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² The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

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Executive Summary

OPTIMISM's main objective was the creation and development of different sets of strategies and methodologies for optimising passenger transport systems based on co-modality ICT solutions.

OPTIMISM also took into consideration passenger needs and the carbon-neutral objective. The main scope was to provide a scientifically documented insight into the transport system and people's travel choices via the study of social behaviour, mobility patterns and business models. This also allowed the definition of future changes in the passenger travel system that would lead to more sustainable method/mode(s) of travelling.

OPTIMISM based its operating principles in three main blocks of activities: 1. Identifying the gaps in and harmonisation of data in travel behaviour. This led to a unified set of data that will serve as reference material for future exploitation of existing studies and baseline information (or data) 2. Definition of the demand and supply factors that shape the transportation system and mobility patterns. This aimed to give an outlook on future development(s) by modelling and scenario simulation, and 3. Defining the potential decarbonisation of the passenger transport system and ensuring the sustainability of the system. The decarbonisation potential and co-benefits of best practice(s)/solutions were based upon an analysis of ICT and co-modality options with an impact assessment of the research results.

The project's main outcomes have been the following:

- Comprehensive analysis of National Travel Statistics in Europe
- Recommendations on harmonization of travel behaviour analysis
- A list of potential megatrends influencing transportation system and mobility behaviour
- Scenario simulation for mobility behaviour concerning future trends at macro level
- Agent based model at micro level representing demand and technology at local scale
- Decarbonisation potential and co-benefits of the best practices
- Framework for assessment of co-modality/ICT options and FP7 projects
- Definition of strategies for integrating and optimising passenger transport systems
- Report on impact of best practices on mobility patterns
- Recommendations on the principles of sustainable mobility

Project context and objectives

A goal of the EU is to establish a transport system that meets society's economic, social and environmental needs and conducive to an inclusive society and a fully integrated and competitive Europe³. The ongoing trends and future challenges point to the need for satisfying rising demand for travel or 'accessibility' in the context of growing sustainability concerns and in the context of an ageing population. The most immediate priorities appear to be the better integration of the different modes of transport as a way to improve the overall efficiency of the system and the acceleration of the development and deployment of innovative technologies within an approach that always keeps transport users (of all ages) and workers, with their needs and rights, at the centre of policymaking. Although a great number of studies have been carried out, at both National and EU levels, on mobility behaviour, there is still no single reference point where all the information can be found. The lack of coordination between the cross-European analyses leads to underutilized results.

OPTIMISM's scope is to provide a scientifically documented insight into the transport system and people's travel choices via the study of social behaviour, mobility patterns and business models. The overall aim of OPTIMISM project is to define which of the future changes in the travel system would lead to a sustainable way of travelling, as people could travel more efficiently, cleaner and more safely, without compromising mobility.

The project aspired to propose a set of strategies, recommendations and policy measures, through the scientific analysis of social behaviour, mobility patterns and business models, for integrating and optimising transport system, based on the modelling of the assessment of the impact of co-modality and ICT solutions for transport.

TRANSTOOLS and TREMOVE models were used for the simulation of the trends at macro level for the scenarios defined in the Delphi analysis while JRC Agent Based transport model was used to model the reaction of specific users to trends in demand, supply and technology at local scale for each of the scenarios.

The figure below illustrates the main concept of OPTIMISM:

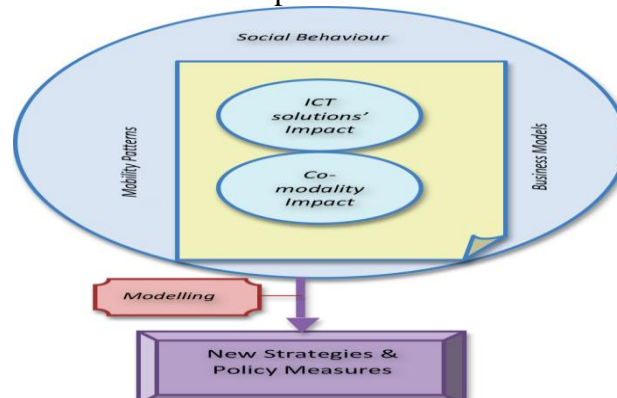


Figure 1: Optimism's main concept

The OPTIMISM project aimed to contribute to a more sustainable transport system in Europe, by focusing on passenger transport behaviour. Sustainable mobility is understood as

