIGH	MEDIUM	NONE

	Taxi operators	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	MEDIUM
	Rail operators	LOW	MEDIUM	NONE	LOW	NONE	NONE	NONE	MEDIUM	HIGH	NONE	NONE
	Road managers	NONE	NONE	NONE	NONE	HIGH	LOW	NONE	NONE	NONE	NONE	NONE
	Air traffic operators	NONE	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Bike sharing operators	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE	HIGH	NONE	NONE
	Departments of travel (at companies/institutions)	NONE	NONE	NONE	NONE	NONE	HIGH	HIGH	HIGH	NONE	NONE	NONE
	Tourist boards / organisations	NONE	HIGH	NONE	NONE	NONE	NONE	LOW	LOW	MEDIUM	NONE	NONE
	(online) Travel agencies	NONE	NONE	HIGH	NONE	NONE	NONE	NONE	LOW	NONE	NONE	NONE
	Car clubs operators	NONE	MEDIUM	NONE	NONE	NONE	MEDIUM	NONE	HIGH	NONE	NONE	NONE
What is the overall magnitude of benefits to operators?	Optimised routes	LOW	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE	HIGH	MEDIUM
	Optimised use of capacity (vehicles and roads)	NONE	NONE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM
	Optimised frequency	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	HIGH	MEDIUM
	Increase sales / revenues / number of customersé	LOW	LOW	LOW	MEDIUM	NONE	NONE	LOW	HIGH	LOW	MEDIUM	HIGH
	Decrease operating costs	NONE	NONE	LOW	MEDIUM	LOW	NONE	HIGH	HIGH	NONE	MEDIUM	MEDIUM
What is the organisational requirement?	Staff number	LOW	LOW	LOW	MEDIUM	LOW	LOW	LOW	LOW	LOW	LOW	LOW
	Skills and training	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	LOW	LOW	HIGH	LOW
	Space (dedicated areas/warehouses/garages etc.)	LOW	NONE	LOW	LOW	LOW	LOW	MEDIUM	HIGH	HIGH	MEDIUM	LOW
	Administrative structure	LOW	LOW	LOW	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW
Is the solution <u>strategic</u> enough for other governments to consider? Stakeholder: Government												
What are the policies targeted by the solution?	Accessibility policies	NONE	HIGH	NONE	NONE	NONE	LOW	HIGH	HIGH	LOW	HIGH	LOW
	Public Transport policies	HIGH	HIGH	HIGH	HIGH	NONE	NONE	LOW	LOW	MEDIUM	HIGH	NONE
	Traffic management policies	NONE	NONE	NONE	NONE	MEDIUM	MEDIUM	LOW	LOW	NONE	LOW	NONE
	Pollution reduction policies	NONE	LOW	NONE	NONE	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH	NONE	NONE
	Sustainability (modal shift) policies	LOW	LOW	LOW	LOW	NONE	NONE	LOW	MEDIUM	HIGH	LOW	NONE
FEASIBILITY												
Is the solution <u>financially viable</u> in another context? Stakeholder: Financier												
What is the overall magnitude of costs for the implementation of the solution?	Capital costs of design, planning, implementation	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH	HIGH	MEDIUM	HIGH
	Running costs	LOW	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
	Whole life costs	LOW	LOW	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
What is the overall magnitude of profitability from the implementation of the solution?	Revenues	LOW	MEDIUM	LOW	LOW	NONE	NONE	LOW	MEDIUM	LOW	LOW	MEDIUM
Are there possibilities to benefit from external financing / co-financing?	International/EU funds	NONE	LOW	LOW	LOW	NONE	LOW	NONE	NONE	HIGH	LOW	NONE
	National funds	NONE	LOW	LOW	LOW	NONE	LOW		NONE	HIGH	LOW	NONE
Is the regulatory framework simple enough to allow straightforward implementation? Stakeholder: Regulator												
What are the legal constraints underlying the solution?	Partnership agreements required	NONE	LOW	LOW	MEDIUM	NONE	MEDIUM	HIGH	MEDIUM	HIGH	LOW	HIGH
	Licenses required	NONE	MEDIUM	LOW	LOW	NONE	MEDIUM	NONE	NONE	NONE	LOW	HIGH
	Contracts	NONE	LOW	LOW	MEDIUM	NONE	MEDIUM	HIGH	HIGH	HIGH	LOW	HIGH
	Privacy protection laws	NONE	MEDIUM	NONE	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	MEDIUM
	Copyright issues	NONE	LOW	LOW	LOW	NONE	LOW	NONE	NONE	NONE	LOW	LOW
	Non-compliance with the current legislative framework	NONE	NONE	LOW	LOW	NONE	MEDIUM	MEDIUM	NONE	NONE	LOW	HIGH
Are there any barriers likely to be insurmountable in a different context?	Lobbies interests	NONE	NONE	NONE	NONE	NONE	NONE	NONE	LOW	NONE	LOW	HIGH

To what extent the solution can be implemented in other contexts? Stakeholder: Technology supplier												
What is the technical requirement for the user?	(Mobile) phone	NO	NO	YES	MEDIUM	NO	NO	NO	NO	NO	YES	NO
	Smartphone/PC/Laptop	YES	YES	NO	MEDIUM	NO	YES	YES	YES	NO	NO	YES
	Internet access	YES	YES	YES	MEDIUM	NO	YES	YES	YES	NO	NO	YES
	Smartcard	NO	NO	NO	HIGH	NO	NO	NO	NO	YES	NO	NO
	On board unit	NO	NO	NO	LOW	NO	NO	NO	NO	NO	NO	NO
What is the technical requirement for the operator?	Equipment and tools	LOW	LOW	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	MEDIUM
	Software	MEDIUM	HIGH	MEDIUM	LOW	HIGH	MEDIUM	HIGH	HIGH	HIGH	HIGH	HIGH
	Information gathering	LOW	HIGH	MEDIUM	LOW	LOW	MEDIUM	LOW	MEDIUM	HIGH	HIGH	LOW
	Data processing	LOW	HIGH	MEDIUM	NONE	LOW	LOW	LOW	HIGH	MEDIUM	HIGH	LOW
	Booking system	NONE	LOW	LOW	NONE	NONE	MEDIUM	MEDIUM	HIGH	HIGH	LOW	HIGH
	Ticketing/paying system	NONE	LOW	HIGH	HIGH	LOW	NONE	MEDIUM	HIGH	HIGH	MEDIUM	HIGH
	Communication system	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	HIGH	LOW	HIGH	HIGH
	Infrastructure system	LOW	LOW	MEDIUM	MEDIUM	LOW	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
Is it an ad hoc solution for a specific problem, transport mode?	Problem solution specificity	NONE	HIGH	NONE	MEDIUM	HIGH	HIGH	LOW	LOW	LOW	MEDIUM	MEDIUM
	Transport mode specificity	NONE	NONE	NONE	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
Is the solution based on a mature technology?	Technology maturity	LOW	HIGH	HIGH	LOW	LOW	HIGH	HIGH	HIGH	HIGH	MEDIUM	MEDIUM
Are there any <u>externalities</u> or side effects linked to the solution affecting third parties other than users? Stakeholder: Non-users												
What are the impacts for non users?	Economic impacts	NONE	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Environmental impacts	NONE	NONE	NONE	NONE	NONE	NONE	NONE	LOW	NONE	NONE	NONE
	Social impacts	NONE	MEDIUM	NONE	NONE	MEDIUM	NONE	NONE	NONE	LOW	NONE	LOW

APPLICABILITY		CLUSTER 5	CLUSTER 5	CLUSTER 5	CLUSTER 5	CLUSTER 6	CLUSTER 7	CLUSTER 7	CLUSTER 7	CLUSTER 7	CLUSTER 8
Is the solution applicable in a different context? Stakeholder: All		EU wide travel planner	Regional travel planner	Rural travel planner	Urban travel planner	Automatic incident detection based	Live travel time info. at bus stops in rural areas	Live travel time info inside buses in rural areas	Live travel time info on smart phone (urban)	Live travel time info on smart phone (rural)	Electronic automated toll payment
What is the area of applicability?	Urban areas	NONE	NONE	NONE	HIGH	MEDIUM	HIGH	HIGH	HIGH	MEDIUM	HIGH
	Rural areas	NONE	MEDIUM	MEDIUM	LOW	NONE	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH
	Regions	HIGH	HIGH	MEDIUM	NONE	NONE	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH
	Corridors	HIGH	MEDIUM	LOW	NONE	HIGH	NONE	NONE	NONE	NONE	MEDIUM
What is the demand segment of applicability?	Short distance travel	NONE	NONE	LOW	HIGH	LOW	HIGH	HIGH	HIGH	HIGH	MEDIUM
	Long distance travel/National	HIGH	MEDIUM	MEDIUM	NONE	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
	Long distance travel/International	HIGH	LOW	LOW	NONE	HIGH	NONE	NONE	NONE	NONE	HIGH
INTEREST											
Is the solution <u>interesting</u> enough to be useful for other users in a different context? Stakeholder: Travellers											
What is the targeted user?	General Public	HIGH	HIGH	HIGH	HIGH	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
	Business travellers	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	LOW	HIGH
	Leisure travellers/Tourists	HIGH	HIGH	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM	HIGH	MEDIUM	LOW
	Commuter/Students	NONE	HIGH	HIGH	MEDIUM	LOW	HIGH	HIGH	HIGH	HIGH	HIGH
	Users of Public Transport	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	HIGH	HIGH	NONE
	Car drivers	HIGH	HIGH	MEDIUM	LOW	HIGH	NONE	NONE	NONE	NONE	HIGH
	Younger people (< 50 years old)	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
	Senior people (> 50 years old)	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	HIGH
	Male	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Female	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Disabled	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	LOW	LOW	LOW
	Low to medium education (below secondary school)	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	MEDIUM
	High education (above secondary education)	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM
	Low income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	HIGH	MEDIUM
	Medium income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM
	High income level	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	LOW	MEDIUM
	People with specific interests/preferences/values (environment-friendly thinking people, people with cooperative values, etc)	MEDIUM	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
What is the overall magnitude of benefits to users?	Decreased travel time	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	NONE	NONE	MEDIUM	HIGH	HIGH
	Decreased travel costs	HIGH	MEDIUM	LOW	LOW	NONE	NONE	NONE	NONE	NONE	LOW
	Increased reliability	MEDIUM	MEDIUM	MEDIUM	MEDIUM	NONE	NONE	NONE	MEDIUM	MEDIUM	NONE
	Increased comfort	HIGH	MEDIUM	MEDIUM	MEDIUM	NONE	MEDIUM	MEDIUM	LOW	MEDIUM	LOW
	Increased frequency	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Increased quality of information	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	NONE
	Improved personal carbon footprint	HIGH	HIGH	MEDIUM	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Increased safety/security	NONE	NONE	NONE	NONE	HIGH	NONE	NONE	NONE	NONE	NONE
	Increased accessibility	HIGH	HIGH	HIGH	LOW	NONE	NONE	NONE	NONE	NONE	NONE
Is the solution <u>attractive</u> enough for other operators to consider in another context? Stakeholder: Operators											
What is the targeted operator?	Local authorities/district planning managers	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	LOW	LOW	MEDIUM	LOW	MEDIUM
	PT operators	HIGH	HIGH	HIGH	HIGH	NONE	MEDIUM	MEDIUM	HIGH	MEDIUM	NONE
	Taxi operators	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

	Rail operators	HIGH	HIGH	LOW	LOW	NONE	NONE	NONE	NONE	NONE	NONE
	Road managers	LOW	LOW	LOW	LOW	HIGH	NONE	NONE	LOW	NONE	HIGH
	Air traffic operators	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Bike sharing operators	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Departments of travel (at companies/institutions)	HIGH	MEDIUM	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Tourist boards / organisations	HIGH	HIGH	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	(online) Travel agencies	HIGH	HIGH	HIGH	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Car clubs operators	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
What is the overall magnitude of benefits to operators?	Optimised routes	HIGH	HIGH	MEDIUM	HIGH	HIGH	NONE	NONE	NONE	NONE	NONE
	Optimised use of capacity (vehicles and roads)	LOW	MEDIUM	LOW	LOW	HIGH	NONE	NONE	LOW	LOW	MEDIUM
	Optimised frequency	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Increase sales / revenues / number of customersé	MEDIUM	LOW	LOW	LOW	NONE	LOW	LOW	LOW	LOW	NONE
	Decrease operating costs	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	MEDIUM
What is the organisational requirement?	Staff number	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	LOW	LOW	LOW	LOW	LOW
	Skills and training	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	Space (dedicated areas/warehouses/garages etc.)	NONE	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
	Administrative structure	MEDIUM	LOW	LOW	LOW	LOW	NONE	NONE	LOW	LOW	MEDIUM
Is the solution <u>strategic</u> enough for other governments to consider? Stakeholder: Government											
What are the policies targeted by the solution?	Accessibility policies	MEDIUM	MEDIUM	HIGH	LOW	NONE	NONE	NONE	NONE	MEDIUM	NONE
	Public Transport policies	HIGH	HIGH	HIGH	HIGH	NONE	HIGH	HIGH	HIGH	HIGH	NONE
	Traffic management policies	NONE	LOW	NONE	NONE	HIGH	NONE	NONE	MEDIUM	LOW	MEDIUM
	Pollution reduction policies	MEDIUM	MEDIUM	LOW	MEDIUM	NONE	NONE	NONE	NONE	NONE	LOW
	Sustainability (modal shift) policies	MEDIUM	MEDIUM	MEDIUM	MEDIUM	NONE	LOW	MEDIUM	MEDIUM	MEDIUM	NONE
FEASIBILITY											
Is the solution <u>financially viable</u> in another context? Stakeholder: Financier											
What is the overall magnitude of costs for the implementation of the solution?	Capital costs of design, planning, implementation	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Running costs	MEDIUM	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH	LOW	LOW	LOW	LOW
	Whole life costs	MEDIUM	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM	LOW
What is the overall magnitude of profitability from the implementation of the solution?	Revenues	MEDIUM	LOW	LOW	LOW	NONE	NONE	NONE	NONE	NONE	LOW
Are there possibilities to benefit from external financing / co-financing?	International/EU funds	NONE	NONE	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	National funds	NONE	LOW	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Is the regulatory framework simple enough to allow straightforward implementation? Stakeholder: Regulator											
What are the legal constraints underlying the solution?	Partnership agreements required	MEDIUM	MEDIUM	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Licenses required	MEDIUM	MEDIUM	LOW	NONE	NONE	LOW	LOW	NONE	LOW	NONE
	Contracts	MEDIUM	MEDIUM	MEDIUM	NONE	NONE	LOW	LOW	NONE	LOW	NONE
	Privacy protection laws	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Copyright issues	MEDIUM	MEDIUM	MEDIUM	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Non-compliance with the current legislative framework	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Are there any barriers likely to be insurmountable in a different context?	Lobbies interests	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
To what extent the solution can be implemented in other contexts? Stakeholder: Technology supplier											
What is the technical	(Mobile) phone	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

requirement for the user?	Smartphone/PC/Laptop	YES	YES	YES	YES	NO	NO	NO	YES	YES	NO
	Internet access	YES	YES	YES	YES	NO	NO	NO	YES	YES	NO
	Smartcard	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	On board unit	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES
What is the technical requirement for the operator?	Equipment and tools	MEDIUM	MEDIUM	LOW	LOW	HIGH	HIGH	MEDIUM	LOW	HIGH	MEDIUM
	Software	HIGH	MEDIUM	LOW	MEDIUM	HIGH	MEDIUM	LOW	MEDIUM	MEDIUM	LOW
	Information gathering	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	LOW
	Data processing	HIGH	MEDIUM	LOW	LOW	MEDIUM	LOW	LOW	LOW	LOW	MEDIUM
	Booking system	MEDIUM	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Ticketing/paying system	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	HIGH
	Communication system	HIGH	MEDIUM	HIGH	MEDIUM	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM	LOW
	Infrastructure system	LOW	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW
Is it an ad hoc solution for a specific problem, transport mode?	Problem solution specificity	NONE	NONE	NONE	NONE	HIGH	NONE	NONE	NONE	NONE	NONE
	Transport mode specificity	NONE	NONE	NONE	NONE	HIGH	NONE	NONE	NONE	NONE	HIGH
Is the solution based on a mature technology?	Technology maturity	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
Are there any <u>externalities</u> or side effects linked to the solution affecting third parties other than users? Stakeholder: Non-users											
What are the impacts for non users?	Economic impacts	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Environmental impacts	LOW	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
	Social impacts	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE

14 Key Findings From Local Assessment

14.1 CS1 - An EU-Wide Multimodal Travel Planner: routeRANK

routeRANK provides a software solution for travel planning. Unlike other solutions that consider only one means of transport at a time, routeRANK addresses the entire travel route by integrating rail, road and air connections and their many multi-modal combinations. In a single search, routeRANK's patent-pending technology finds and ranks the best possible travel routes, allowing users to sort them according to their priorities such as price, travel time and CO2 emissions. This is done by checking websites of uni-modal transport providers, combining the findings to multi-modal transport chains and then display these travel suggestions with their attributes (route, schedules, prices é) together with a link leading the user to the website(s) where a distinct travel solution then can be booked.

Custom developed versions of the proprietary software are offered to corporate customers and organizations, for their internal use or use on their own website, in both travel and logistics. Alternatively, corporate customers can easily sign up for the Standard Professional version or use the API to implement routeRANK functionality into their own system or portal. Website owners benefit from the routeRANK widget.

Another version illustrating the software is also publicly available on routeRANK's website. Although here the focus is on European travel, airports and flight connections worldwide and road connections in North America are also integrated.

Technical requirements

From a user point of view, no special setup needs to be done to use routeRANKõs web-based versions. User only needs an Internet connection and a Web browser.

The documentation of how to use the basic public version of routeRANK is available in English, German, French, Spanish, Italian, and Dutch and can be found at http://www.routerank.com/en/faq/.

Business model

routeRANK provides a range of products based on its patent-pending technology to companies and organizations. Each version of the proprietary software solution addresses their respective requirements.

- Smaller institutions in particular can sign up for the Standard Professional version to optimize their travel planning with minimal effort.
- Custom developed versions of the proprietary software are offered to corporate customers and organizations, for their internal use or use on their own website. This might entail adapting the branding, integrating their own data sources and existing online booking tool as well as additional features.
- Webmaster's can easily integrate the Widget on the 'contact us' or 'how to find us' pages of any website. Event organizers can use it on their dedicated event websites.
- Transport companies can benefit from the Logistics version for the optimal, end-to-end shipment of freight.

A detailed comparison of the features offered in different above versions, as well as a list of selected customers of routeRANK, can be found at the Business Applications page at http://www.routerank.com/en/business/

Capabilities

Compared to other projects on multi-modal journey planners, routeRANK offers the widest coverage in terms of travel information at its deep level of integration and thus computes optimal travel plans based on relevant criteria.

Detailed coverage depends on the version in question, however generally speaking there is world-wide air coverage, car routing for Europe, North America, Asia, train transportation information for the most parts of Europe and increasingly North America. In addition, airport shuttle and transfers via buses, taxi, rental cars and car sharing are readily available. Diverse localizations are support as well as currently six languages (English, German, French, Dutch, Spanish and Italian). This includes the localized booking information in the language of the relevant provider, e.g., not only is the routeRANK website supporting Spanish on the public version, but for booking a user will also be forwarded to the Spanish version of Expedia.es, say, typically a different commercial organization from Expedia.fr.

routeRANK also developed and operates dozens customized versions of its journey planner, both own versions and customized ones for corporations. A wealth of additional features is available with them, including a meeting optimizer and an accommodation optimizer.

Limitation

The current limitation of routeRANK is in its lack of content (schedule and fare) coverage in some parts of world. While in general routeRANK provides world-wide coverage for flights, for other means of transportation the data is still not available for some countries, e.g. Asian train connections are not yet covered, car routes are not fully provided for Africa. routeRANK thus still provides an added value in these parts of the world over existing online travel agents or online booking tools, but does not yet fully exploit its potential there. In some cases train fares for international journeys cannot displayed exactly, but at least as an approximation, as railways companies often do not provide international rail fares on their own websites. Also some airlines some airlines (like Ryanair) prevent automatic data retrieval from their websites by using captchas, so that their flights cannot be incorporated into multi-modal travel chains.

User behavior statistics

For the case study an extensive logging system has been implemented and usage data from real users (randomised 100,000 searches from mid of February to end of May 2013) have been retrieved to provide the following statistics. For business travel (i.e. users of the standard professional or a customized version of routeRANK, "B") and as well as for non-business travellers (i.e. from users of the publicly available routeRank services, "NB") the core results are:

- Users sorting travel solutions by emission travel criteria: 8% NB, 23% B
- Users who prefer economic travel options, i.e. sort travel solutions by price: 47% NB, 46% B
- Users who prefer shortest travel duration, i.e. sort travel solutions by time: 28NB, 38% B
- Users who follow the CO2-emission offset links, i.e. pay for a CO2 compensation: 4%NB, 3% B.
- Business travellers sorting travel solutions by their customised (individually weighted time, cost, emissions, number of transfers, etc.) overall ranking: 18%.
- Short-distance (no flights) vs. long-distance searches (with flights): NB: 53% vs. 47%, B: 26% vs. 74%.

14.2 CS2 - A REGIONAL MULTIMODAL TRAVEL PLANNER: MARCHE REGION OF ITALY

This case study addresses the potential in serving sustainable transport policies as a result of the use of regional traveller information systems; applications situated at an intermediate level between the urban scale and the national/international one, with reference to the passenger transport segment. At the urban scale, the multi-modal passenger travel information system essentially aims to favour short-distance trips through the utilization of public transportation modes, e.g. primarily buses and metro, including options to reduce walking distance to the destination point. At the national/international level, the multi-modal passenger travel information systems cover in general all transport modes, focusing on long distance trips (e.g. including air and maritime transport means), for which the existence of effective interconnections (infrastructure, interchanges, etc.) between the trip legs can be considered as a necessary requirement (see, for details, INTERCONNECT, 2011).

More specifically, the objectives of the regional case study on the Marche region traveller information systems intend to address the following two issues:

- An assessment of their environmental impacts, based on hypothesis on modal shift from car to public transport;
- An assessment of their contribution to the improvement of mobility in general, and accessibility to remote areas in particular.

Pursuing the two objectives has been made possible thanks to the characteristics of the regional travel planners under examination.

- The Regione Marche Orari TPL, which provides information of the main public transport timetables and transfer times at interchanges from an origin to a destination point across the region. http://orari.trasporti.marche.it/prod2/default.asp
- The Mobilitami regional travel planner, which provides timetables, transfer time at interchanges and walking distance to the destination points of the regional public transport network (coaches, buses and regional trains). http://www.mobilitami.it/tp/mobilitami/home/index#

Data collected from the analysis of the two data set relate to the on-line access to the regional travel planners in 2012. Data analysis, after adjustments, has led to the following steps:

- Identify the origin/destination paths through the usersô indication of public transport means in isolation or in combination (buses, train, coaches) to reach a given site or address.
- Estimate the origin/destination paths by car, corresponding to the origin/destination paths for which the user has not indicated any public transport means among the available options..

The assessment of the environmental impacts (avoided transport external costs) are summarised in the following table. They are expressed in daily impacts at 2012 (ú) resulting from shifting 5% of daily car trips to public transport in the Marche Region. Congestion costs are not calculated, due to the non availability of information on traffic flows (O/D matrix) by the regional network of road and rail links..

Table 14-1 Synthesis of avoided transport external costs in CS2

External costs	Urban	Extra urban	Total
Climate Change	1,148	6,077	7,225
Accidents	9,147	27,679	36,795
Total	10,295	33,725	44,020

The reduced social costs from modal shift amount in total to about ú 47,000 daily (of which about ú 10,000 in urban areas and about ú 33,000 in extra-urban areas). The assessment is carried out under the assumption that the diverted demand from road transport (car) can be met by public transport without additional costs (spare capacity available). On annual basis, the avoided social costs amount to about ú 16 million.

The improvement in mobility and accessibility emerges from the analysis of the access to the regional travel planners by month and destination.

Concerning mobility and accessibility, data analysis on the monthly access to the regional travel planners shows the higher peak in correspondence of bad weather conditions (February). In fact in Italy, during the winter of 2012, particularly in February, the weather was characterised by storms and heavy snow. The Marche region and in general the Central-Northern part of Italy, were mainly concerned, with transport activities strongly hampered by network disruption and service interruptions. During February the share of regional plannersô users in the most remote areas (mountainous municipalities) increased by 6.3% compared to the average annual access, indicating an attitude of the travel planners towards the improvement of mobility in prohibitive conditions and remote areas.

Main conclusions and recommendations are:

- From CENSIS analysis (CENSIS, 2011), 37.9% of the Italian population using the Internet regularly (53.1% of the total population age 14-80) use the Internet as a means to query about ñroads and destinationsò.

- Assuming hypothesis on modal shift from car to public transport due to the information delivered by the regional travel planners, significant savings in car usersô vehicle operating costs and environmental costs (avoided external transport costs) may potentially accrue to users and society.
- Data analysis on access to the regional travel planners also allow to infer improvement in accessibility to remote regional areas (mountainous municipalities) and increase of mobility in presence of adverse weather conditions.
- However, to fully exploit the potential of traveller information systems, the following issues must be considered:
  - Importance of the public sector. The public sector may play an important role, addressing several aspects. It is likely in fact that the public sector (i.e. the regional and local authorities in this case study) is an important shareholder, if not the principal stakeholder, in the portfolio of public transport operators (e.g. buses and coaches). Therefore, it can facilitate data collection, favouring the establishment of common standards for data exchange and overcoming administrative barriers, e.g. streamlining the process for the definition of objectives, services and characteristics of the application. Furthermore, the role of public sector may be decisive in order to involve the private sector in the definition of the business models of the application. Internet-based applications like travel planners may represent the basis for the provision of several services, e.g. commercial banners, involvement of touristic companies, subscriptions, etc. The public sector may encourage the involvement of private sector through public procurements.
  - The importance of shared procedures for data collection. Travel planners at regional/national level need data from several transport operators. Short and long-distance transport modes are involved as well (ferry, rail, air transport, road public transport). The issue of data collection from different platforms becomes in such a way decisive. The experience of regional travel applications has stressed how to harmonize the procedures for data collection from different data sets plays an important role in ensuring an efficient service.
  - Data maintenance and renewal. How to ensure data maintenance and information updating in the long term horizon represents an important aspect to be considered. This aspect can also be dealt with in the context of business model of the application. Regional travel planners data in fact need to be updated and this activity, on the top of initial not prohibitive investment, can represent a considerable barrier. Possible solutions to overcome this barrier are to set up multiannual agreement with data providers and to support data collection/updating with new technologies and services.

14.3 CS3 - Accessibility Applications for Disabled People

This case study looked at a range of smartphone travel applications (apps) with a range of different attributes with the potential to improve accessibility to the transport system for disabled people. It is estimated that disabled people comprise approximately 15% of the population. Furthermore, it is widely observed that there is a strong link between ageing and impairment and that the proportion of older people in society is increasing over time.

To be clear, ñappsò are software applications designed to run on mobile devices such as smartphones and tablet computers. They are typically designed to offer a single service or task in a simple, direct, self-contained way, or to interact with a single service, task or website on the internet and, consequently, tend to be relatively simple to use. The apps considered in this case study target disabled car drivers, disabled car passengers, disabled public transport users and disabled pedestrians, and fall into three broad categories, as set out in the next table.

Table 14-2 Overview of Accessibility Apps for Disabled People in CS3

Type of app	Specific examples	Cost*
➢ **Apps which assist with navigation and wayfinding, particularly for visually impaired people**	➢ **Navigon** ï this uses the mobile deviceõs GPS capability and links with digital mapping to provide a fully-functioning mobile navigation system, enabling text to speech voice guidance, turn by turn pedestrian directions, a ótake me homeö function, and links to the userõs contact list to provide directions to a selected contact.	➢ £21.99
	➢ **Blind Square** ï uses the IOS deviceõs GPS capability to determine the userõs location, and then links with FourSquare and Open Street Map to look up and speak, in its synthetic voice, information about nearest street intersections, nearby shops, restaurants and other facilities, and distance travelled.	➢ £16.99
	➢ **SeeingAssistant-Move** - launched in 2013, this provides for route planning and route recording, advanced neighbourhood scanning with world directions, location search, ówhere-am-Iö functionality, input of sharing points and use of voice commands.	➢ $7.99
➢ **pps which provide specific and tailored accessibility information, relevant to particular impairments**	➢ **Jaccede** - launched in 2012, this enables users to search for places that are accessible to those with a disability. Information, such as whether the entrance is step-free and accessibility of toilets, is displayed alongside photos, user comments and other relevant information. Users can contribute by adding accessible places anywhere in the world, or by editing existing listings.	➢ Free
	➢ **GoGenie** - this app aims to help disabled and deaf people find access information online for any location such as a shop, cinema, cultural event or town centre, based on the recommendations and comments of others. Specific features include access information, contact, maps, facilities to add reviews, photos and videos, and a óreport-itö feature enabling people to complain directly to inaccessible venues and organisations.	➢ Free
	➢ **Ldn Access** - this app is designed to be used as a source of access-related information for places to eat, hotels, entertainment, attractions etc. throughout London. It is targeted slightly more broadly at disabled people (either physical or none physical or both), older people, families with young children, and visitors to London, and provides information on wheelchair access, disabled toilets, induction loops, baby changing facilities, customer parking etc.	➢ (Still in development)
➢ **Apps which provide communication assistance between the disabled person and customer-facing transport staff.**	➢ **Assist-Mi** - this app can be used by disabled people to alert participating sites such as shopping centres, railway stations and airports know when they are on their way and when they have arrived, while conveying all their access needs so they can be met by staff and properly accommodated. In addition, the Parking Space Finder function can help locate nearby Blue Badge spaces and indicate how far away the space is, any special parking restrictions the space may have and what kind of parking it offers.	➢ Free

* Costs sources: iTunes, Google Play, Nokia Store.

As part of the case study, an online survey on the usefulness and value of smartphone apps to provide travel assistance to a specific sub-group of disabled people - those who have a physical mobility impairment - was conducted amongst UK residents during spring 2013. From the results, the following conclusions can be derived:

Almost two thirds of the sample (65%) reported that their mobility fluctuated from day to day, and more than four fifths (82%) reported that, even on a good day, they would be capable of comfortably walking no more than 100m without needing to take a rest. Whilst less than a fifth of our sample (15%) reported that they always need assistance when going out, close to half of our sample (44%) stated that they do not go out as often as they would like to, and a similarly high proportion (41%) stated that they always had to plan their journeys really carefully.

Nearly three quarters of our sample (71%) uses the internet in connection with their travel, and nearly all possess a mobile phone, with almost half 49%) being smartphone users. Yet, only just over a half of our sample (52%) report that they use their mobile phone to assist with travel at present, and very few (7%) reported having specific travel apps which they use.

The stated choice experiment conducted within the survey demonstrates that some smartphone app attributes are indeed valued, whilst others are not. For car-users, the most useful attributes of the apps presented to them were those which provided them with en-route directions and those which enabled them to request assistance via road break-down services and to pre-book a disabled parking space. The values obtained for these attributes can be thought of as being approximately equivalent to the value of saving 10-20 minutes travel time on a round trip.

For the public transport users, the most useful attributes of the apps presented to them were those which enabled them to pre-book staff assistance and to pre-book an accessible taxi, and those which provided them with Information on next station/stop and arrival time, with up to date connection information and with Accessibility information about the arriving train or bus. The values obtained for these attributes can be thought of as being in a range approximately equivalent to the value of saving 10-40 minutes travel time on a round trip.

Interestingly, the values of the features of an app and the propensity to buy one are somewhat larger for public transport than car users. Given that the consequences of poor accessibility information and support are likely to be more problematic when travelling via public transport, this seems quite plausible.

As they are focused on disabled people, many of whom are older, and as they are provided via smartphones, the costs of owning a smartphone and their usability for older and disabled people is an important factor which, at present, appears to serve as a limitation on take-up. Whilst we would expect that as a greater proportion of the population becomes older and more familiar with technology this problem will subside, some further research into the barriers to take-up would be interesting. Also, our survey assumed that smartphone apps would be most useful for trips of a less routine nature, and so was focused on respondentsôoccasional or rare medium to long-distance trips, but it emerged that some 20% of our sample had, in fact, not made such a trip recently. Consequently, these respondents were screened out from taking part in the stated choice experiment. One useful area for future development, therefore, would be to conduct further work with this group, to understand the reasons for them not making any non-routine medium to long-distance trips and to test our assumption about the tuype of trip smartphone apps would be most useful for.

By opening up information sources and support services, smartphone travel apps offer huge potential to help and liberate disabled and older people who face challenges with other methods of communication and information-gathering. Whilst our survey indicates that people do place value on particular aspects of these apps, their potential is, as yet, under-utilized, and so actions to improve take-up should be explored further.

14.4 CS4 - ITS SOLUTIONS FOR BARCELONA'S LOCAL BUS NETWORK

With a decreasing trend in passenger ridership, Barcelonaõs bus operator TMB is doing a series of improvements in the organisation of the service operation, the comfort of vehicles, the equipment of bus stops and the information services to travellers (internet, smart phones, on-vehicle, at bus stops); all in all to increase the attractiveness of the bus in relation to other competing modes, e.g. metro or tramway.

The headline initiative by TMB is the transformation of the current organic network onto a systematically structured orthogonal network making use of the particular structure of the Barcelona urban tissue. The Barcelona bus network today is in fact the result of the addition and adaptation of lines for more than 100 years. The resulting network is difficult to read and this discourages its use by non-frequent travellers who prefer clearer modes such as metro; simultaneously, the bus lines have overlapped itineraries with each other, and with tramway and metro lines incorporated since the 90s, and today is operating at a below optimal level.

The operator is taking the opportunity of these structural changes to test new concepts for bus stations, which if successful, might be generalised at intersections of vertical and horizontal lines in the new orthogonal network. This includes several ITS features to assist the guidance of users in the Barcelona public transport network (touch screens with integrated travel planners, information on expected time of arrival for next services), as well as facilitating the sells of riding tickets (sells booths). At the same time, TMB is enhancing its smart phone application with innovative features aiming at becoming increasingly useful to users.

An interesting initiative by the TMB implemented since the 90s is the network of proximity buses within neighbourhoods envisaged for facilitating short-distance mobility e.g. of old people, or people with an impairment, but also as feeder services to other city-wide bus lines or to metro and tramway lines. With relatively short demands, especially on weekends, this case study explores the possibility (in neighbourhoods surrounding the recreational area of Collserola hills, i.e. mountain neighbourhoods) to eventually increase the demand of these services by combing the classic operation with an adapted demand responsive transport system (DRT) linked to weekend leisure mobility.

The technical solutions introduced and presented in this case study are in short the following:

- **Smart phone applications**: it is analysed the general functioning and the innovative features of the "TMB on your mobile phone" smart app, and its level of awareness and use by citizens. The case study also surveyed the interest of citizens in other potential smart phone applications.
- **Smart bus stops**: it is analysed the ITS equipment of new pilot bus stops: interactive multi-modal travel planners for public transport services in Barcelona and its metropolitan region; real time information screens on expected times of arrival of buses (updated every 30 seconds); information on eventual service disruptions; audio systems assisting blind people; ticket sells booths.
- **Advanced applications for DRT services** in Barcelona mountain neighbourhoods: the case study surveyed the potential interest of implementing DRT systems between the city of Barcelona and Collserola, and between other relevant metropolitan rail stations and the Collserola back land.

This case study was based on desk work and a user survey carried out at different access points of "Passeig de les Aigües" in the Collserola hills. The survey was held on the February 3rd 2013 (Sunday) from 8 am till 5 pm (9 hours in total) with a total number of 533 surveys obtained from 329 to pedestrians and 240 bikers.

The survey was specifically focused on gaining knowledge of:

- Citizens' awareness of the services that TMB offers today to improve the general bus services in Barcelona (orthogonal reorganisation of bus services, upgraded bus stops, TMB smart phone app)
- Citizens' awareness of the services that TMB (Barcelona's bus operator) offers to access the mountain neighbourhoods of Barcelona (proximity buses).
- Willingness of citizens to pay for additional services provided with smart phone applications.

In synthesis, this case study has concluded the following points:

- Awareness of area inhabitants of the improvements TMB is performing on the Barcelona bus network and bus services are relatively high, with no major complaints linked to them. Area inhabitants showed relative high awareness of initiatives by TMB to improve bus services in Barcelona, especially regular and frequent users of the municipal public transport. In particular, 3 out of 4 respondents were aware of the reorganisation of the bus services in Barcelona, and 2 out of 3 were aware of the existence of neighbourhood proximity bus services providing access to the mountain neighbourhoods. Observation at new pilot bus stops (*not based on user surveys*) seem to indicate that new ITS equipment at bus stops has a fairly good public acceptance (time indicators, ticket booths), but in particular, the use of on-stop interactive travel planners seems low at this point, probably due to user unawareness.

- The TMB smart phone tool for user information is clear and easy-to-use, especially the travel planner, the atlas of bus lines and the module for querying expected times of arrival for services at stops; the augmented reality feature seemed like having still way for improvement, especially on the clarity of indications, being user guidance to closest bus stops a natural key dimension of the app. As a result of all previous, user acceptance of the app is high, it is estimated necessary and potentially very effective in increasing the quality of public transport services in Barcelona. The survey revealed that amongst those owning a smart phone and knowing of the existence of the app, more than 1 out of 2 used it regularly. With increasing user ownership of smart phones (1 out of 3 does not own a smart phone yet today), and awareness rising of the service (another 1 out of 3 does has not tried/does not know the app), the total number of users for such services is estimated to have a strong potential to increase (only 16% of survey respondents were today active users of the service).
- Willingness of citizens to pay for additional services provided with smart phone applications is substantially lower. Applications attracting most interest by users are directly related to guidance, personal safety and emergency assistance (1 out of 2 surveyed revealing they would pay for their acquisition). Other applications are less suggestive, like parking booking applications, and more complex proposals for services like DRT linked to smart phone applications (with around 1 out of 5 willing to pay for them; still 25% of bikers suggested might be interested in such services). It also seems that user acceptance of services is rather linked to their level of clarity and simplicity.

14.5 CS5 - Future Interurban Public Transport in Warminsko-Mazurskie Voivodship

This case study uses test bed approach for identification of possibilities and barriers for introduction of some ITC solutions into rural areas. It is based on transport users response to the proposed ICTs as recorded through qualitative and quantitative surveys. Surveys were carried out in Szczytno region in the warminsko-mazurskie voivodship North-Eastern part of Poland. This is low GDP rural area. It has about 25000 inhabitants, while in the close vicinity of Szczytno area (poviat) lives about 70000 people for whom Szczytno is centre of gravity. ICT solutions tested in this setting were:

9) Internet based travel planners.
10) Electronic real time information at bus stops.
11) Ticket purchasing via mobile phones / internet.
12) Real time information on services via mobile phones / internet.
13) Real time information on estimated arrival times, stops, route on board of vehicles.
14) Demand responsive services - possibility for direct pick-up/delivery of passengers in response to prior demand.

The quantitative survey allowed for answers regarding acceptability of different ITC solutions among different user age groups and in regard to different distances travelled. Three different trip types have been taken into consideration: local (short distance up to 40 km), medium (still rather short distance - below 100km, however purpose of the trip was not local ï those were routes to/from voivodship capital) and long distance (more than 100 km routes to Warsaw and Gdansk). Five different user age classes have been established: 15-18 years old, 19-29, 30-45, 46-60 and 60+. This allowed for testing the acceptability as well as user willingness to pay for ICTs if introduced among different user segments. Also price elasticity has been tested. Again the responses were differentiated in regard to age and distance travelled. The main patterns emerging from the quantitative analysis were further researched in-depth using qualitative ï focus groups approach in order to establish main factors responsible for identified user behaviours. Furthermore interviews with representatives of service provider were conducted to amend overall picture by the opinions of the operator. Altogether this approach allowed to formulate complete opinion as the barriers, opportunities and possibilities for transferability of ICTs into rural regions.

The overall result of the study is that ICTs very much sought after by local transport users. Rurality and characteristics typical for remote locations do not reduce demand for modern transport system. To the contrary many ICTs are considered as essentials which might help to remedy typical failures of public transport system in those areas. For instance lower frequency causes increased necessity for perfect information provided through ICTs ï which is even more important in rural setting than in urban ï high service frequency areas. User acceptance for majority of tested ICTs is high or very high. The highest score in this regard is attributed to the youngest respondents who are most familiar with the technology and more inclined to accept innovations. The lower acceptance among older users results from rooted behaviours but could also be effect of fear of new technology and unwillingness to learn how to use it. Nevertheless overall clear majority of all users are in favour of ICTs although some solutions (especially those oriented at information provision) score better than the others (lowest score is noted for demand responsive services). This translates to more than 75% in favour of travel planners, electronic information at bus stops and on-board electronic information. At the same time electronic ticketing or real time vehicle positioning information is sought after by about 50% of users. Lowest interest is expressed in regard to demand responsive service with only 37% in favour of this measure. This also tells a lot about transferability ï those ICTs which are most acceptable should be transferred to the rural areas first to allow users to familiarize with them and build a stronger acceptance base for ICTs.