³ European Commission (2009), Memo: Future of Transport Communication, Brussels

a long term vision that needs to be achieved in the context of achieving a more inclusive and competitive society and economy in a continuous changing context. For example, the fact that Europe is now experiencing a rapidly ageing population will bring new challenges in terms of how we provide good quality, sustainable transport systems that meet the needs of European citizens.

The specific objectives of OPTIMISM were to:

- Gather, analyze and harmonize the national travel data statistics, which are based on different methodologies.
- Identify and classify the key factors defining the demand for different passenger transport modes and different types of travel (e.g. Gender, age, income, market forces, internet penetration)
- Assess the impact of co-modality and ICT solutions for passenger transport especially based on their decarbonisation effect.
- Develop a modelling technique that will result in new and improved service offerings that promote and encourage changes based on best practice
- Develop recommendations for strategies, technologies and methodologies for the integration and optimisation of the transport system for supporting the aim of sustainable mobility.

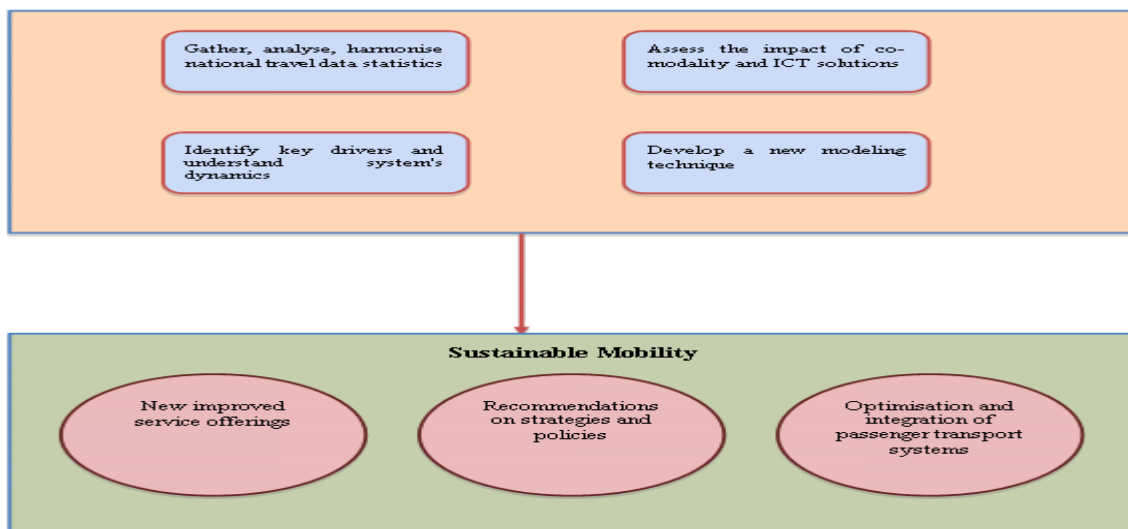


Figure 2: Interrelation among project's objectives

A detailed analysis of the objectives is presented below:

Gather, analyze and harmonize the national travel data statistics, which are based on different methodologies.