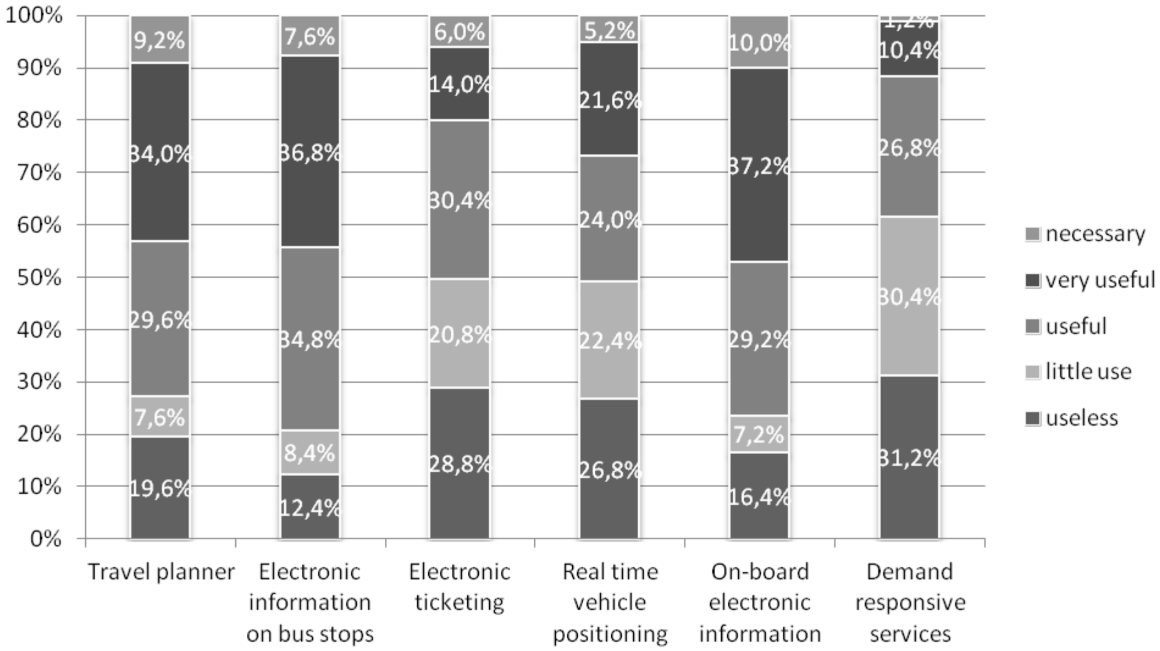


Figure 14-1 User acceptance of proposed ICT solutions in CS5

Interesting point could be made by analysing which advantages of ICTs are considered as most profitable to potential users. The convenience factor seems to be most important. For all information providing ICTs users pointed out that main advantage is possibility to better plan their journey. Also psychological effect of better assurance that particular service will be offered was important. The scores differ between age and distance groups. For example users who travel only locally (up to 40 km) rated this feature at 2.7 (adopted scale 1- definitely not useful, 5-definitely useful) while those travelling distances of 40-100 km considered it more useful with average rating of 3.12. At the same time those who travel over 100 km attach to this type of application even higher value rating it at 3.31. The same numbers for the group of youngest users are considerably higher with age group of 15-18 years old real time information scored highest 3.74 points for those of 19-29 years it was 3.63, for travellers aged 30-45 the score was 3.5. At the same time older users were not impressed with those aged 46-60 rating this innovation at 2.18 and those over 60 years of age at only 1.56.

Time savings on the user part for D2D travel are another factor which in theory should be crucial to users. The study shows that in local travel passengers expect to save about 15 minutes, the same holds true for long distance travellers while medium distance expectation is of about 12 minutes. It could be concluded that average time savings of about 14 minutes are certainly more valuable to those travelling short distances. At the same time it is obvious that the main reason of time saving results from elimination of need to be at the bus stop earlier than necessary. Yet lack of significant differentiation between values attached to time savings between short and long distance travellers indicates that this is secondary feature to them.

Interestingly the highest time savings are expected by members of age group 30-45 (20 minutes) while those who pointed at the proposed solution as most useful (younger users) expect to save due its introduction on average only 13 minutes.

The possibility of introduction of ICTs in rural areas is seriously handicapped by financial barriers. The research among operators shows that initial investments needed are high and beyond financial means disposable to the local service providers. It is unlikely that without external support (e.g. government sponsored projects) ICTs could be introduced by operators on their own. This unfavourable condition is reinforced by the fact that additional maintenance costs must be considered for operating ICTs and this cannot be compensated through increase in operator incomes. While there is some potential for modal shift generation caused by ICTs it is difficult to say how strongly the declarations reflect reality. About 55% of current car users rejects possibility for switching from private car to public transport even if it is ICT intensive. The rest declares that they will certainly change to public transport when ICTs are introduced (slightly more than 2%) will likely do so (about 16%) or will do so on occasions (remaining percentage). At the same time higher operator costs cannot be compensated by ticket price increase due to strong user unwillingness to pay for ICTs. Among all users acceptance to pay extra is as low as 20% and even among those willing to pay for additional services three-fourth majority accepts only symbolic payments (up to 1 PLN).

Main conclusions and recommendations from this case study are:

- ICTs are useful for rural areas transport users and they are well accepted. The rural features of region actually cause even higher demand for ICTs than in well-developed regions. The acceptance levels vary in different user segments with majority of supporters among younger users.
- There are no technical barriers preventing introduction of ICT’s. The mobile phone density even if it is rural area is high and ICT technology available does not have to be extensively tailored to the needs of rural transport.
- There is significant financial barrier resulting from high initial investment costs not likely to be compensated by increase in number of travellers due to low population density in rural area. Moreover additional maintenance costs will not be compensated by ticket price increase due to high unwillingness to pay on the user part.
- There are certain operational barriers especially resulting from unfamiliarity of operators and their staff with ICT technology. Especially vehicle operators fear that they will not be able to operate ICT systems and prefer solutions which work without need for driver/operator staff input.
- The best reception is given to ICT’s which offer better information. This results from rural region transport system characteristics – reduced frequency and increased possibility for delays and breakdowns. Any solution which provides comfort of knowledge about delays and changes is important. Time savings although noted by users are not considered primary benefit.

14.6 CS6 - Mobile Applications for Taxi Services

This case study considers the use of mobile applications (Apps) applied to the taxi industry using the experiences of (different) Apps in peer cities. The case study is motivated by the impacts that the taxi app may have on the industry. Four peer cities have been analysed: one on the east and one on the west coast of the USA, London and Edinburgh.

Apps have a demonstrable impact on the use of taxis and similar services served by ‘taxi’ Apps. They have been suggested to increase accessibility, ease of use and convenience of the taxi mode. The potential benefits of the ‘taxi’ App extend to the (various) passenger(s) both current and intending; but should also be considered in terms of positive and negative impacts on the industry and on the regulating authorities.

App features

Taxi Apps are based on a series of complementary ICT functions that vary across App ‘generations’. Functions and expectations of Taxi apps are rapidly expanding in a competitive market that faces some conflicting controls reflecting the nature of legislation applied to the supply of taxis. The nature of this conflict varies between locations reflecting the local nature of taxi legislation and regulation, though the fundamental issues leading to conflict all fall into three areas in which control may be applied: Quantity, Quality and Economic regulation. Taxi App Generations are broadly defined as:

- Generation 1: Taxi Company Directories, providing broad listings and telephone numbers
- Generation 2: Taxi Company Booking, using existing infrastructure, typically existing taxi dispatch company systems. Examples include TaxiMagic.
- Generation 3: Taxi / FHV Direct Booking, using bespoke infrastructure to bypass existing taxi dispatch systems, typically engaging drivers directly. Using a single vehicle type on a single platform. Examples include Hailo.
- Generation 4: Taxi / FHV and Car Sharing, offering a wider range of vehicle type on a common platform. Examples include Uber (UberX / UberSUV / UberTaxi / UberBlack).

Economic potential

There are four fundamental economic relationships which affect the success of an app. These can be defined as:

- Passenger to app, linked to the willingness of a customer to accept any booking charge or additional costs associated with using an app-based taxi booking. This is a particular issue in terms of ‘surge pricing’, a policy adopted by some app providers and resulting in higher pricing at points of greater demand. This issue has created a disagreement in some jurisdictions between app supplier and licensing authority and is considered illegal in many. Despite the regulator view on illegality, the practice continues to be applied by some apps.
- Driver to app. The majority of app suppliers consider drivers to be their customers as well as the passengers. This differs in apps to dispatch, see below. Not only does an app needs to appeal to its passengers, it needs to provide a sufficiently broad range of taxi suppliers. Taxi apps require sufficient supply to be attractive to users in the long run, and sufficient passengers to be attractive to drivers. Absence of either reduces relevance and may exclude the app in some markets.
- Dispatch to app. The third relationship relates to agreements between app manufacturers and dispatch companies where dispatch companies are involved in the app booking process. The involvement of traditional dispatch in app technologies is declining as it represents an avoidable process. Taxi company own label apps fit in this category.
- App to Regulator. The most complex relationship exists between the app supplier and the regulator (if any relationship exists at all).

Peer City Review

Three primary datasets are applied in addition to a review of local operating conditions: Operational data obtained from a variety of sources from peer cities; Taxi User data obtained through street surveys; and Operator perception data obtained through focus group and structured interview. The main findings can be grouped in two categories as follows:

Trip Structure – market opportunities

- Residential trips, particularly those from more distant suburbs, tended to be dominated by dispatched trips. This reflects the relative low densities of demand, which limit the commercial opportunity for cruising taxis, boosting the opportunity and benefits of app use.
- City centre trips, including those from entertainment venues are more likely to be served by the taxi cruising and ranking markets. Concentrations of demand into defined areas, or at defined stances, are better suited to cruising and ranking taxis, reducing, but not excluding, opportunities

for apps. Cities with lower levels of traditional taxi service appear to attract greater interest in app based services even in traditional cruising markets and in particular demographic groups.

- Airport originating trips reflect a further pattern of engagement based on defined stances permitted by the airport. The relationships include an additional market participant, the airports, most of which derive economic gain in the form of airport concessions ï competitively tendered óright to operateômaking entry of app operations as problematic, and generally not welcomed by the airport authority.

Operator and Regulator Response – Barriers to entry

- The response of the taxi and private hire market to the development of mobile applications has been mixed, with a degree of hostility both on the part of the operator and the regulator, with a more muted response on the part of drivers. Apps are a new, and unknown, market participant.
- App based engagements are taking some market share from existing companies, both competitively (within the market) and, through attrition, to parallel markets.
- Taxi driver communities may also be less opposed than at first appears. The Apps do, after all, offer new business, both focusing business, and growing the market. Logic suggests a desire not just to be tied to one App but to many, as each brings with it the opportunity for work.
- Regulator and industry operator communities appear the most opposed. The App has changed the market or will change the market, in a way not envisaged at the time of legislation. Few city codes/regulations fully accommodate the operation of Apps, with many App developers seeking to sidestep traditional definitions to expand their market share.

Financial Viability

The viability of an app may rest upon the extent to which its legality is challenged, rather than the basic costs of operation itself. Costs and benefit ratios may be estimated in relation to the total numbers of trips and market take. In one of the case study locations, an estimated ótaxiômarket of 5,219,433 journeys is identified, of which App use represents 11%. An estimate of use based on public survey an individual app may receive around 150,000 bookings per annum (2012 figures), valued at circa $2,400,000.

Technical Feasibility

Technical requirement include: the ability to locate a passenger vehicle; the ability to transmit and receive booking; and the ability to facilitate payment. Additional features may develop from the set of information, such as the upward feed of information from app to regulator, itself a desirable requirement. Relatively few genuine technical barriers exist to the operation taxi apps. The most significant challenge relates to the development of API links between apps and existing software. This challenge exists in relation to apps to dispatch, and is not applicable in apps to driver.

Overall Impact

To the member of the public seeking reliability, speed and service, the taxi App is already a reality. The consumer may play between alternatives, taking a look at the latest or the most visible. This reflects the nature of the Internet-type mentality underlying both the Apps and their users. The need to make taxi bookings and the need to have a visible and reliable service will be understood far more than the legal framework under which such services are provided therefore app market will probably expand despite the conflict with regulators. The taxi appears, and is likely to, contribute to better services and increasing mobility. The apps can make the service more attractive, but will be impacted by regulatory structures in place. The overall impact on traffic is not expected to be particularly relevant. However the taxi is, by its nature, a more environmentally friendly vehicle than a privately owned car. Any activity that diverts private car use to collective transport, such as taxis, will actively reduce carbon emission at point of use and life cycle carbon production. The Taxi Apps contribute to this, as do any activities promoting taxi use.

14.7 CS7 - Bike Sharing in Vienna and the Surrounding Region

In this case study, the focus is set on the bike sharing schemes in Vienna and the surrounding region Lower Austria (*Niederösterreich*). A computer assisted telephone interview (CATI) was carried out to capture user responses to two different bike-sharing schemes in and around Vienna. The survey was carried out in Vienna, where Citytbike is in operation, and in Lower Austria, where nextbike, also sometimes called as LEIHRADL-nextbile, is in operation. The survey conducted in Lower Austria is designed to be comparable to a survey in 2009 and thus the survey result is presented together with 2009 data where comparable, while the survey in Vienna is the first of its kind. The CATI survey in Lower Austria was carried out in small villages up to 2500 inhabitants, (7 municipalities), towns up to 5000 inhabitants (5 municipalities), regional centre up to 10,000 inhabitants (5 municipalities), large regional centre more than 10,000 inhabitants (2 municipalities) as well as in a town in a suburb of Vienna (1 municipality), and in total 248 valid responses are collected. Distribution among the municipalities corresponds to the actual population based on the 2001 census, which was the latest available one at the time of the survey. The survey in Vienna was carried out in all districts in Vienna and 252 valid respondents are collected. The proportion of the respondents between Lower Austria and Vienna is also in line with the 2001 census.

The one in Vienna, CityBike, has been in operation since 2003 and currently served with about 100 stations with in approximately 3km radius from the city centre. The one in Lower Austria, nextbike, started in 2009 as a replacement and an extension of its manually-operated predecessor *Freiradl*. It is installed not only in cities but also in small towns and villages as well as in several rural touristic regions such as Wachau along Danube. CityBike has a terminal equipped with touch-panel screen at its stations and users operate this terminal to use the shared bicycle. On the contrary nextbike's stations do not have such terminal and users have to operate via mobile phones. Both systems require registrations of personal data and payment method such as credit or debit card number in advance.

In Vienna, the survey revealed that more than 90% of the people know about the bike-sharing scheme and 28% of the respondents have already used it. In Lower Austria, the awareness of the bike-sharing scheme is as low as 20%, while a comparison of the surveys revealed that there is an increase of bicycle use in general (including non-shared bicycle) while awareness of the bike sharing scheme that is employed in the region remains low. Meanwhile, awareness of the Viennese bike-sharing scheme has become higher over the four year period in Lower Austria. 17% of the respondents in Lower Austria have used the shared bike in Lower Austria at least once and 10% of the respondents have used the shared bicycle in Vienna.

Despite the high level of awareness in Vienna, the majority of the respondents have not yet used the bike sharing schemes. 28.4% of the Viennese respondents have used CityBike at least once, while 70.7% of the respondents have never used any bike-sharing schemes. The low rate of experience applies to the inhabitants to Lower Austria, too, with 10.1% of the respondents having used Viennese CityBike and 3.7% having used nextbike in Lower Austria. The most typical reason for not using shared bike is the ownership of the own bicycle. The data about the usage frequency shows that there are a certain proportion of the users in cities who use it regularly – 11.8% in Vienna use it weekly and 20.6% monthly, while 9.4% in Lower Austria use it monthly. 69% of the Viennese respondents and 56% of the Lower Austrian respondents indicates that they got to know about the bike-sharing on the street – either at the renting stations or by seeing shared bikes in use.

Among those who actually use, the leisure activities in the same area are dominant as the main trip purpose when shared bikes are used (67.9% in Vienna and 59.5% in Lower Austria) and the leisure activities in other cities/regions (6.2% in Vienna, 21.4% in Lower Austria). Certain proportion of the people in Vienna uses it as an alternative transport mode for daily trips such as for commuting (11.1%). A certain proportion of the respondents still prefers the cash payment to the debit or credit card payments (30.9% in Vienna and 47.2% in Lower Austria), and thus such payment methods has to be well considered although the current system with debit or credit card payments has to be kept to meet the needs for those who wishes to pay with them (42.6% in Vienna and 34.9% in Lower Austria preferring debit card/direct debit from bank account, and 14.9% in Vienna and 10.4% in Lower Austria preferring credit cards). The preference for identification method is not uniform and there are two groups – one that prefer phone-based identification (by SMS or calling) and another one that prefers card-based identification (dedicated bike-sharing card or debit/credit card).

Regarding ICT-relevant aspects asked in the survey, roughly two-thirds of the respondents recognise themselves as familiar with the ICT-based user interface in general. The survey results are shown in the following figure.

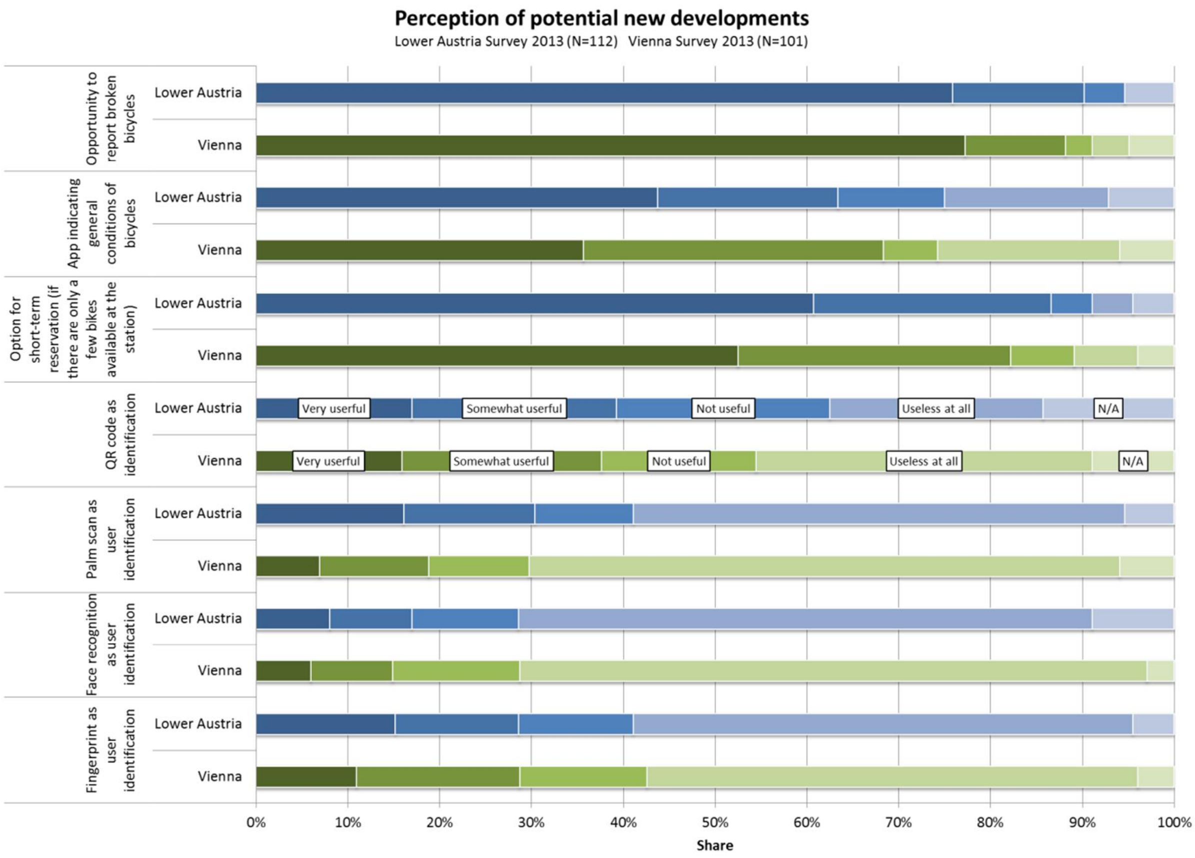


Figure 14-2 Perception of potential new system developments by bike-sharing users in CS7

Regarding the transferability, it has to be mentioned first that similar bike sharing schemes are already in operation in various cities including London, Paris, Lyon, Barcelona, Frankfurt am Main, Warsaw and Riga, as well as Baku (Azerbaijan), Dubai (UAE), Kaohsiung (Taiwan) and Toyama (Japan). Thus in urban areas it appears that the bike sharing has good transferability. There are several important framework conditions that should be achieved for a successful implementation of bike sharing schemes: (1) good cycling infrastructure must exist, (2) the climate and topography must be suitable for the bicycle usage, (3) scheme itself and bicycle-relevant traffic regulations are designed so that users just get identified and then start riding, and (4) the user interface is simple such as card-based or phone-based identification. If these are not met, the transfer may fail. For example, the bike sharing scheme installed in Melbourne turned out to be unsuccessful after a year since its launch with rider numbers falling short of expectations. The reasons were a combination of difficult-to-use renting stations, a humid summer and inadequate bike lanes, and above all, a traffic law to make it compulsory to use a helmet when using bicycle, which forced the user to bring an own helmet to use the shared bike.

Transferability to the rural areas is still not comprehensively understood while similar framework conditions are expected as in the case of the urban area. Judging from the implementation in Lower Austria (and Burgenland, which is not the subject of the survey this time), important additional framework conditions appear to be the following: (1) the bike-sharing scheme needs to be installed not only in one single town/village but in a wide area such as all the towns within 50km to 100km radius, (2) users can use them with a single registration regardless of the municipality, (3) the initial cost of the scheme must be inexpensive, and (4) cities and towns serving as regional centres installs the same system. Additionally, flat touristic regions such as lake, river and coastline are one of the areas that are expected to have a good transferability as a touristic region.

Main conclusions and recommendations from this case study are:

- Awareness of bike-sharing schemes in general is high in the surveyed region, especially of the one in Vienna that has been in operation for a decade. Meantime, the proportion of the people who uses the scheme regularly is fairly low, and among those who use it regularly, the leisure trips are dominant. Some uses for commuting and other daily trips in the city.
- The current pricing that is set to low appears to be well accepted.
- Making the stations denser and/or extended is an important development so that more population can be covered within a reasonable catchment area from the stations. This will eventually help to increase the awareness through on-street visibility of the bicycle. Such enriched ħardò infrastructure for the bike-sharing will capture more potential users.
- Several ICT-based development is recommended including short-term reservation to make the users guaranteed with a bike available at a station, diversifying identification methods especially with phone and own or bank/credit cards, and further easy booking/identification systems, as well as the smartphone apps to show availability and conditions of bicycle and to report broken bikes.
- Regarding booking/identification system, it will have to be considered to integrate various schemesôuser accounts so that one user account from a scheme can be recognised automatically by another schemes as bike-sharing schemes requires the users to create an account for it. Especially in light of the fact that a certain number of the people from rural area use the system not at home but rather at the urban destination such as Lower Austria using the shared bike more in Vienna, such integrated user account may be fairly useful to motivate the people to use the bicycle in two senses.
- The technologies used by bike-sharing schemes are becoming fairly mature and thus the bike-sharing scheme is easily transferable.
- Initial investment cost is high with approximately ú 25,000 per station if the one employing docking station with touch-panel terminal is chosen. The maintenance cost per bicycle is between ú 1,500 and ú2,500. This type is thus suitable for medium-sized to large cities. The one operated fully by mobile phone is less expensive and it costs around ú 5,000 with lower maintenance cost and thus it is suitable for small cities and also for rural areas.

14.8 CS8 - Car Sharing in Karlsruhe

Car sharing in Karlsruhe, when measured by cars per inhabitant, probably is the most successful system of this kind of mobility concept in the world. It is a system of classical car sharing (car club), where all cars have fixed locations i.e. when renting a car, the user has to pick it up at a distinct location and drop it off at the same point.

Manifold reasons for the success of car sharing in Karlsruhe apply. Concerning the demand side there are to mention:

- From the beginning in 1995 bookings could be done all day and night even in pre-internet era by co-operating with a call centre of a facility management company staffed 24 hours seven days a week.
- Car positioning focused on city centre districts in the first years, but with many different locations to minimise access distances for users.
- Co-operation with regional public transport service to promote the combination of season ticket (for all day mobility) with car sharing for occasional trips.
- Providing a wide variety of different cars, enabling car sharing as a transport solution for all purposes, for all users.
- The acquisition of private companies and public institutions as customers enabled a base load during the week of those part of the fleet, which otherwise would only be needed to cope with peak demand of private users on the weekend. This minimises the occurrence of unsatisfied demand at reasonable costs.
- Smart fleet management, with focus on efficient cars provided in line with seasonal demand.
- Using economy of scale effects to balance raising fuel and vehicle costs and making car sharing continuously more attractive when comparing with private car usage instead of raising prices for maximising return on investment.

- And last not least: Providing very attractive tariffs, making car sharing competitive with private car usage in many different using profiles. The actual costs applying for car sharing usage in Karlsruhe are significantly lower either than those offered by other classical car sharing providers in other cities and as well as those costs applying in systems of dynamic car sharing (see following section).
- From the demand side view the following circumstances helped a lot:
- Very attractive public transport in the Karlsruhe region with corresponding high mode share, so that many people do not need a car for their daily ways.
- High share of single-households in the city centre districts, which not necessarily need an own car, as these people do not have to commute longer distances.

Concerning the general patterns of use:

- A variation of demand applies concerning season, weekday and hour of the day, which must be considered by the fleet management, to assure a high availability of cars for the customers but in parallel an efficient usage of the vehicles to enable attractive costs for using the system and a financial viability to run this system economically successful.
- The tariff system charges by time and mileage a car is rented, providing discounts for longer trips and in addition requires a monthly membership fee and a one-time charge for registration and a deposit resulting in average costs per kilometre of about e 0.40. This is not much higher than the full costs of owing a private car, but enables the customer to chose the right car for a specific purpose among fifty different types of cars.
- An analysis of long-term booking behaviour showed that the annual mileage per user significantly decreases with the years to about 1400 kilometres a year. Assuming a consistency in the number of ways undertaken per person, the conclusion can be drawn, that car classical sharing causes a switch in mode choice towards public transport and bike usage. This is backed by results of a mobility survey undertaken in Karlsruhe in 2012.

Comparing this system of classical car sharing with dynamic or floating car sharing, as provided e.g. by Daimler motor company in Ulm since 2009 under the brand car2go, shows severe differences between these systems in user behaviour, efficiency and therefore also in financial viability. The system of dynamic car sharing focuses on a revitalisation of car usage in urban areas, where figures for car ownership and the mode share of car usage decreased in the last decade, especially among younger people, while it is not intended to replace existing car ownership by usage of dynamic car sharing. The existing tariff structure (making long-distance trips unattractive) and the uniform car fleet, consisting of just Smart 2-seater cars, supports this focus of dynamic car sharing, towards a mode shift from public transport and bike usage to car driving in urban areas.

In Karlsruhe, the average mileage per car is at 28,000 kilometres, while this benchmark figure for car2go is about a just third of that value for classical car sharing, resulting in a missing profitability.

So classical car sharing can be considered as a mobility concept, which is sustainable, on the ecological as well as on the economical view, while this does not apply for dynamic car sharing, as performed by car2go.

14.9 CS9 - Grass-Root Cooperative Smartphone-Based Car Sharing in Austria

This case study set its focus on newly-appearing grass-root cooperative car-sharing, called CARUSO, in Austria. It has several interesting features different from conventional car-sharing:

- It is used not only in urban areas but also in rural areas.
- The scale is small with one or a few cars to be shared among up to 30 users.
- The users have to form a car-sharing group spontaneously based on their needs.
- The shared cars are provided by a group member (e.g. an individual, public organization such as municipality, private companies, etc.) or procured cooperatively by the group and there is no car-sharing company owning and offering vehicles.

- A special insurance policy package dedicated for CARUSO offered by a regional insurance company covers the mandatory insurance needed for this form of car-sharing.
- The reservation and usage-logging platforms on board are provided as an Internet application by CARUSO.
- The user fee can be set in a flexible way and each group adopts different pricing models such as linear per-km tariff with or without annual fee or just 6-month user fee divided based on the approximate usages by users.
- Some groups share EV(s).

The platform consists of three different stakeholders as shown in the table below. There is a system provider who provides a web-based reservation and logging system, smartphone-based on-board system, and organizes an extra insurance with a regional insurance company. The second generation on-board system called CARUSO Box was under development at the timing of the research, as well as a smartphone app to enable reservations from this. The role of group organiser is to manage the cars and contract, as well as accounting.

Table 14-3 Stakeholders involved in grass-root cooperative car-sharing in CS9

Stakeholders	System Provider	Group Organiser	Ordinary Users
Roles	Provision of on-board system, reservation system, drive log and insurance	Procurement of shared cars, Contract management, Accounting, Usage of shared car, Payment of user fee	Usages of shared car that belongs to the group, Payment of user fee
Who can be?	Developer of the system	Private person, municipal office, company, association, etc.	Any who is admitted to be a member

In this case study, three different types of surveys were carried out, namely focus group interviews to the users, an online survey to the users, and a telephone survey to the users and non-users. The focus group interviews and online surveys were carried out in four municipalities where active grass-root cooperative car-sharing groups exist, as shown in the following figure. The online survey was carried out to the users of Carsharing 24/7, another peer-to-peer car-sharing mainly used in Vienna and Graz.

With these three different types of survey, following the fact-finding research works at the very beginning, various key aspects are found as described below. It has to be noticed however that these conclusions are mainly derived from the survey onto a limited number of current users (c.a. 30 people) and it may change if it expands largely in the future.

In terms of organization, in addition to the basic features listed at the beginning of this subsection, the following two key points were found.

- The largest challenge is probably the vehicle insurance. Although CARUSO offers a special insurance package with the support of a regional insurance company, problems can occur when shared cars are seriously damaged and the question of responsibility in such case is unsolved.
- Another important aspect is the national legal framework for renting a car which varies from country to country. For example, in Austria, car-sharing is seen as a commercial activity if it is considered as profit-generating (e.g. if the price for car-sharing is equal or higher than the government-set travel cost per kilometre). Thus, as far as CARUSO remains non-profitable, this problem does not arise, while once it becomes profitable, much complexity is foreseen in this term.

As for the grass-root car-sharingӳ basic characters, the following points were found as the main features.

- The closed group structure and the limited number of the members up to 30 people enable almost all members to know each other and it reduces the barriers to use the shared car through the grass-root cooperative car-sharing platform casually. In addition, this brings about the trust among the group members and thus each member feels higher responsibility to keep the conditions of the cars well.

- The high usability of the online reservation system seems a very important advantage for grass-root cooperative car-sharing: even the people with little experience with the Internet are able to book for their own.
- In rural areas, the grass-root car-sharing appears to work when it is also used as the official cars of the municipality.
- In cities, the system appears to work when it is employed within a housing complex or in a neighbourhood. This may also be applied in the rural areas; however, there is no working example existing as of yet.
- Typical users are both male and female and balancing ï this is in contrast with the peer-to-peer car-sharing users, among which male users are the majority. The users of the grass-root car-sharing are in the age between 26 and 50 and they tend to be highly educated compared to the average. This implies that the future challenge of the grass-root car-sharing will be how to make it usable for those who are older than 50 and especially than 60, who need more demand responsive transport.

Regarding the user responses to the grass-root cooperative car-sharing, following main conclusions are drawn.

- The motivation for car-sharing differs from group to group while one important common factor is the curiosity whether this system will work or not. It seems important for people to try out such systems to know whether car-sharing fits to his or her mobility behaviour or not.
- Saving automobile-relevant costs and saving a second car are often strong motivations for starting car-sharing. If the car is seen just as a mean of transport out of many and not as a status symbol and/or is used for special purposes, the willingness for car-sharing is higher.
- Most of the participants of the focus group interviews own a car and the car-sharing car replaces their second cars in the households. But the focus group interviews showed that, in some cases, sharing a car can actually substitute the main car even in remote rural municipalities with scarce public transport.
- The trip made with the grass-root cooperative car-sharing is for various purposes including shopping, short-term leisure, carrying heavy luggage, private such as visiting doctor or friends, and so on, and they balances. The usage is typically within 30km driving range, and the usage on weekdays and weekends balance well. This is in contract with the peer-to-peer car-sharing, with which the leisure trips longer than 50km in total on weekends are dominant.
- The actual CARUSO users find a number of advantages in the private grass-root car-sharing model, especially in the exclusiveness of the car among the car-sharing community and the low costs for the car usage. Many users also recognise the easy user interface of the booking system as an important advantage. Most of the disadvantages that the respondents refer to are associated with the electric vehicle, especially the driving range of the car and the sparse battery charging infrastructure and not directly associated with the grass-root cooperative car-sharing itself.
- Sharing a car can raise the awareness about the own mobility behaviour and can lead to changes in that, such as lower perceived cost of owning and driving cars and higher actual cost of them, and the idea to choose a suitable one according to the trip purpose.
- Survey respondents who do not own their own cars typically have access to the cars of their family members, relatives and/or friends, while most of them prefer the car-sharing vehicle to such other accessible vehicles.
- As for the experiences with ICTs, there seems no practical barrier as most of the users recognise themselves as fairly experienced with the Internet or any other ICT-based services.
- The concept of car-sharing is well known among non-users in rural areas. Thus this type of car-sharing appears to have a large potential to be employed in other rural areas with similar characteristics, where car-sharing has been considered unrealistic.

14.10 CS10 - SANT CUGAT INTELLIGENT MOTORWAY SYSTEM

The motorway between Sant Cugat and Barcelona is a 13 km toll highway operating since 1991. The entering in service of this motorway, which includes a 2.5 km tunnel under the Collserola hills, had a great impact on the attractiveness of Sant Cugat and the Vallès Occidental county as levels of accessibility increased dramatically, inducing an important migration flow of middle and upper class residents from Barcelona. Sant Cugat population has doubled ever since, and increased by 60% only since the year 2000 reaching a population of 84.000 people in 2012. Prior to the existence of the motorway, a regular trip from Barcelona to Sant Cugat took approximately 40 minutes, whereas today a regular trip takes no more than 20 minutes during rush hours.

The motorway corridor is also served by suburban rail line, with service frequencies up to 3 minutes during peak hours, and allowing to reach Barcelona city centre in 25 minutes. Rail and road modes are in direct competition, and the quality of service that each of the modes is able to provide is one of the key elements for users to chose between one or the other.

Tabasa, a public operator has managed the motorway until December 2012, time at which it was sold to Abertis Corporation. It has traditionally pioneered the implementation of smart infrastructure equipment, enabling semi-automatic free-flow toll payment already in the 90s, then introducing automatic incident detection systems inside the tunnel, environmental toll reductions for clean vehicles linked to OBU devices, and more recently a computer based HOV recognition system at tolls allowing for automatic vehicle occupancy detection and fare reduction.

The technical solutions introduced analysed on the Sant Cugat case study are aimed at improving safety, reducing congestion and increasingly becoming environmentally friendly. They are the following:

- *Automatic detection of High Occupancy Vehicles and applications of discounts*. Sant Cugat Motorway is applying discounts for vehicles with 3 or more occupants. In order to be able to materialise the discount, drivers need to belong to the ViaT program, the OBU based system for semi-automated free-flow toll payment linked to a bank account. The client must go through the toll lane signalised as VAO3+; the user then stops the car in the toll and pushes the button to apply for the discount. The plate and the occupants are photographed. The camera recognises automatically the number of occupants. If the system can automatically recognise 3 or more people the discount is directly applied, otherwise, the picture is validated manually by Tabasa personnel. Discounts are applied at the end of the month through the ViaT program. HOV get a 40% discount.
- *Environmental discounts for ecological vehicles*. Sant Cugat Motorway has implemented discounts for low emissions cars since the 2000s. Users who own an environmental friendly car must register on the website www.ecoviat.com, where they need to enter their personal details and their car registration details. Once the service documentation has been completed, users receive an SMS indicating the date from which the discount is activated. Having authorised the registration, when the vehicle passes through the toll a camera system reads the vehicle registration number and reads the ViaT number (DSRC electronic toll), authorising the discount.

  The vehicles that can register on the ecoviat program are those with emission ratios under 120 gr/km for gasoline and 108 gr/km for diesel, and also vehicles run by hydrogen, GPL or electric. ECO vehicles get a 30% discount.
- *ViaT Electronic Toll System*. ViaT enables users making toll payments on Sant Cugat Motorway on the move, without having to stop. A wide-spread system in Europe today, the motorway was one of the first ones in Spain to implement such system already in the 90s. Once a user has registered the system, being linked to a Bank savings account, an OBU device is sent to him which needs to be installed on the windshield of the vehicle. With the OBU receptor installed, a vehicle travelling along an electronic toll lane get the device read by the antenna on the lane using a DSRC technology (Dedicated Short Range Communication). If the vehicle is authorised, the transaction is validated and the vehicle is allowed to pass, the system automatically charges the toll to the clientôs account. The system also recognises recurrent users having the right to have toll discounts applied; and it is also linked to the clean vehicles and the HOV programmes.

  The discount for recurrent users is only applied for those travelling off-peak hours balancing the traffic along the day and optimizing the capacity of the highway. Recurrent vehicle can get up to a 20% discount for more than 31 trips per month.

Discounts for the toll fare are cumulative, therefore one user can cash up to 90% discount in case of being ECO, HOV and recurrent user.

- *Automatic Incident Detection System*. The Sant Cugat motorway is equipped with technology in order to automatically manage incidents inside the tunnel, increasing the overall levels of safety. The tunnel is equipped with cameras linked to incident recognition algorithms, which in case of emergency or of heavy congestion activate a red traffic light located at the entrance of the tunnel not allowing more vehicles in.

The analysis of these applications allows for the following final considerations:

- <u>Misaligned interests between the private and public sector</u>. The Sant Cugat motorway has pioneered many initiatives to enforce civic behaviour on the road mode, e.g. increasing average vehicle occupancy, promoting fleets of environmentally friendly vehicles. Being these objectives of general interest, the framework of a public operator managing the motorway was an element facilitating the implementation of these experiences in the corridor, even when at stages where technologies were not yet mature. One year after the sell of the operator to the private sector, discounts are still applied subsidised by the public administration. However, the general HOV strategy aims at promoting lower vehicle flows, an element that a priori may conflict with the operator legitimate objective of maximising toll income, provided that congestion levels are low enough to maintain traffic flow under capacity limits. It will be interesting to follow the evolution of these programs in the mid and long term.
- <u>Discount linked to frequent users</u>. Providing discounts for recurrent travellers was introduced by the public administration on motorways of their competence to compensate drivers ŉforcedò to use the motorway for everyday mobility. This initiative is to be understood in a context of high levels of citizen concern for toll systems in Catalonia, mainly motivated by the fact that toll policies in the Spanish motorway network are not harmonised; the existence of tolls, and eventually the level of fares applied, respond more to financiering mechanisms and needs, and agreements with concessionaries at the time each segment being promoted, rather than to integrated traffic management criteria. This policy enters in conflict with congestion charging initiatives applied in the 2000s in cities like London and Stockholm, having had clear success in reducing congestion and promoting public transport. However, being discounts only applied to those travelling off-peak, it can be considered that the system has a management dimension aiming at moving travellers from peak to off-peak periods.
- <u>Complex procedures for obtaining discounts</u>. The impact of behavioural incentives in the Sant Cugat motorway is relatively limited compared to what one would expect (only 36% of users having the right to apply for a HOV discount are currently doing so, according to surveys by the operator and they represent the 5.74% of the total traffic). A possible explanation to this observation is the fact that discounts can only be applied to users engaged in the ViaT program. The engagement into this program requires a certain number of formalities (e.g. linking it to a savings account at bank account), and it has a yearly cost of 12 euros plus a one-time payment of 34 euros for the acquisition of OBU receptor (50% of the highway vehicles use the ViaT paying system, above the average of 40% of the Catalan motorways).

14.11 CS11 - LATIS: ICT MODELLING IN SCOTLAND REGION 2007 TO 2027

This case study uses the existing Transport Model for Scotland which is owned by Transport Scotland (The Scottish Government) to produce quantitative estimates for traffic and emissions reductions resulting from the potential implementation of two general ICT solutions.

The ICT measures assessed in the case studies generally have a broad range of impacts, the relative impacts of which have been assessed against the COMPASS assessment matrix. This case study aims to quantify some of the potential impacts relative to reduction in CO2 emissions and traffic congestion levels. This quantification is made feasible by the existence of the LATIS model (Land Use and Transport Integration in Scotland) which is an integrated Land-use and Transport model for strategic assessment across the full Scotland Region. The nature of the model is such that the relative impact of possible ICT scenario effects could be assessed across different sub-regions; specifically Urban regions, inter-urban and rural.

The first solution assesses the impact of a reduction in In-Vehicle travel time on road-based Public Transport which may be the result of smart ticketing measures. (Other ICT measures such as improved traveller information and bus signal priority may also contribute to the reduction in overall/in-vehicle Public Transport journey time).

The second solution assesses the impact of increased car occupancy levels which may be achieved by lift-sharing initiatives.

Model data outputs were extracted from the TMfS07 2007 Base Year, 2027 Do Minimum Forecast year scenario and each 2027 Option Test scenario. The following scenarios were appraised and analysed:

- Test 1 PT: 5% reduction in urban bus journey times (Glasgow, Edinburgh, Aberdeen & Dundee) ï all journey purposes and time periods. The in-vehicle time (IVT) factor for urban buses was reduced from 1.2 to 1.15;
- Test 2 PT: 10% reduction in urban bus journey times (Glasgow, Edinburgh, Aberdeen & Dundee) - all journey purposes and time periods. The in-vehicle time (IVT) factor for urban buses was reduced from 1.2 to 1.1;
- Test 3 Car: 5% increase in car occupancy - subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08);
- Test 4 Car: 5% increase in car occupancy for ócityô origins ï subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08);
- Test 5 Car: 5% increase in car occupancy for ónon-cityô origins ï subsequent reduction in AM & PM Peak commuter matrices (Car occupancy increased from 1.03 to 1.08)

Generally, the impacts of each of the tests is relatively marginal (when compared to major schemes such as infrastructure schemes), but some of the measures do start to take an impact with the higher-end assumptions in place. The relatively marginal impacts are likely to stem from some of the test assumptions, whereby the aspects that are changed/appraised here only make up one specific component of travel time. This illustrates some of the challenges of encouraging greater use of public transport or car sharing, but whilst reductions are not large relative to major strategic assessment, the carbon reductions are apparent and in some cases could be quite significant.

First Solution: Reduction in Urban Bus Journey Times as a Result of ICT

The change to in-vehicle time (IVT) for urban buses to represent smart ticketing has little effect at a 5% level but the trend associated with decreasing IVT becomes more apparent in the 10% test, where small but consistent percentage decreases may be observed across Carbon and CO2 emissions (tonnes) and total v-km. As might be expected the effects of reduction in PT journey times in the urban regions shows some spill over into the adjacent interurban regions and negligible impact into the rural regions. The city of Glasgow would benefit most from a 10% decrease in PT-IVT with a reduction of 108 tonnes of CO2 (equivalent per annum) and a reduction in 1.06 million veh-kms (per annum). Emission/Congestion maps (from the model-base year 2007) show that the rural areas are generally uncongested and that reductions are most beneficial within the central belt.

For a 10% decrease in PT-IVT in city regions, v-km driven reduce across all regions ranging from 0% to 0.06% reduction and the annualised CO2 (equivalent) emissions reduce across all regions ranging from 0% to 0.06% reduction. This gives average reductions by region of:

- Urban(City) 0.48 mill-v-km/annum 38 tonnes;
- Interurban 0.15 mill-v-km/annum 18 tonnes;
- Rural 0.05 mill-v-km/annum 4 tonnes.