The basic element was to reveal and realise the functions of the transport system and passenger needs. Designing efficient passenger transport modes and/or improving mobility by travel information services requires meeting and exceeding the needs of all users, at least the majority of them. Therefore, there was a necessity to identify how and why needs arise and how surrounding conditions influence them. To find the key drivers of the system and to quantify their influence on the system was one of the main objectives of the OPTIMISM project. Statistical data was used to generate knowledge on this issue – to analyse mobility patterns as well as their influencing factors. As statistics are based on different methodologies

their uncritical may use mislead conclusions and scientific results, thus a harmonisation exercise took place from which recommendations on good practice were derived.

Identify and classify the key factors/drivers for of passenger transport demand for different transport modes and different types of travel motives (e.g. home-work trips)

A prerequisite of influencing the system is to understand the dynamics involved. The system of transport and mobility works as a market. The analysis of the key drivers of mobility helps to model the demand side while, on the supply side, traffic infrastructure and new technologies have to be included. To estimate the future development of demand and supply (and the needs and possibilities to influence them with the objective of decarbonisation) it is necessary to identify the main influencing trends. OPTIMISM was designed to integrate those megatrends with regards to their impact on the current system as well as in the future. Metanalysis on megatrends provided a deep understanding on this issue, estimating their impact on demand and supply factors of the mobility and transport system

Enhancing co-modality by assessing the impact of ICT solutions for passenger transport especially based on their decarbonisation effect.

The direction of technological development affects the potential for decarbonisation. The technology of travel information systems is expected to provide solutions for managing the future challenges for transportation and mobility. According to the TRANSvision study (2009), the impact of ICT on transport is a much debated and still controversial issue. Indeed, overall impacts can be of two contrasting effects (related to GHG increase or GHG reductions): A. Stimulating more travel as new opportunities become available; B. Substitution for travel as some activities can now be carried out remotely rather than by travel. In which area these expectations will be fulfilled depends on the technological progress: do new technologies fit the future needs for mobility and how big is their potential contribution to decarbonisation? To answer this question, it was necessary to estimate the impact of ongoing trends concerning demand for mobility and to weigh them against technological development in ICTs as well as in transportation technologies. OPTIMISM focused on the analysis of the potential of ICT-solutions and co-modality without neglecting the importance that ICT tools can play a role into substituting for travel. However, since the main aim was not to compromise mobility, an overview of best practices (containing results from FP7 projects) was provided and used as a guideline to elaborate a catalogue of effective measures. The impacts of these measures on mobility patterns and environmental indicators were estimated. Within the framework of the project, we used a narrow definition of co-modality: this means that we considered ICT options which support multi-modal and/or intermodal passenger transport.

Develop a modelling technique that will result in new and improved service offerings that promote and encourage changes based on best practice

Knowledge on megatrends addressing future development can only partly be generated by statistical analysis (e.g. by figuring out ongoing trends). Megatrends are the changes that have a character of being fundamental, long lasting (more than 10 years), global or international transformation processes with a certain direction, including the economic and the socio-cultural dimensions, and affecting multiple aspects of life. To estimate future trends influencing transport and mobility requirements it is necessary to include knowledge beyond statistical data. Some trends of economic and social development are too complex to be

identified by statistical analysis alone. OPTIMISM aimed to give a solid base for future challenges concerning mobility by a synthesis of statistic based trends and experts' points of view. Expert interviews on impacts of megatrends and key drivers covered this part of knowledge generation. The findings defined the parameters of the modelling technique which was used to develop future scenarios. The models, which were already available, were modified and applied taking into consideration the new elements:

1. TRANSTOOLS and TREMOVE models were used for the simulation of the trends at macro level for the scenarios defined in the Delphi analysis
2. Agent based transport model was used to model the reaction of passengers against changes of some mobility system characteristics under certain constraints of transport service capacity and traffic congestion at local scale

Develop recommendations on strategies, technologies and methodologies for the integration and optimisation of the transport system

The success of measures for decarbonisation depends on their feasibility. Principles of sustainable mobility and starting points for decarbonisation were formulated. The OPTIMISM project defined strategies for integrating and optimising the transport system. With the estimated decarbonisation potential of different technologies, a set of measures was proposed. This included: defining the linkages between the various individual measures, timing of their implementation, how these strategies could be institutionalized as well as a providing relevant business cases.