Second Solution: Mobile technology to encourage car sharing

The change to car occupancy levels to represent increased lift-sharing presents much more promising results in terms of quantifiable carbon reduction. If average car occupancy levels were increased from 1.03 to 1.08 across the entire Scotland region, an annualised equivalent CO2 saving of 17,897 tonnes could be made. The modelling suggests that regional effects would produce regional benefits and that the percentage benefits are slightly more favourable in Interurban/rural regions than in urban regions, which supports the introduction of lift-sharing schemes in rural areas. The change in both congestion and emissions for a 5% increase in vehicle occupancy caused by lift-sharing is much more significant than for reducing public transport in-vehicle journey time.

Table 14-4 Impacts of CS11 scenarios on vehicle·kilometes travelled and CO2 tonnes emitted

	vehicle-kilometre (10^6)			CO2 (tonnes)		
	All	Urban-origins	Non-urban origins	All	Urban-origins	Non-urban origins
Urban	-5.00	-3.82	-1.27	-552	-444	-97
Interurban	-5.20	-1.21	-3.94	-660	-179	-470
Rural	-5.13	-0.45	-4.65	-606	-57	-550

Source: LATIS Model, 2013

Significant reductions in overall CO2 emissions could be achieved if national car occupancy increases could be made. Any scheme to promote this objective would be expected to perform well on emission reduction measures. Local schemes however would be expected to benefit the local area and whilst detailed local schemes have not been specifically tested it is clear that the location of the origin where the increase in occupancy occurs will produce a strong local effect.

- The effects of this measure were significant for all tests and approximately an order of magnitude greater than for the PT journey reduction of 10%
- The regional effects were strongly apparent suggesting that local-lift sharing schemes with high take up could produce significant carbon reductions at a local level
- City-based lift sharing schemes would have little impact in rural areas.

15 FROM CASE STUDIES TO EU-WIDE ASSESSMENT

15.1 AIM

This chapter reports the outcomes of the works undertaken in Task 6.3 of COMPASS.

The objectives of task 6.3 are mainly to model the impact of ICT solutions on European scale to become able to assess the impact that ICT solutions could have on a European scale.

Based on the findings at local scale by case studies and in knowledge gained from the analysis of ICT transport solutions in the COMPASS Handbook, quantitative modelling is then used to assess to the potential impact of ICT solutions at European scale.

15.2 METHODOLOGY

15.2.1 MOSAIC Model

The assessment of long-distance ICT solutions is based on quantitative modelling using MOSAIC, the European-wide model developed in the INTERCONNECT FP7 research project. (*Full reference of the model characteristics are presented in the Annex to this report).*

MOSAIC is a modal choice and assignment module originally programmed to investigate how interconnection facilities and services influence the costs of transport, and therefore, how the upgrading of interconnections in Europe may impact on the European transport system.

MOSAIC has been developed in C++ on top of BridgesNIS. BRIDGES/NIS is a suit of C++ routines developed in the Bridges 4th EU Research Framework by MCRIT (1999), and continuously upgraded since (www.mcrit.com/bridges). The outputs produced (16Gb, 450 million registers) are processed by ad-hoc routines programmed to compute specific indicators measuring transport performance and interconnection, as well as to carry on sensitivity analyses.

State-of-the-practice forecast models are based on a conventional modular structure with trip generation, distribution, modal split and network assignment, having two major draw-backs:

- The separation between mode choice and traffic assignment means that intermodal chains can be hardly included and analysed in these kinds of model.
- Interconnections between local and regional networks are neglected.

MOSAIC is intended to overcome the weaknesses of state-of-the-practice forecast models at continental level in relation to the integration of interconnections into their modal choice and assignment procedures.

MOSAIC is fed with trip matrices originated by TRANS-TOOLS, and works as stand-alone software to perform multi-modal network assignments. A meta-model approach is later adopted to process the large data outputs of MOSAIC and produce sets of indicators.

In particular, COMPASS assessment at European level has been carried out with TRANS-TOOLS 2010 and 2030 Baseline matrixes produced during the TEN-CONNECT2 project (DG MOVE 2010).

MOSAIC network graph is based on the so-called *supernetwork approach*. In this approach, the different modal sub-networks (uni-modal networks) are completely integrated, and the combined modes and the interactions among the vehicular modes on the roads might be explicitly taken into account. The multi-modal graph was constructed using the road, rail and air graphs from TRANS-TOOLS, identifying intermodal terminals and establishing connectors between networks at these points.

The multi-modal graph includes the TEN-T core and comprehensive networks, and major national infrastructures. All in all, it considers 37,000 road links; 12,000 rail links; 3,200 air connections; and several ferry connections (linking road and rail networks).

Connectors between networks were initially created automatically using the following criteria: all cities are connected to closest roads, but only to closest rail stations when these are located nearer than 15 kilometres. Airports are connected to the closest rail stations when these were located nearer than 10 kilometres, and to the closest roads when located nearer than 5 kilometres. Rail stations are always connected to roads. Needless to say, this procedure implies a substantial simplification of local and regional networks and was refined manually on a case by case basis.

Basic average values of time by trip purpose are based on TRANS-TOOLS, ranging from ú 7.5 per hour for holiday travellers to ú 25.0 per hour for business travellers. As the value of travel time for each traveller also depends on the personal income, average European values have been refined using dispersion coefficients to consider the effect of GDP per capita disparities on travellers depending on their NUTS3 of origin. Average travel fees are also based on TRANS-TOOLS services and refined to consider the effect of GDP per capita disparities in different areas of Europe

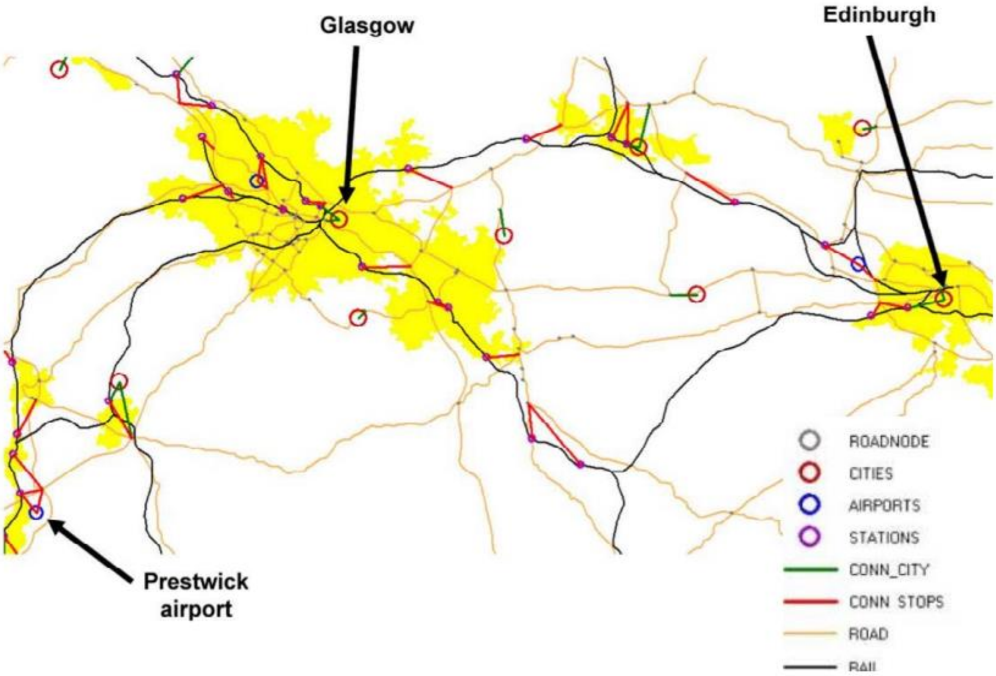


Figure 15-1 Multi-modal transport graph in MOSAIC Model

Each transport network has a different travel cost per kilometre ranging for ú 0.09 per kilometre for local rail services and ú 0.20 per kilometre for long-distance rail services, with ú 0.15 per kilometre for road mode. The air mode costs are estimated in function of the size of the airport of departure ï directly proportionally- and the relative length of the trip.

The costs of interconnections are calculated based on the costs attached to the intermodal connectors, in euros per kilometre -as a fee ranging ú 0.1 per kilometre in city to rail connections, to ú 0.25 per kilometre in city to road and road to rail connections-, and the cost of facing increased travel times due to the speed attached to the connector, in euros per hour. Connector speeds aggregates in one parameter both access and waiting times. Additionally, 90 minutes average time is imposed between successive air services. No additional transfer time is considered in connections between long-distance rail networks (TEN-T) and regional or short-distance networks. Aviation is facing much higher interconnection costs than rail, all considered.

MOSAIC assigns TRANS-TOOLS Origin-Destination matrices between NUTS3, rearranged to be assigned all together onto the multi-modal graph. IntraNUTS3 are 90% of the trips in EU27, and 75% in pax-km. Therefore, MOSAIC models 25% of total EU27 mobility. For intraNUTS3 different modelling assumptions are needed.

Traffics on the networks - travel behaviour - depend on the topology of the integrated multi-modal graph and the impedance of its different elements. Interconnections are an additional element equivalent to other transport links, having a direct impact in the route choice processes. The variation of multi-modal parameters at connectors and transport terminals allow for analysis of the influence of interconnections in the behaviour of travellers.

All itineraries between centroids representing NUTS3 are finally computed based on lower cost paths by trip purpose. Trips are assigned following an AON multiclass algorithm. A total of 1,441 NUTS3 are considered, generating a total of 8.3 million possible minimum cost itineraries between NUTS3, considering the existence of four different trip purposes with different travel costs. On the other hand, the total number of long-distance trips in Europe is 5,800 million, according to TRANS-TOOLS second version, giving a total of 1,170,000 million trip-kilometres

The model does not take into account congestion in the networks, given that the analysed flows are long distance. Long distance traffic takes place during time periods usually much longer than the peak hours last; travellers tend to avoid these peak hours whenever possible to improve travelling times. The hypothesis of not taking into account the congestion might lead to slightly incorrect results when the long distance traveller has to use networks running around big cities, as congestion might change the shortest path (in time) by using a longer (in distance) by-pass. However, the effect of these route changes has a very low impact on the costs in long distance trips.

Default cost and time impedance parameters in MOSAIC have been adjusted in a validation process against TRANS-TOOLS results aggregated at European level. The adjustment process was carried out by a process of successive simulations, instead of by an optimisation, given the number of parameters to be adjusted and the need to monitor the process step by step. The final difference in trip-kilometres obtained, after 20 simulations, was considered acceptable: below 0.5% for roads, below 2% for air and 6% for rail, resulting in a weighted error of 1% for all modes, as shown on the next graphic:

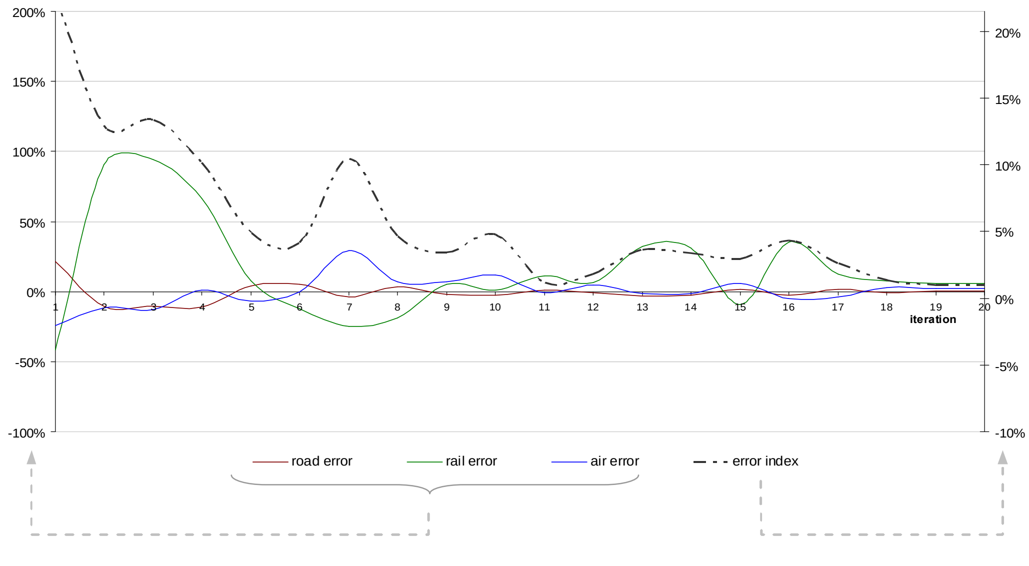


Figure 15-2 **Validation process of MOSAIC (validation consisted in adjusting the total trips-km of each mode at aggregated level to TRANS-TOOLS figures).**

The following facts may directly or indirectly influence the nature and magnitude of the results obtained by applying MOSAIC. First, the NUTS3 divisions differ between EU27 core regions, EU27 peripheral regions, and other neighbouring regions (Iceland is represented by one NUTS3, Belarus by 6 NUTS3, Spain by 52 NUTS3 and Germany by 439 NUTS3). In peripheral areas beyond the EU, traffic has fewer options to travel from one point to another, since networks are less dense, and this results in fewer transport options. Also, the definition of long-distance travelling by trips originated and bound onto different NUTS3 incorporates a number of relatively short inter NUTS3 trips (e.g. between German NUTS3). Because transport networks and modelling parameters were always defined, and validated, at European level, MOSAIC at this stage does not guarantee reliable absolute results at national or regional level, and always have to be analysed in relative terms. More than absolute values, it is always the comparison (e.g. between NUTS3, trip lengths and purposes, modesé) in the different scenarios studied, always at the European scale, that is relevant. Nor are trips from Europe to the rest of the World (not included in the reference area displayed in the following maps) considered.

15.2.2 Hypothesis for Modelling European-Wide Impacts of ICTs

From the demand side, research on ICT impacts on transport has demonstrated that on one side there is a trip substitution (e.g. teleworking, teleconferiencing...) and on the other side a trip induction (e.g. more and further dispersed and distant personal and business relations supported by ICT, inducing trip demand increases).

- The net effect of ICT is an increase on travel demand, following the trends that started already with the first telegraph and telephone connections more than one century ago. The net impact of ICT in travel induction and substitution is difficult to assess, however, isolated from other social, economic and technologic drivers affecting transport demand.
- On the other hand, ICT allows for better real time transport management of user needs, transport conditions and externalities, therefore creating incentives for more informed user choices (e.g. modal choice, trip timing, service or route...) contributing in principle to a much fair competition between modes and service providers and leading to more efficient transport system. User travel experience is enhanced with more convenient and comfortable services.

From a supply point of view, the ICT implementation on transport systems results on efficiency improvements, in a number of aspects:

- <u>More efficient traffic management leading to travel time reductions</u>: traffics from all modes can be to some extent managed online, adapting commercial speeds and frequencies to travel demand and traffic conditions. Therefore, travel times will tend to decrease. This is especially relevant for intelligent traffic systems on congested roads (either speed limit controls and/or automatic tolling systems).
- <u>More efficient infrastructure management, leading to operating costs savings and, to the extent infrastructure managers transfer these savings to users, also to travel fees and user costs reduction.</u> Among other positive externalities, ICT allowing vehicle to vehicle, and vehicle to infrastructure online communication reducing the risk of accidents, and all costs associated. Information gathered in relation to the actual use of the infrastructure is expected also to lead to a more efficient management of the exploitation and a decrease of maintenance costs over time.
- <u>More reliable transport services and vehicles leading to a change in the perception of the value of the time spent when travelling</u>, since waiting times are reduced in both the origin and destination of the trip, and travelling time can be more easily used to work or carry on personal activities. Therefore, travellersô costs will be lower than they are now.

Transport market can also be much better regulated because of ICT, since better information, often on real time will be available. Road pricing for freight and passenger vehicles (e.g. by satellite positioning systems) will result on more efficient use of roads as well as may shifts to other modes, like rail, depending of other factors such as the evolution of oil prices and taxation, the evolution of hybrid and electric engines, and the overall regulation of the transport system. Even if very much helpful (e.g. facilitating rail interoperability and therefore opening national rail markets) ICT is not indispensable neither sufficient to improve market regulation, and it is in this respect a neutral tool that can have positive or negative impacts depending on the regulatory policies being applied.

15.2.3 Background of Modelling Impacts of ICTs on the Perception of the Value of Travel Time

The following considerations are based on the analysis of the article “Valuing Transit Service Quality Improvements. Considering Comfort and Convenience In Transport Project Evaluation” by T.Litman of the Victoria Transport Policy Institute (November 2011), and the report “Results of Behavioural Response Survey Deliverable D3.2 of ORIGAMI, Cofunded by FP7” by Shires, J.D., Shepherd, S, Dekker, T. and Hess, S. (project coordinated by TRI Edinburgh Napier University, 2013)

The value people place on travel time varies depending on the type of trip, peopleô preferences, and travel conditions. People are often willing to pay extra in money or time for more convenience or comfort. Transit travel time unit cost values are extremely variable, depending on the transfer requirements, transfer conditions, crowness indexes, or reliability of pre-established schedules. Many transit systems now offer real time information and this information provides many benefits (Turnbull and Pratt 2003). It reduces waiting stress and allows passengers to better use their time and coordinate activities. This has important implications for planning since time costs are a dominant factor in transport project evaluation. Conventional evaluation practices tend to ignore qualitative factors, assigning the same time value regardless of travel conditions, and so undervalue service improvements that increase comfort and convenience. (Litman 2011)

Table 15-1 Factors Affecting Travel Time Costs

Source: Litman 2011 based on Pratt 1999, Li 2003; Litman 2006

Factor	Description	Transit Evaluation Implications
Waiting	Waiting time is usually valued higher than in-vehicle travel time.	Transit travel usually requires more waiting, often along busy roads, with little protection.
Walking links	Time spent walking to vehicles is usually valued higher than in-vehicle travel time.	Transit travel usually requires more walking for access.
Transfers	Transfers impose a time cost penalty.	Transit travel often requires transfers.
Trip duration	Unit costs tend to increase for trips that exceed about 40 minutes.	Transit travel tends to require more time than automobile travel for a given distance.
Unreliability (travel time variance)	Unreliability, particularly unexpected delays, increase travel time costs.	Varies. Transit is often less reliable, except where given priority in traffic.
Waiting and vehicle environments	Uncomfortable conditions (crowded, dirty, insecure, cold, etc.) increase costs.	Transit travel is often less comfortable than private vehicle travel.
Productivity and entertainment	The ability to be productive or entertained, by a computer, telephone, reading or telephone reduces unit travel time costs.	Transit travel that is conducive to productive and entertaining activities, with adequate workspace and on-board wireless services, can have lower unit travel costs.
Sense of control	A person's inability to control their environment tends to increase costs.	Transit travel is often perceived as providing little user control.
Cognitive effort (need to pay attention)	More cognitive effort increases travel time costs.	Varies. Driving generally requires more effort, particularly in congestion.
Variability	Transit travel conditions are extremely variable, depending on the quality of walking, waiting and vehicle conditions.	Transit benefit analysis is very sensitive to qualitative factors that currently tend to be overlooked and undervalued.
Captive versus discretionary travelers.	Some transit users are captive and so relatively insensitive to convenience and comfort, but discretionary travelers tend to be very sensitive to these factors.	Achieving automobile to transit mode shifts requires more comprehensive analysis of transit service quality factors and their impacts on transit demand.

The following parameters have been suggested as multipliers to basic unit transport costs, to take into consideration the subjective perception of travel costs resulting from intangible factors, such as increased traveller information (derived e.g. from travel planners and other traveller information applications. See http://80.33.141.76/compass/ for a detailed list of such applications).

In particular, for short distance transport, Litman (2011) suggests the following:

- perceived wait time at public transport stations decreased by 20% when real-time information on services was displayed[31] (Dziekan and Vermeulen, 2006)
- in a study of motoristsôpreferences, Harder, et al (2005) found that travellers are willing to pay up to $1.00 per trip for convenient and accurate travel-time predictions, such as when traffic is delayed and alternative routes would be faster.
- walking and waiting time unit costs are 2 to 5 times higher than in-vehicle transit travel time (Pratt 1999).
- transfers tend to impose extra costs (*transfer penalty*) due to the additional physical and cognitive effort they require, and the risk of missing a connection, typically equivalent to 5-15 minutes of in-vehicle travel time (Horowitz and Zlosel 1981; Evans 2004).

[31] Dziekan and Vermeulen (2006) evaluated the effects real-time information has on tram passenger perceived wait time, feelings of security and use in The Hague, the Netherlands. One month before, and 3 months and 16 months after implementation, the same sample of travellers completed a questionnaire. They found that perceived wait time decreased by 20%.

- being productive or entertained results in reduced travel time costs, particularly on longer trips (Schwieterman, et al. 2009). The portion of travel time devoted to productive activity is higher for business travel than for commuting or leisure travel, and increases with journey duration.
- for non-work (personal) travel, standing bus passengers have about twice the travel time costs as seated car or bus passengers, and a third higher than car drivers.
- the average value of onboard train time was found 20% higher during peak periods than during off-peak periods in a research for RailCorp in Australia (Douglas Economics, 2004 and 2006).
- unexpected delays impose 3.7 times standard onboard travel time costs (the same multiplier applies to peak and off-peak trips). (Douglas Economics, 2004 and 2006).
- additional fares or time travellers would willingly bear in exchange for a 10% improvement (from 50% to 60% acceptability ratings) for different train improvements is shown next:

Table 15-2 Value of Train Improvements

Source: Litman 2011 based on Douglas Economics 2006

Type of Train Improvement	Additional Fares (2003 Aust. Cents Per Minute)	Additional Onboard Time (Additional Time in minutes)
Layout & Design Improvements	5.6¢ (2.2%)	0.38
Cleanliness	3.8¢ (1.5%)	0.26
Ease of Train Boarding	3.2¢ (1.2%)	0.22
Quietness	3.2¢ (1.2%)	0.22
Train Outside Appearance	2.3¢ (0.9%)	0.15
On-Train Announcements Improved	2.3¢ (0.9%)	0.16
Heating & Air Conditioning	2.2¢ (0.8%)	0.15
Improved Lighting	1.9¢ (0.7%)	0.13
Smoothness of Ride	1.5¢ (0.6%)	0.10
Graffiti Removed	1.2¢ (0.5%)	0.08
Seat Comfort	1.1¢ (0.4%)	0.07

Value of improving train attribute rating from 50% to 60%. This indicates, for example, that an average traveler would willingly pay an additional 5.6¢ in fares or an additional 0.38 minutes (23 seconds) in travel time for that incremental improvement.

For long-distance transport, Shires, Shepherd, Dekker and Hess (2013) reiterate on the importance of soft factors and increased traveller information. A number of key messages are provided resulting from stated preferences surveys, and are outlined below:

i. Respondents place a high value on soft improvements.
ii. There are very real practical time and cost savings from the soft improvements that carry a high value, e.g. time savings when checking in at airports or when using online planners.
iii. Other improvements are valued because of the assurance they bring to the LD traveller, especially when arriving in an unfamiliar place, particularly a foreign country, i.e. integrated LPT and main mode tickets.
iv. WTP values tend to be lowest for coach, reflecting income and cost differences between coach and other modes.
v. Car users either did not engage with the ranking exercise or dismissed the improvements on offer as not important or realistic.

15.2.4 Assumptions for Modelling ICT Impacts on Transport in COMPASS

ICT impacts will be modelled mostly from a supply-side point of view, since these impacts are to some extent specific to ICT implementation, even if they can be promoted by adequate market regulation, or restricted.

Userõs behaviour, policies and technologies such as ICT are always translated into four main set of input variables:

- Commercial and free-flow speeds on road, rail, airport and ferry links.
- Transport fees for rail, air and ferry links.
- Values of time for different types of users.

- Interconnectivity costs and times between modes.

The most interesting usefulness of a modelling exercise is investigating the sensitivity of key indicators at European level (e.g. total costs reduction, total veh-km increases, modal shares, emissions...) in relation to assumptions on the input variables defined according to different scenarios.

Three aggregated scenarios of ICT implementation are defined (low ICT implementation, medium ICT implementation and intensive ICT implementation).

Each one of the scenarios is defined with a particular set of changes in travel times, travellersô value of time, operating costs, and fees applied by modes and by modal interconnections and connections to cities, grouped in four main areas:

- ICT impact on infrastructure managers and service operators[32]
  - optimised infrastructure and service management
  - optimised intermodality
  - optimised traffic management
- ICT impact on users (enhanced traveller comfort and convenience)

For modelling purposes, 7 scenarios will be modelled: mid/high/very high ICT implementation impacts on users, and mid/high/very high ICT implementation on infrastructure managers and service operators, as well as a reference baseline scenario.

How much ICT will affect travel times, travellersô value of time, operating costs, and fees, for long-distance travel depends on the specific ICT system being used and the specific place where it is implemented. ORIGAMI, and previously INTERCONNECT, have reviewed a number of cases in order to get a reference of the magnitudes of impacts, even though these magnitudes are often rough general expectations. Values for the potential ICT impacts are estimated based on these cases.

15.2.5 ITS Scenarios in COMPASS

The translation of changes in ICT into modelôs input values is based on the expert judgment of modeller. In the case of the ICT analysis, the empiric evidences to support the judgment are mostly based on the COMPASS and ORIGAMI case-studies and user-surveys.

- *Optimised infrastructure and service management*: road mode benefits most (-2,5%, -7,5%, -12,5% cost reduction respect to baseline) due to better vehicle performance and more efficient driving regimes via semi or fully-autonomous vehicles (it is estimated that more efficient driving regimes can reduce fuel consumption and costs associated to vehicle parts up to 25%)[33] as well as less congestion (e.g. more intelligent GPS routing avoiding congestion, traffic jam assistants)[34]. Air mode and long distance rail have moderate improvements (-2,5%, -7,5%, -12,5% cost reduction respect to baseline) due to more efficient fleet management. Improvements in urban and regional rail from ITS technologies will be dedicated to reduce rail subsidies so impact to fees paid by users will be limited.
- *Optimised intermodality*: all road interconnections improve in cost by -5%, -10%, -15% respect to baseline, just like general road infrastructure. City-Rail interconnections improve like short distance rail, while Airport-Rail interconnections improve like long distance rail. Time for formalities in airports (e.g. check-in, security, boarding, transits) improves in line with ACARE vision 2020.

[32] It is assumed the ICT impact on infrastructure managers and service operators will impact on the costs of transport as perceived by users, and is therefore modelled in terms of benefit to travellers.

[33] ñEco-driving easily saves 10-15% fuel reduction on averageò according to FIA: http://ec.europa.eu/transport/road_safety/pdf/ersd2012/gabriel-simcic.pdf

ñEco-driving allows for average savings in fuel consumption up to 20% without reducing average speedò according to RACC foundation: http://w3.racc.es/index.php?mod=paginas&mem=detalle&id=100013&relmenu=1174

[34] ñPlanning your route can avoid delay and diversion. Ten minutes of unnecessary driving in a one-hour trip results in a 14% increase in fuel consumptionò according to Australian Automobile Association http://www.racq.com.au/__data/assets/pdf_file/0005/4973/FactA4_EcoDriving.pdf

- *Optimised traffic management*: for air mode 5%, 10%, 15% speed increase respect to baseline obtained from more direct routing and better management of take-off and landing operations (e.g. FRAM, A-SMGCS, optimised cue-management software). For rail gains in speed are lower, 0%, 5%, 10%, due to more difficult implantation of ERTMS all over Europe. Road mode has speed increases of 2,5%, 7,5%, 12,5% due to better management of congestion (e.g. Ramp metering, HOV/HOT lanes, variable speeds) and more autonomous vehicle driving (e.g. SARTRE platooning, Advanced Cruise Control). Limited ferry speed improvement linked to better information protocols between ships and ports.
- In relation to *Enhanced traveller comfort and convenience*: reduce the perception of travel time costs (through the value of time) by 5%, 10% and 15% respect to baseline for all trip purposes, except 10%, 20% and 30% for business trips because it is expected a more intensive technologic implementation in more expensive travel services.

Based on the previous discussion the values of parameters for Baseline and the relative variation of the three scenarios are presented in the next table. The Baseline is considered to be a scenario with low ICT implementation.

The selected horizon of analysis is 2030. The base of the modelling exercise is the TEN-CONNECT transport matrix OD for 2030, produced with TRANS-TOOLS, and already used in the ORIGAMI FP7 project.

Table 15-3 Quantitative definition of scenarios Mid, High and Very High ICT implementation impacts on infrastructure managers and service operators

		units	Baseline	Mid ICT	High ICT	Very High ICT
Optimised infrastructure and service management	Road direct costs paid by the user (tolls and vehicle operation)	ú/km	0,15	-2,5%	-7,5%	-12,5%
	Rail interNUTS3 SD user-fees	ú/km	0,09	0%	0%	-5%
	Rail interNUTS3 MD user-fees	ú/km	0,15	0%	0%	-5%
	Rail interNUTS3 LD user-fees	ú/km	0,2	-2,5%	-7,5%	-12,5%
	Air user-fees	ú/km	Variable	-2,5%	-7,5%	-12,5%
	Ferry fees	ú/km	Variable	0%	0%	-5%
Optimised intermodality	City-road local connection speed	Km/h	Variable	-5%	-10%	-15%
	City-rail local connection speed	Km/h	Variable	-5%	-10%	-15%
	Airport-road local connection speed	Km/h	Variable	0%	0%	-5%
	Rail-road local connection speed	Km/h	Variable	-5%	-10%	-15%
	Airport-rail local connection speed	Km/h	Variable	-2,5%	-7,5%	-12,5%
	Time spent at airport terminals (check-in and security formalities; transits between consecutive flights)	minutes	90	70	50	30
Optimised traffic management	road speed	Km/h	Variable	2,5%	7,5%	12,5%
	rail speed	Km/h	Variable	0%	5%	10%
	air speed	Km/h	Variable	5%	10%	15%
	ferry speed	Km/h	Variable	0%	0%	5%

Table 15-4 Quantitative definition of scenarios Mid, High and Very High ICT implementation impacts on users

		units	Baseline	Mid ICT	High ICT	Very High ICT
Enhanced traveller comfort and convenience	Commuter VOT	ú/h	10	-5%	-10%	-15%
	Private VOT	ú/h	10	-5%	-10%	-15%
	Holiday VOT	ú/h	7,5	-5%	-10%	-15%
	Business VOT	ú/h	25	-10%	-20%	-30%
	Car occupation	users	1,5	1,75	2,0	2,25

15.3 Impacts Resulting from Optimised Service and Infrastructure Management with ITS

15.3.1 Approach

The following figures show the variation of values for different indicators between the Baseline scenario 2030 and the 3 scenarios defined by COMPASS: Mid ICT / High ICT / Very High ICT scenarios.

These scenarios consider only changes in service and infrastructure management.

In all figures the variation in each different mode is shown by bars and scaled according to the left axis, while the total variation is shown in percentage by the black line and scaled according to the right axis.

15.3.2 Discussion of results

Road modal share increases in each consecutive scenario

The increased intensity of ICT solutions on the transport system along the COMPASS scenarios results on the road modal share increasing from 69.8% in the Baseline to 71.2% in the *VeryHighICT* Scenario.

The reason behind this increase is the higher decrease in the cost of interconnections involving the road, as the decrease in travel costs and fees is assumed the same for all modes simultaneously. More performing interconnections between the road mode and all others implies allowing easier access to the road mode. This fact, in combination with a relatively high increase in speed makes roads become more competitive, gaining modal share.

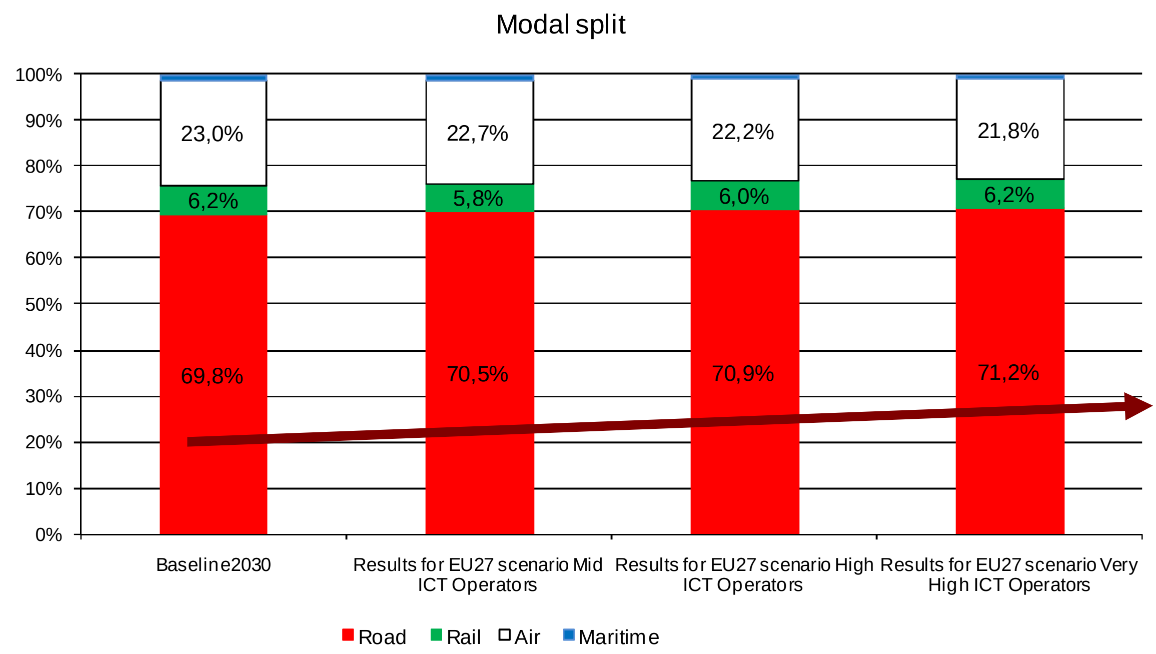


Figure 15-3 Modal Split variation between COMPASS scenarios. Scenarios impacting on service and infrastructure management.

The improvement of road interconnections with other transport mode is mostly related to the decreasing congestion levels of metropolitan motorways, represented in COMPASS by *city to road*, *rail to road* and *air to road* connectors. This can be achieved via a number of different ITS solutions applied to urban and metropolitan motorways, such as the implementation of dynamic speed limits, active hard-shoulder management, or ramp meters in accesses (infrastructure management dimension). It can also be addressed with smarter on-board route assistants for vehicles that consider real-time congestion on the network, Advanced Driver Assistance Systems (ADAS) that allow for more stable traffic flows, or with traffic jam assistants that allow quicker dilution of congestion waves (service management dimension).

Rail modal share decreases initially but then recovers between Mid and High/Very High ICT scenarios

It is observed that while the rail modal share decreases from 6.2% to 5.8% between the Baseline scenario and the *MidICT* Scenario, it is then able to recover its initial share of 6.2% between the *MidICT* Scenario and the *VeryHighICT* Scenario.

The reason behind this behavior is the different speed increases on each of the transport modes in the long distance segments of the network (e.g. in the HSR, motorways, air flights and ferries). Whereas between the Baseline and the *MidICT* scenario, the road mode increases network speed on a 2.5% and the air mode in 5.0%, the rail mode is assumed not to increase. Then, between the *MidICT* and the *HighICT* Scenarios, the rail mode begins increasing speed, up to 5% in the *MidICT* Scenario (7.5% for road and 10% for air) and 10% in the *VeryHighICT* Scenario (12.5% for road and 15% for air).

When rail gains operational speed, it also gains competitiveness against other modes in a much faster proportion, allowing it to recover initial modal share. The air mode, compared, is not able to materialize the greater increase in average operational speeds, and keeps losing modal share from 23.0% in the Baseline to 22.7% in the *MidICT* Scenario to the 21.8% in the *VeryHighICT* Scenario.

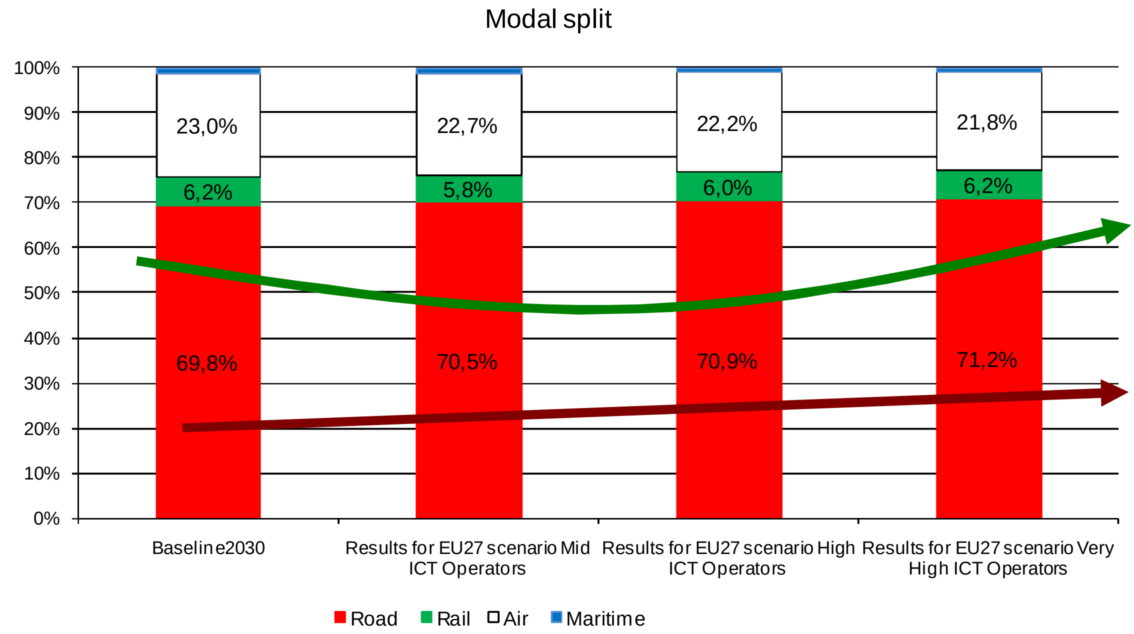


Figure 15-4 Modal Split variation between COMPASS scenarios. Scenarios impacting on service and infrastructure management.

Impacts seem more important for mid and long distance trips, with lengths above 1000km. Between 1000km-2000km, air and road-air trips tends to win against pure road. Beyond the 2000km, it would seem that road-air chains win over pure air segments.

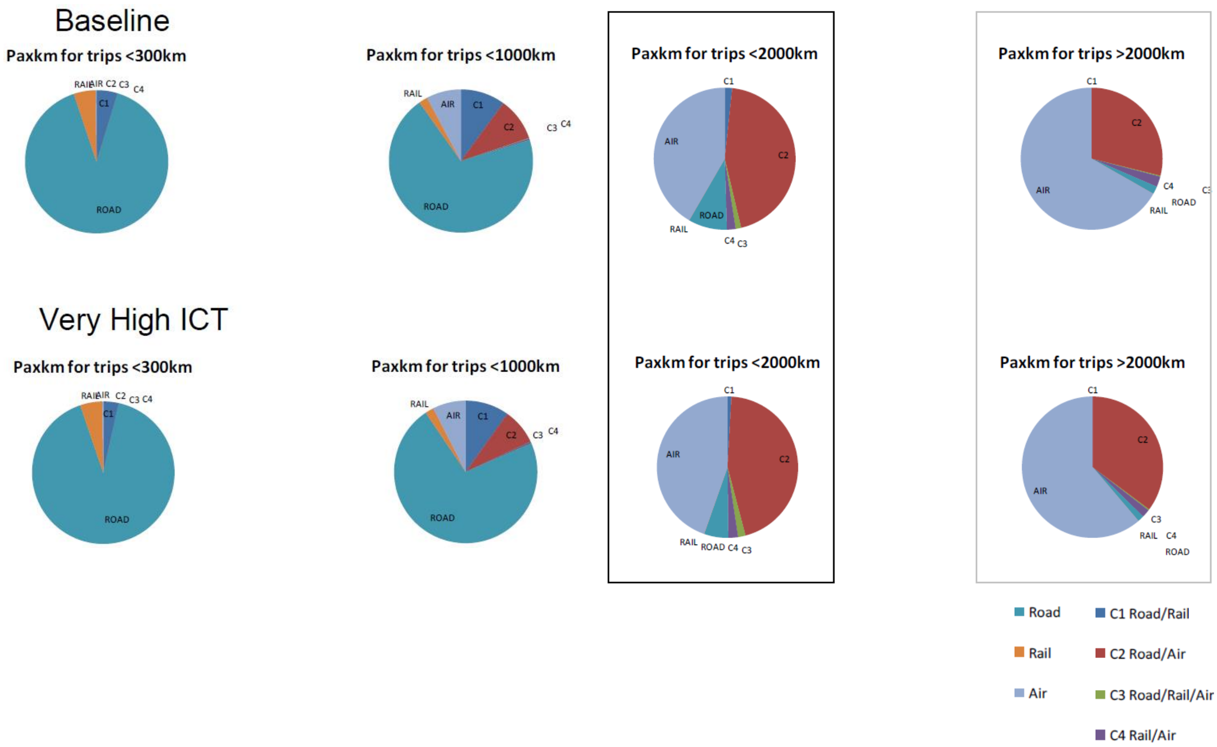


Figure 15-5 Modal Split variation between COMPASS scenarios for different trip ranges. Scenarios impacting on service and infrastructure management.

Business travellers seem to confirm these trends more clearly. Road-air chains win over pure air segments. More performance of roads allows user to access the air network from an airport located a bit further from origin than before.