Policy and planning are used to be confronted with unforeseen development. Concrete measures will not provide comprehensive solutions. A major objective of the project was to make the elaborated knowledge valuable; therefore, general guidelines for policymaking and transport planning were developed. OPTIMISM aimed to define principles of sustainable mobility and transportation by providing scientific documentation to policymaking and planning. These guidelines suggested measures which dealing with the future changes in mobility behaviour and/or in the transportation system.

Main results

Harmonisation of national travel statistics in Europe

The results of harmonization exercise are based on the empirical analysis of available National Travel Surveys (NTS), a subsequent data gap analysis taking European policy requirements into account, and a further review of alternative sources of information, of innovative data collection techniques and of options to merge various data sources.

The objectives of the NTS analysis were:

1. To establish which countries collect National Travel Surveys,
2. To identify the information and travel data that is collected in those NTS,
3. To examine how the surveys are designed in terms of classification of data, sampling and survey implementation, and
4. To compare travel data and collection methodologies from different countries.

In the study we examined all NTS for potential parameters of policy requirements and we compared across all surveys to identify the coverage and, later, the gaps

The data gap analysis commenced with building a theoretical framework which consisted of a selection of future mobility policies identified for all EU Member States. These policies were linked to a set of parameters and variables that are required to perform a sound quantitative and qualitative analysis of the current and future status of the mobility network in relation to these policies. Those parameters were identified for which NTS are an appropriate instrument, resulting in a final set of 48 parameters along with methodological information (sampling frequency, data format, data grouping etc.). Parameters were assigned to 9 thematic domains such as demographic information, general mobility information, transport infrastructure, transport quality, multi-modal transport, environment, cost internalisation, safety, and vehicle usage.

Against the background of previously collected information on European NTS, all parameters were reviewed in terms of data availability (gap analysis) and comparability (grouping of data). Two groups of countries were identified: A first group of countries already collect a substantial share of the required parameters (Finland, Germany, the Netherlands, Sweden, Switzerland, and United Kingdom). However, even within this group, significant differences exist in terms of the precise type of data that is collected and the way data is classified and held in groups. For the remaining second group of countries, data availability is a larger issue (Cyprus, Hungary, Ireland, Italy, Latvia, Poland, Spain, and – to a lesser extent – Belgium and France).

The final proposition for the content of a harmonised NTS included a listing of parameters and variables, for which data should be collected, but also the variables' type and suggested grouping. However, when aiming at harmonised travel data, the following have to be taken into account:

- The existence of harmonised NTS does not discard the need for other specialised mobility-related surveys or other alternative surveys (please see recommendations on alternative sources of information) which could offer relevant data. The current proposal starts from a standard set of objectives and initiatives, but national objectives and initiatives can differ. Such differences may warrant additional, more detailed surveys.

- NTS should not be overloaded with too many questions. Asking respondents to provide answers to a large set of questions causes the risk of low-quality data to increase. Respondents may experience extensive surveys as a burden, resulting in general displeasure and unwillingness to participate. It is preferential to focus on the most important items to provide a continuous stream of high quality information and to get ‘secondary’ information via other means.
- The use of NTS needs to be seen in light of the availability of other data collection techniques and more validated databases. Over the past years, alternative data collection techniques and databases have become more readily available. In order to optimise the use of NTS as a data collection method, this implies that a frequent analysis of existing NTS needs to be considered. As a result, NTS may undergo continuous evolutions. Special care should be taken to guarantee that these evolutions do not jeopardise comparability over time.