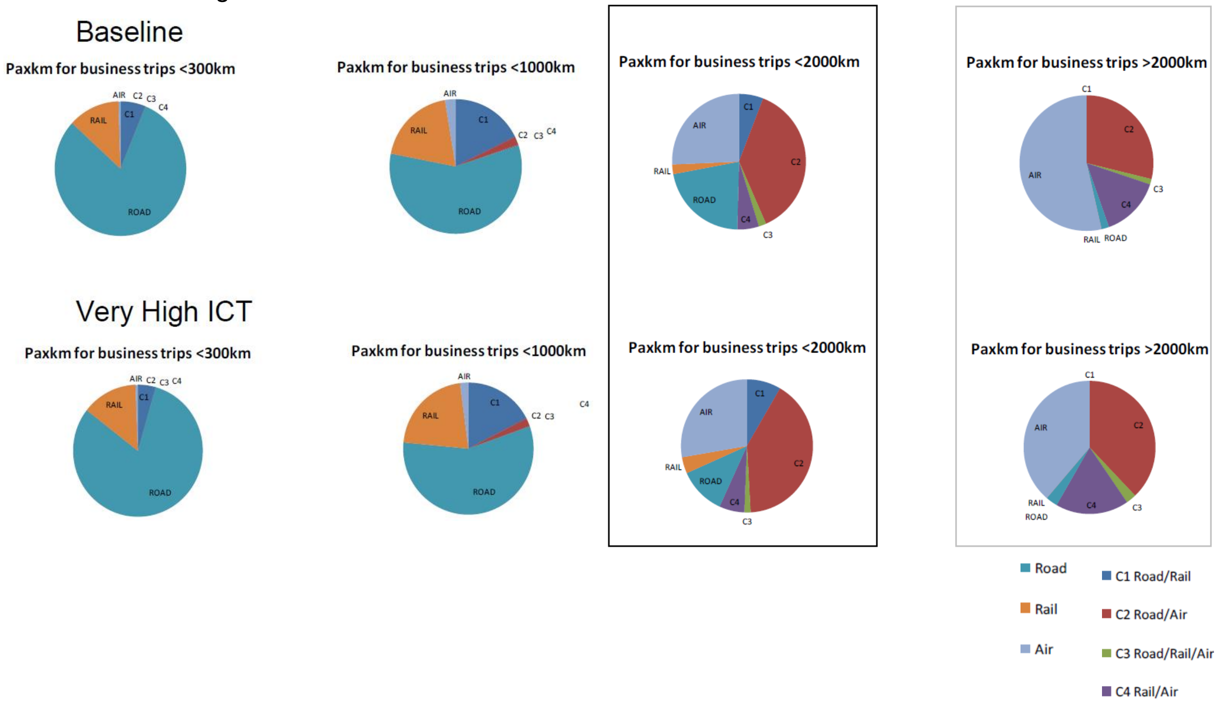


Figure 15-6 Modal Split variation between COMPASS scenarios for different trip ranges and only business travellers. Scenarios impacting on service and infrastructure management.

The speed increases in the air mode are assumed to derive from more direct routing of flights facilitated by more integrated air space management (already tested by EUROCONTROLõs FRAM pilot initiative above the skies of Maastricht); it is also assumed that planes can fly closer to each other thanks to more accurate radars (satellite based ADS-B successor to radar); and that take-off and landings are faster at airports as surface movements become optimally managed with new initiatives such as A-SMGCS. Ensuring better punctuality of flights allows for faster terminal transits during plane connections, which can get reduced from 90 to 30 minutes (according to ACAREõs ñFlightpath 2050ò the goal is to reach that all flight arrive within 1 minute of the planned arrival time regardless of weather conditions).

Speed increases in the rail and road modes derive from technologies ensuring safety at higher speeds. In the case of rail, ERTMS is to allow for greater operating speeds (as trains are able to autonomously regulate operating speeds and automatically break in case of emergency with lower reaction times) and services can operate closer to each other (more service frequencies in busiest corridors). For cars, many devices aimed at increasingly autonomous driving regimes (e.g. ADAS, car platooning like in SARTRE, robotically driven cars such as Audiõs TT trial or Googleõs) allow for increased driving speeds at motorways without compromising safety, vehicle-to-vehicle communications on VANET platforms (Vehicular Add-hoc Networks) allow anticipating incidents on the road before vehicles reach hot spots, or even vehicle-to-infrastructure communications allow for vehicles anticipating bad road conditions or eventual traffic speed restrictions.

VeryHighICT Scenario results on less network usage in passenger·kilometres

A decrease of -0.25% passenger kilometres for very high ICT scenarios. This suggests that moving traffic from air and rail modes to the road results in slightly shorter trips.

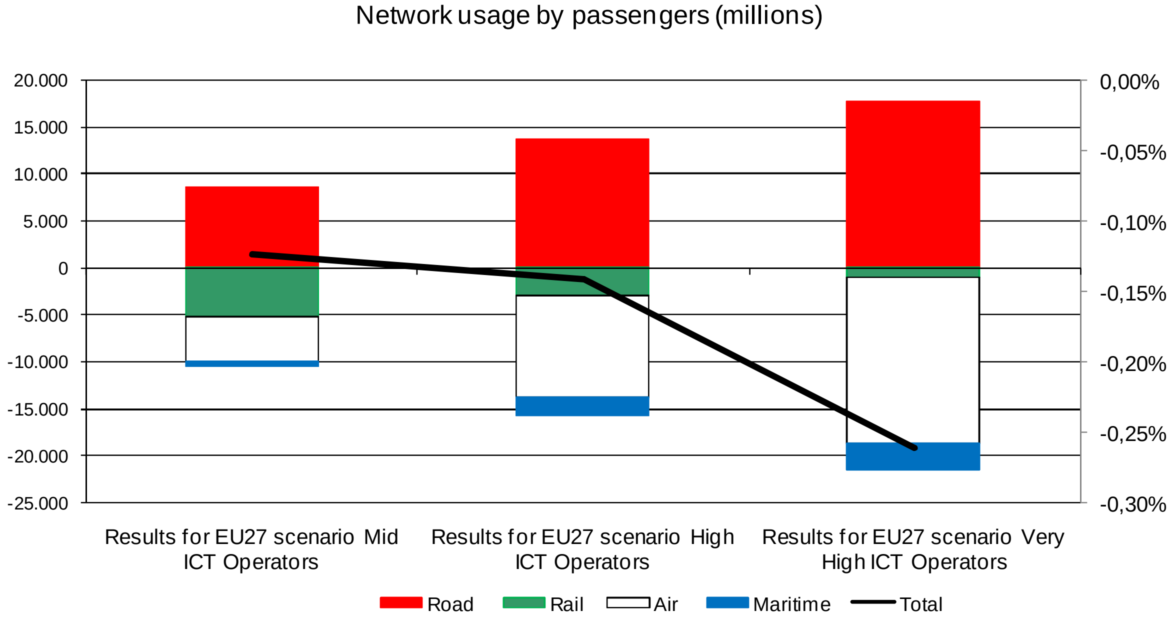


Figure 15-7 Network use by passengers (pax kilometres). Different ICT Scenarios impacting on service and infrastructure management

Modal shift from air, rail and maritime to the road implies more vehicles on the network, up to 1.8% increase

The increase in use of road mode results in up to 1.8% increase in the number of vehicles in the network. This seems contrary to the fact that passengers-kilometre decrease a little, but is explained due to the modal shift from air, rail and maritime to the road, as these modes use high occupancy vehicles translating in a large number of cars needed to substitute them. Large number of cars are needed to substitute air, rail and maritime services.

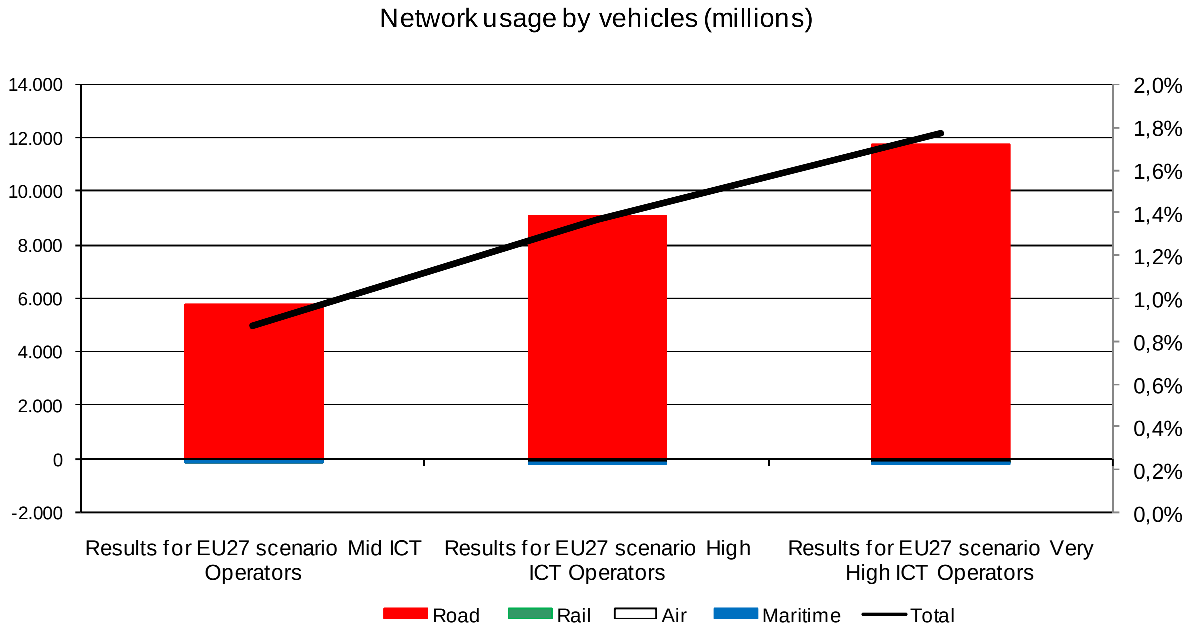


Figure 15-8 Network use in vehicle kilometres. Different ICT Scenarios impacting on service and infrastructure management.

Increased fuel consumption and CO2, but decreasing particles

A modal shift from air, rail and maritime to the road implies an overall increase on fuel consumption, up to a 4.5% respect to baseline.

The increase in the use of road (more vehicle kilometres driven yearly) increases road fuel consumption. The increase is greater than the decrease in air and maritime fuel consumption (under the hypothesis that engine efficiencies are not relatively altered between scenarios and modes).

Vehicle kilometre increases in the road mode are driven by the attraction of passengers in a mode where vehicles have less capacity (road is less occupancy-efficiency). Also, speed increases on the road, air and maritime modes increase the overall levels of fuel consumption.

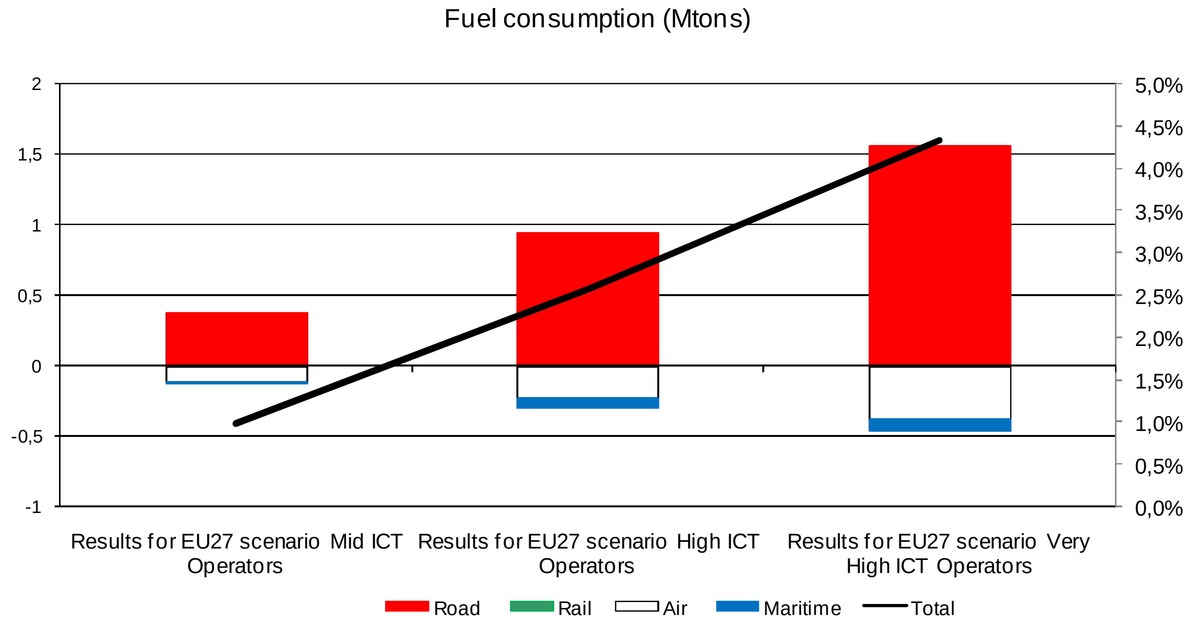


Figure 15-9 Fossil fuel consumption. Different ICT Scenarios impacting on service and infrastructure management.

Following the trend of growth in fuel consumption, the CO2 emissions increase accordingly up to 4.2%. Emission factors are kept stable among scenarios, as no ICTs applied to emission reductions of vehicles are considered in COMPASS.

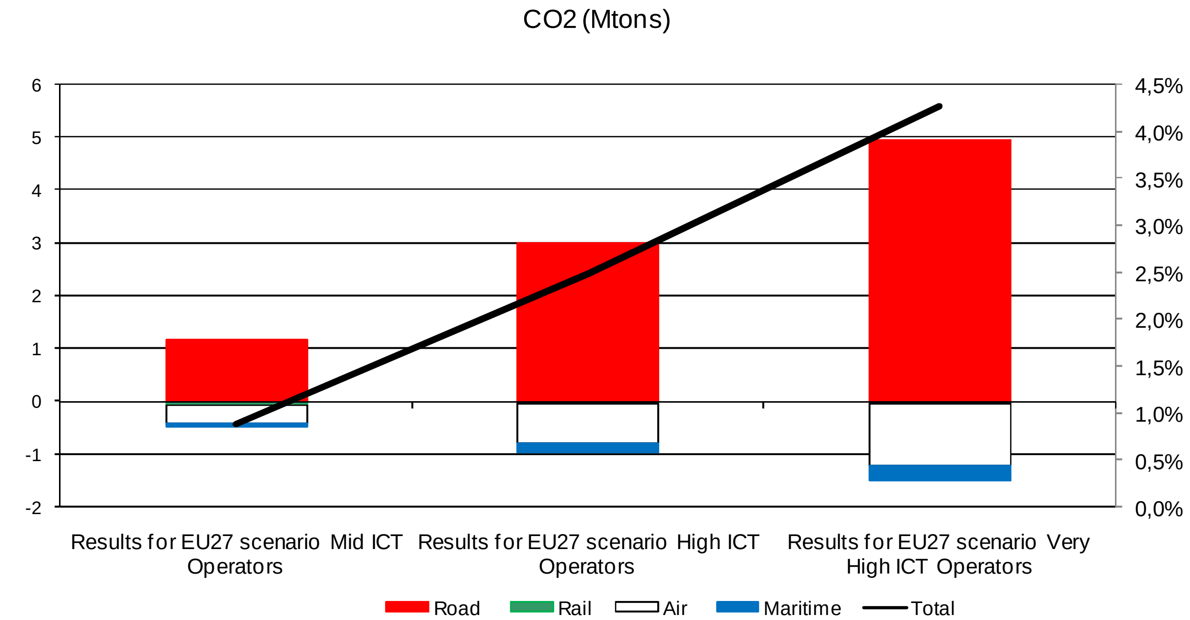


Figure 15-10 CO2 emissions. Different ICT Scenarios impacting on service and infrastructure management.

An overall decrease on particulates emissions is registered, up to almost 7%, due mainly to reduction of maritime and air traffics. These modes are the most particulate-emitters.

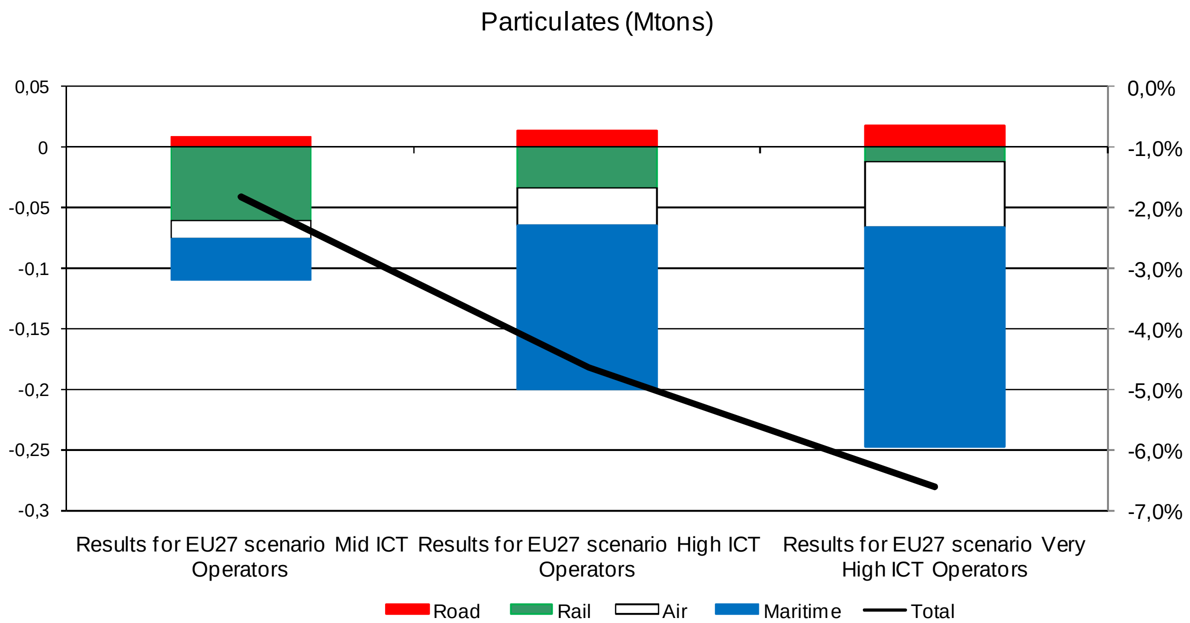


Figure 15-11 Particulate matter emissions. Different ICT Scenarios impacting on service and infrastructure management.

Decreased travel time as operational speed increases in all modes with ICT implementation

Travel Time in the network decreases, due to management measures that increase the average speed in all modes (exogenous) and in the interconnections between them. Especially important is the decrease for the road mode given that road has the biggest modal share

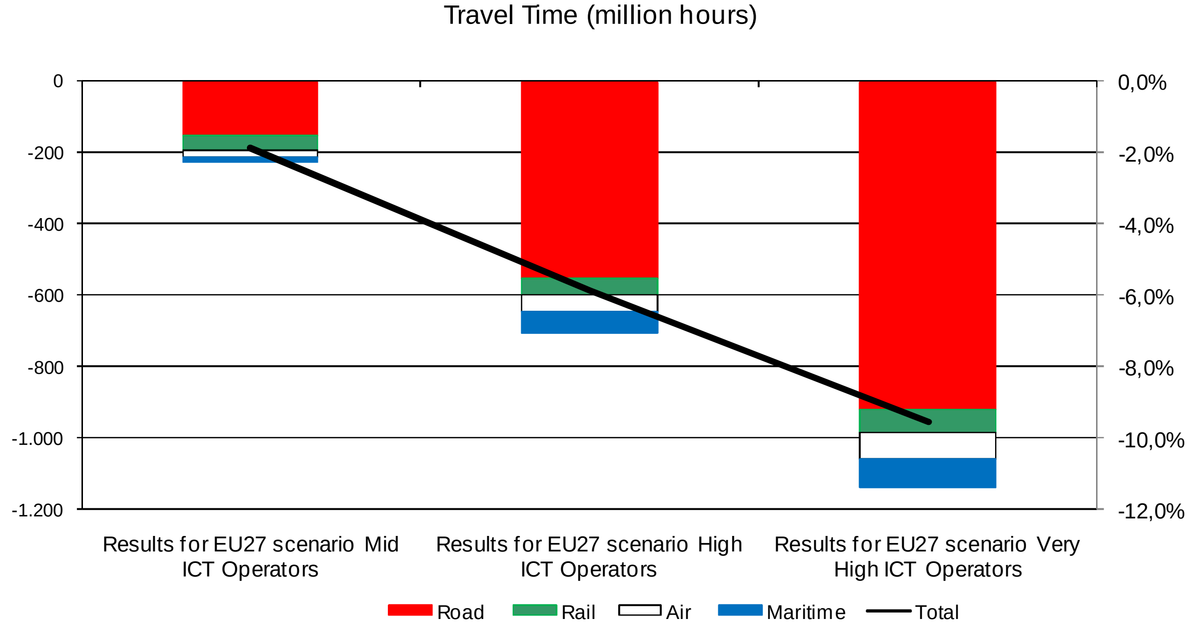


Figure 15-12 Travel time spent in the transport system. Different ICT Scenarios impacting on service and infrastructure management.

15.4 Impacts Resulting from Changing Travellers Behaviour and Perceptions of Travel Time Cost Driven by ITS

15.4.1 Approach

The following figures show the variation of values for different indicators between the Baseline scenario 2030 and the 3 scenarios defined by COMPASS: Mid ICT / High ICT / Very High ICT scenarios.

These scenarios consider only changes derived from traveller behaviour and his perception of his personal value of travel time.

In all figures the variation in each different mode is shown by bars and scaled according to the left axis, while the total variation is shown in percentage by the black line and scaled according to the right axis.

15.4.2 Discussion of results

Decreased travel time costs perception as a result of better information and comfort favours road preferentially

According to literature, the value users place on travel time varies depending on the type of trip, peopleĝs preferences, and travel conditions (read background literature in chapter 15.2.3 of this report). The impact of ñsoft-factorò solutions addressing user comfort and convenience is assessed in COMPASS by testing how the model responds to reductions in the value of travel time of users. In particular, the value of travel time is lowered evenly for all passengers alike (business, private and tourists) and in all modes of transport, a total of -5%, -10% and -15% in relation to Baseline for the *MidICT*, *HighICT* and *VeryHighICT* Scenarios respectively.

The presumed impact is the increase of road modal share, from 69.8% in Baseline to 71.1% in *VeryHighICT* Scenario. ICTs, provided that they are able to impact evenly on the perception of travel time costs on users in all modes the same, increase the attractive of the road mode more than others.