The proposed set of 48 parameters can be considered as a starting point of the harmonisation of data collection, a key element towards ultimate data comparability and the selection of appropriate measures for a sustainable passenger transport system. Because of on-going evolution in the domains of data collection, position tracking, etc. some considerations need to be made. The availability and usability of other techniques than NTS to collect mobility data is increasing. The combination of traditional NTS methods and modern data collection techniques can lead to an improved data collection, allowing for a higher quality of data analysis. Similarly, the availability of validated databases allows for the mutual enrichment of mobility data. This is in particular the case when the element of sustainability is introduced in an analysis: emission data, safety related information, network information, etc. are typically not collected through NTS but are available in validated databases.

After identifying respective data needs, the project focused on unavailable or insufficient data items. In this respect, previous projects and more recent activities dealing with similar issues, alternative sources of information, the potential use of modern data collection techniques as well as options to merge all of them with NTS data were explored. The findings were presented to stakeholders and practitioners in a workshop in Brussels attended by DG MOVE, DG REGIO, DG RTD, EUROSTAT, JRC and several transport experts from universities and the private sector. Finally, recommendations for a Europe-wide travel survey considering the current data needs for policy making were developed.

Parameter Groups	Name of Parameters	Available through NTS	Partly available through NTS	Available through European Legislations or other Agreements	Not Available through NTS and European Legislations	Existence of format mismatch among NTS
Demographic Information	Respondent age	+				Yes
	Respondent sex	+				No
	Additional age		+			Yes
	Additional sex		+			No
	Vehicle ownership	+				No
	Car fuel	+				No
	Level of education	+				No
	Current employment	+				No
	Income		+			Partly

	Home location	+				No
	Work location	+				No
Information on Transport Quality	Duration of trips	+				No
	Lost time per trip (Congestion Time)				+	NA
	Use of travel management systems				+	NA
	Use of travel man. sys. on % of trips				+	NA
Information on Multi-Modal Transport	Availability of trans. inf. for multi-modal assistance				+	NA
	Availability of integrated ticketing system				+	NA
	Number of multi-modal trips		+			Partly
	Number of multi-modal chains				+	NA
	Accessibility of public transport		+			Partly
Information on Transport Safety	Total number of accidents			+		NA
	Number of accidents per vehicle type (per mode)			+		NA
	Number of accidents per region				+	NA
	Total number of injuries			+		NA
	Number of injuries per vehicle type (per mode)			+		NA
	Number of injuries per region				+	NA
Information on Vehicle Usage	Car occupancy rate		+			Partly

Table 1: OPTIMISM data gap analysis on NTS in Europe – A summary of the findings

Subject Area	Alternative Data Sources*	
Demographic information	<ul style="list-style-type: none"> ▪ population statistics/projections ▪ household statistics/projections ▪ time-use surveys ▪ income statistics/surveys/projections ▪ family expenditure surveys 	<ul style="list-style-type: none"> ▪ driving license registers ▪ vehicle registers ▪ employment and commuter statistics ▪ macro/ micro census data
General mobility information	<ul style="list-style-type: none"> ▪ mileage surveys ▪ commuter statistics 	<ul style="list-style-type: none"> ▪ time-use surveys
Transport infrastructure	<ul style="list-style-type: none"> ▪ infrastructure availability 	<ul style="list-style-type: none"> ▪ infrastructure accessibility
Transport quality	<ul style="list-style-type: none"> ▪ congestion indices 	<ul style="list-style-type: none"> ▪ public transport performance
Multi-modal transport	<ul style="list-style-type: none"> ▪ time-use surveys 	<ul style="list-style-type: none"> ▪ public transport performance
Environment and emissions	<ul style="list-style-type: none"> ▪ vehicle registers ▪ fuel sales/consumption (per fuel type) 	<ul style="list-style-type: none"> ▪ mileage surveys ▪ TERM indicators
Cost internalisation	<ul style="list-style-type: none"> ▪ income statistics/ surveys 	<ul style="list-style-type: none"> ▪ family expenditure surveys
Safety	<ul style="list-style-type: none"> ▪ accident statistics ▪ regular inspection for cars 	<ul style="list-style-type: none"> ▪ TERM indicators
Vehicle usage	<ul style="list-style-type: none"> ▪ vehicle registers 	<ul style="list-style-type: none"> ▪ traffic counts

* The table contains duplication as some data sources provide information related to more than one subject area.