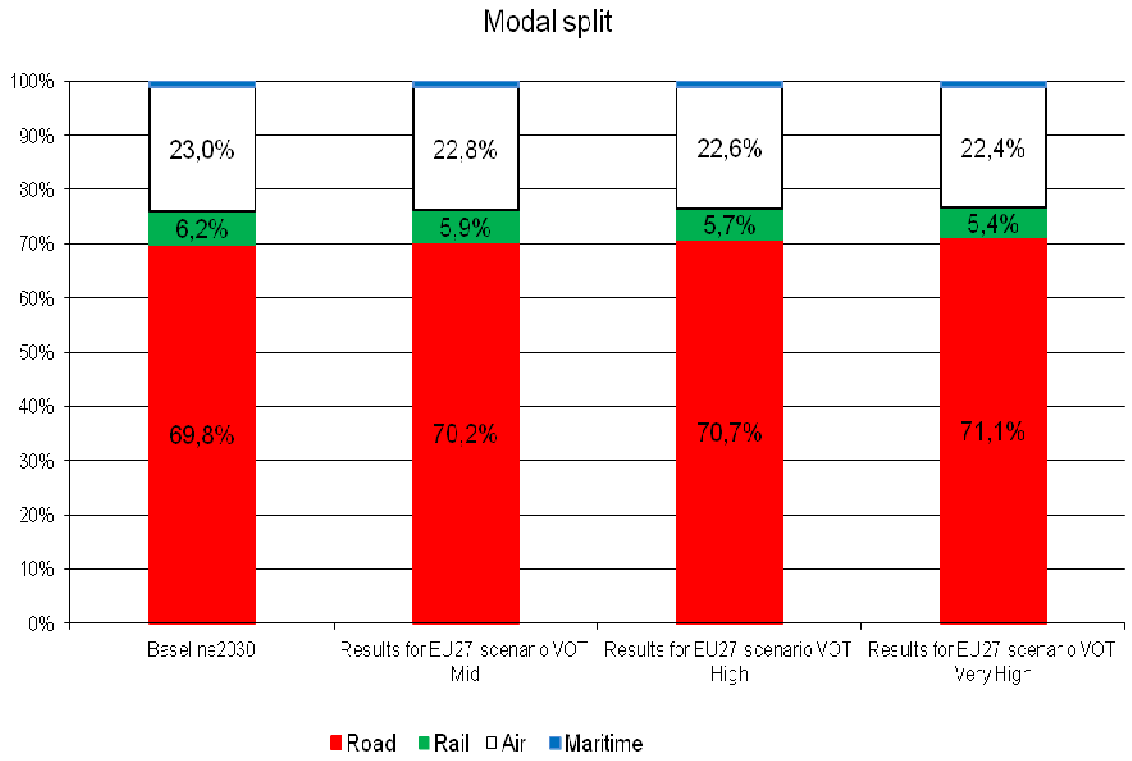


Figure 15-13 Modal Split variations among COMPASS scenarios. Scenarios impacting on user perception of travel time costs.

It is discussable to what extent ICTs can impact on all modes alike:

- On public transport modes (i.e. air, rail and ferry), there are many ñsoft factorò solutions which have an impact on the way users perceive travel time. Real time information to users on service operation reduces the uncertainty of passengers when waiting at stops. Collaborative P2P information networks on public transport service operation and eventual service disruptions allow passengers to seek for alternatives, or to handle exceptional situations with lower levels of stress. Travel planners on smart phones allow users to seek routing assistance at all times, reducing the possibilities of using wrong travel choices or getting lost. Increased amenities in vehicles (e.g. WiFi internet) or allowing more informed pre-trip seat choices (e.g. seat allocation in planes based on social network profiles, or on collaborative P2P aircraft information as in SeatGuru) allow more convenient and comfortable journeys, especially on very long trips.
- On the other hand, Litman (2011) points out that the road mode seems to be the mode that better understands the willingness of passengers to maximise their comfort and convenience. In fact, the basic engine and safety performance of vehicles these days is ensured by all makes alike provided that drivers respect road regulation (e.g. speed limitations, minimum resting during longer trips, no drug use, no drinking). The vehicle industry is therefore constantly working on increasing the comfort of cars to provide added value to car owners.
    - More spacious interiors, better materials, less noise from the engine, more performing entertainment systems (e.g. music, DVD) increases the comfort of users and passengers.
    - Having pioneered in route planning applications with early GPS devices, new vehicles now increase the information to users by considering real time congestion when proposing routes, and with many new possibilities rising from upcoming systems such as VANET.

- Semi-automation solutions for most bothering driving operations are in constant development, such as automatic vehicle parking assistants, traffic jam assistants and smarter cruise control devices
- New ICTs to ensure that vehicles are safer in all traffic and weather conditions (e.g. head-up display, night vision, automatic pedestrian detectors, pre-crash systems), reducing the levels of stress of drivers.

In it clearly user-targeted strategy, the car industry is successful in constantly reducing the perception of travel time cost by users. All these ñsoft-factorsò not having direct impacts on travel time may result in a given journey being perceived as shorter for an auto compared to other modes, especially for trips under a certain range threshold. For longer trips, the rail mode is most likely to take this approach compared to the air mode.

Increasing vehicle occupancy a 50% results on a 39% vehicle kilometres reduction, and 24% fuel consumption and emissions decrease

In COMPASS it is checked the impact of increasing vehicle occupancy. The increase in vehicle occupancy is derived from policies favouring behavioural changes, which can be more easily applied thanks to ITS, like HOV discounts at tolls (e.g. in the Sant Cugat COMPASS case study - see previous chapter), or HOV/HOT lanes in metropolitan motorways. It is also the result of the implementation of applications allowing to share vehicles with other users, like car pooling platforms already much popular in northern Europe (e.g. www.carpooling.com).

The occupation of vehicles in MOSAIC model is an exogenous assumption. It is modelled in COMPASS only to asses how the impact of car occupation increases are transmitted onto all the other indicators in the model.

In COMPASS, it is assumed an increase of average car occupation from 1.5 occupants/vehicle in the Baseline, to 1.75, 2.00 and 2.25 in *MidICT*, *HighICT* and *VeryHighICT* Scenarios respectively. A direct result is an important impact in the number of cars on the road, with vehicle-kilometres decreasing up a 39% in the *VeryHighICT* Scenario.

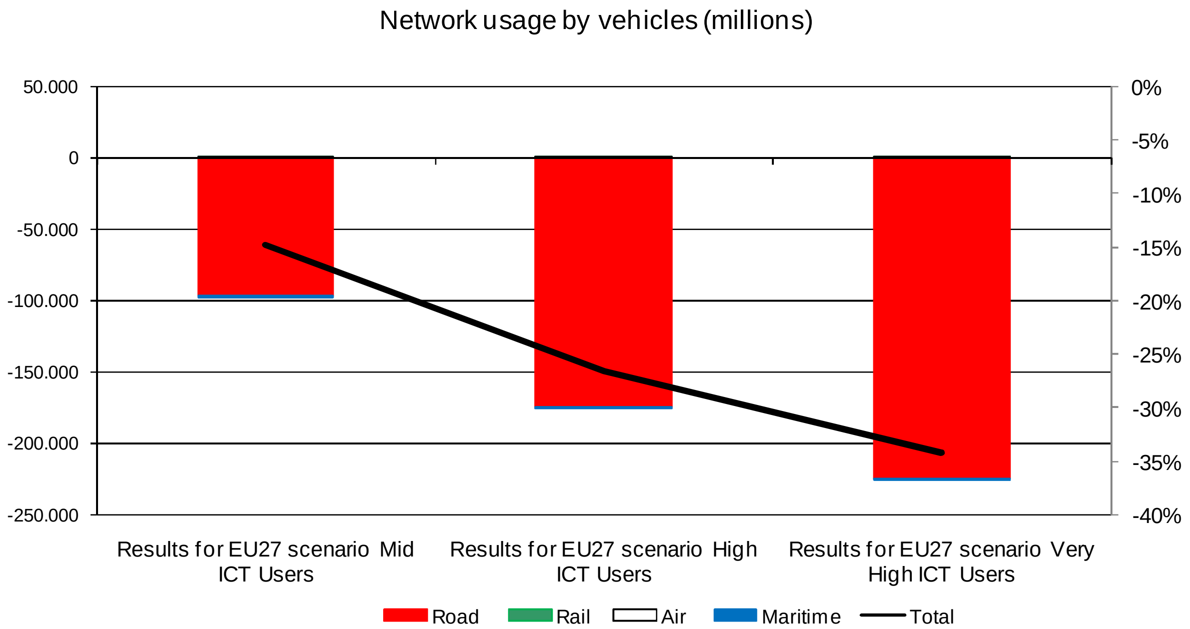


Figure 15-14 Network use in vehicle kilometres. Scenarios impacting on increased vehicle occupancy

39% less vehicle·kilometres on the road network has an important effect in the fuel consumption, decreasing it by almost 24% in the *VeryHighICT* Scenario. The CO2 emissions decrease with the reduction of vehicles at almost the same level as the fuel consumption.

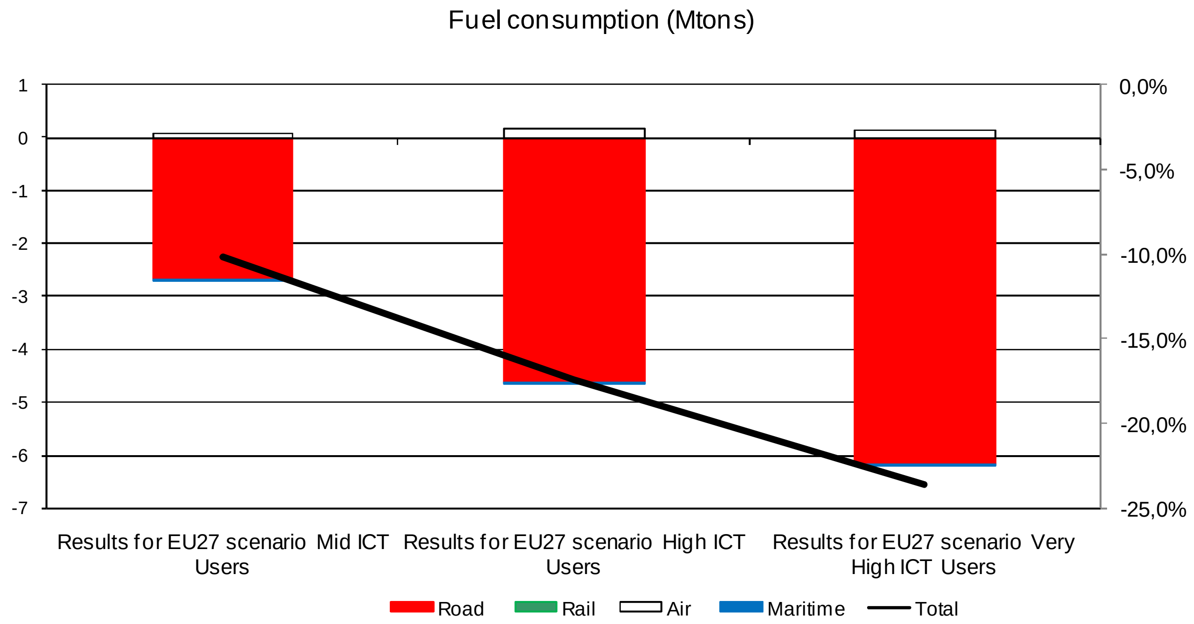


Figure 15-15 Fossil fuel consumption. Scenarios impacting on increased vehicle occupancy

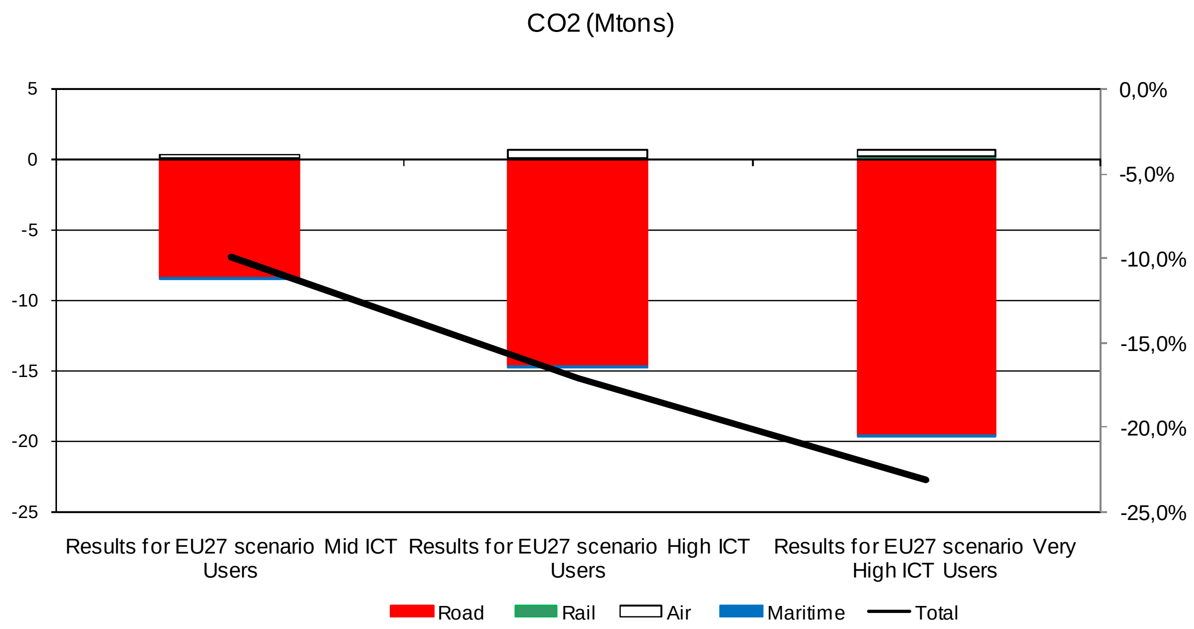


Figure 15-16 CO2 emissions. Scenarios with impact on users.

15.5 Conclusions

From the analysis of COMPASS case studies and the solutions discussed by the COMPASS Handbook of ICT Solutions, the following potential impacts of ICT are established, being at the basis of the modelling exercise for EU-wide assessment in COMPASS:

- Transport demand induction / substitution: ICT may provide with more trips, with more added value
- More efficient infrastructure plans & management: resulting on better cost-effectiveness of transport services
- Online collaborative and collective mobility: promotes increased vehicle occupancy
- Seamless travel: faster intermodal connections
- Smart vehicles: new hybrid modes collectively managed for individual use
- Increasing safety: towards zero accidents by 2050
- Increasing comfort in the travel: willingness to spend less money to save travel time
- Improved service and route planning: lower fees to be paid by passengers
- Just in time intelligent traffic management: more reliable commercial speed of transport

Based on the results of the COMPASS modelling activities, the next five points are proposed to synthesise the potential impact ICTs on EU-wide transport:

1. **Limited ICT impacts on modal split**. With increases in the road modal share from 69.8% in the Baseline to 71.2% in the Very High ICT scenario, and with decreases on the air modal share from 23.0% in the Baseline to 21.6% in the Very High ICT scenario, the impacts of ICT solutions on modal split can be stated to be relatively limited overall. ICT may likely result in a positive reduction of transport costs.

2. **Moderate increases on long-distance vehicle kilometres on the road network**. From 1.0% to 1.8% increases for COMPASS scenarios in relation to Baseline. The increase in road modal share results on more vehicles on the road, and more CO2 emissions. This effect may be counterbalanced by increased vehicle occupancies thanks to ICTs.

3. **Vehicle higher occupancy results on much less vehicle kilometres**. ICTs aimed at increasing the occupancy of cars and the load factors of airplanes and trains seem to lead to most significant road mode traffic decreases on vehicle kilometres. The potential impact of ICTs on increasing occupancies seems significant as they allow increased passenger to passenger collaboration (e.g. ride sharing) and better management of vehicles by operator (ticket sells, boarding).

4. **ICT may likely result in a lesser user's willingness to pay to save time**. With increased travel comfort, in-vehicle amenities, better real-time traveller information (soft factors) passengers may be willing to spend more time travelling in relation to less comfortable or reliable modes. This may favour cars in relation to public transport for urban areas, and rail in relation to air for mid and long distance travel.

5. **ICT may likely result in an increase of Co-modality**. Assuming all modes implementing ICT to improve its competitiveness, each mode may promote its competitive advantages. Impact on interconnectivity can be a moderate increase, if only marginal improvements on modal transfers are achieved.

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NICHES+ project *(* http://www.niches-transport.org/).

ORIGAMI project (Optimal Regulation and Infrastructure for Ground, Air and Maritime Interfaces) was concerned with improvements in long-distance door-to-door passenger transport chains through improved co-modality and intermodality (http://www.origami-project.eu/).

United Kingdom Census 2011-
http://www.gro-scotland.gov.uk/statistics/theme/population/estimates/mid-year/2012/index.html

TMfS07 National Road Model Development Report
http://www.transportscotland.gov.uk/analysis/LATIS/library/National-Model-Reports/tmfs07.

APPENDIX 1

SPQR DESCRIPTION OF MOSAIC MODEL

MOSAIC MODEL DESCRIPTION

The next table presents the structure of MOSAIC model, specifying the data (or samples), the formulation (or postulates), the queries the model can address, and the results it can produce. The inputs and outputs of the model are detailed thereafter.

MOSAIC Specification
(Source: ESPON ET2050 2012)

NAME	MOSAIC
BACKGROUND	
Last update	2011
Developer	MCRIT based on TRANS-TOOLS (TT) previous developments.
Developed in the project	7th EU Framework Programme (INTERCONNECT)
Ownership	MCRIT co-financed by EC. No commercialised.
Main applications	TT is the best state-of-the-practice transport-oriented forecast model available at EU level. DGMOVE has required the application of TT model in all studies carried out during the last years in the process to redefine the Transeuropean transport networks and the new Transport White Book 2010-2020. TT model is being continuously improved in different projects of the 7^{th} European Framework Programme. In the INTERCONNECT (2010) MCRIT developed the MOSAIC model, based on TT trip generation and distribution results, being also applied in ORIGAMI (2011-2012) to assess four different transport policy-scenarios for 2030.
Documents of reference	INTERCONNECT Final Report (www.interconnect-project.eu)
Scientific papers	TRA2012 î*Impacts of improving interconnectivity between local and long-distance transport networks in Europe: Conclusions from the modelling activities in the INTERCONNECT 7th EU Framework Programme project*ò
Running time	12 hours
Size of total results	16 Gb
Data exchange format	Results can be provided in MDB format
Software platform	BridgesNIS (proprietary software programmed in C++ by MCRIT) linked to most GIS packages, especially Geomedia Intergraph. Tutorial and guide under development.
S A M P L E S	
Reference data from	2005
Data for calibration	MOSAIC internal parameters are calibrated with TT 2005 results.
Data inputs	Multimodal Transport Networks (50.000 links) including detailed intermodal exchanges and proxy to long-distance passenger services. Information restricted.
	TRANSVISIONS socioeconomic, trip generation and distribution databases 2005-2020-2030 produced by TRANSTOOLS for baseline scenarios at NUTS3 level. Publicly available information.
P O S T U L A T E S	
Forecast reliable up to	2030
Geographic coverage	EU27 and neighbouring countries
Adm. desegregation	NUTS3
Thematic scope	Passengers (freight not included)
Theory of TT-MSAIC	Integrated modal split and assignment for passengers applied to TT trip distribution matrices

Theory of TRANSTOOLS (TT)	4-steps passenger and freight transport model see: http://energy.jrc.ec.europa.eu/transtools/
QUERIES	
Transport supply-oriented policies	How *infrastructure provision policies* (new infrastructure) may change traffics in the networks?, induce modal shifts?, change energy consumptions and emissions?, accidents?, increase accessibility?
Transport market regulatory policies	How *pricing and subsidy policies* may change traffics in the networks?, induce modal shifts?, change energy consumptions and emissions?
Technologic innovation	How changes on *vehicle technologies* may change traffics in the networks?,, induce modal shifts?, change energy consumptions and emissions?, accidents?
RESULTS (Main families of indicators)	
Transport endowment	Aggregated, by NUTS3, by mode
Infrastructure investment	Aggregated, by NUTS3, by mode
Costs of travelling	Between NUTS3 by trip purpose using optimal transport chains
Time of travelling	Between NUTS3 by trip purpose (business, visit, inter-NUTS3 commuting, holydays)
Accessibility	Surface, people or activities (GDP) at a given distance or time or cost from a given place
Trips	Between NUTS3 by trip purpose (business, visit, inter-NUTS3 commuting, holydays)
Modal shares	% trips between NUTS3 by trip purpose (business, visit, inter-NUTS3 commuting, holydays)
Modal chains	% length or time or cost between NUTS3 by trip purpose (business, visit, inter-NUTS3 commuting, holydays)
Emissions	CO_2, PMx, NOx by network link, aggregated at NUTS3 or NUTS0
Typical graphic output (maps, diagrams)	Maps with traffics on transport links Accessibility maps displayed by 5x5 km2 cells Maps with patterns for NUTS3 Time lines for key indicators aggregated at different scales
DATA MANAGEMENT IN NON EU27 COUNTRIES	
ESPON space countries *(Iceland, Norway, Switzerland and Lichtenstein)*	Networks and travel data available, at a lower resolution than in EU27 countries. Data available for all ESPON partner countries
Accession countries *(Western Balkans and Turkey)*	Networks and travel data available, at a lower resolution than in EU27 countries. Data available for Western Balkans and Turkey
Neighbouring countries	Networks and travel data available, at a lower resolution than in EU27 countries. Data available for Ukraine, Belarus, Russia. No data available for Northern Africa nor Middle East.