Table 2: Alternative data sources by main subject areas

Europe is looking for efficient and innovative solutions for a cleaner, safer and more sustainable transport system. In order to achieve this goal for passenger transport several policies and many initiatives have recently been developed. Success in these efforts depends particularly on effective and thorough analysis of proposed policies and effective monitoring of their impacts. Therefore, availability of high quality, comparable travel behaviour data with minimum required detail is crucial. In this respect, the following recommendations were put forward:

Recommendations to harmonise NTS in Europe

- A core set of parameters should be developed to properly analyse the most important European transport policies. A proper data grouping, data format and units of measurement should be defined for the parameters. The OPTIMISM suggestion for grouping is: I) demographic information, II) emission and cost information, III) vehicle usage, IV) general mobility information, V) infrastructure, quality of mobility and multi-modality, and VI) accidents, injuries and fatalities.
- Clear methodologies and methodological frameworks for all NTS should be put in place and the main purposes of surveys should be conformed, EUROSTAT can lead the activities to construct necessary groupings in relation to different data sets and to develop a fixed methodology with clear frameworks of data collection in the Member States.
- It is necessary to identify an adequate frequency for repeating NTS to guarantee data continuity and comparability. It is suggested that data are collected regularly on a yearly basis, a time period of more than 5 years is not recommended for comparison reasons.
- The sampling composition should also be consistent among countries. It is suggested to use the population registries in the Member States to compose representative population samples; sample sizes should be large enough to facilitate detailed analyses for smaller sub-samples.
- Alternative sources should be used together with NTS to enrich awareness of travel patterns and to validate collected data through the NTS; new technological advances (e.g. GPS, GSM, GIS technologies, internet, smart cards etc.) should be used to complement NTS; their potential role in data collection should be further investigated.
- At the time being, it is not recommended to abandon the use of traditional instruments (pen and paper, telephone and face-to-face interviews, etc.) for the collection of data through NTS. The parallel usage of traditional and new technologies would allow for improved data collection, mutual data validation (checking for consistency) and a swifter data flow.

Recommendations to use alternative sources of information for travel data

- In addition to official transport statistics and NTS, there are numerous other data sources expected to be of substantial value for quantitative and qualitative analysis of the current mobility system in order to support policy decisions.
- Population and household statistics together with respective long-term projections can provide a framework for the development of future mobility (demand) scenarios.
- Income statistics as well as expenditure data may also facilitate development and elaboration of future mobility scenarios, in particular in conjunction with population and mobility data generated by dedicated travel surveys.
- Employment and/or commuter statistics, if contain spatial information on residential and working places, may help develop origin-destination matrices which may provide information on the extent of spatial interrelations and potential transport demand.
- Time-use surveys may provide detailed insight into activity schedules of individuals or entire households including any interdependencies between family members.
- Travel distance surveys, usually based on vehicle samples, may provide detailed data on vehicles (such as vehicle type, engine type) in conjunction not only with the actual mileage of each vehicle, but also characteristics of its owner.
- Fuel sales (per fuel type) can be used not only to assess resulting mileage, but also, if combined with vehicle fleet data, to calculate the respective environmental impact in terms of exhaust emissions.

- Using GPS based historic and real-time in-vehicle navigation and tracking data, and mapping of actual road congestion over time allows for the development of congestion indices.
- Finally, commercial data providers exploit many of these data sources. Based on data processing and/or modelling they maintain comprehensive databases in order to offer tailored information in various formats and for various purposes.

Recommendations to use ICT in travel data collection

- Global Navigation Satellite System (GNSS), Global Positioning System (GPS), Mobile device localisation, Radio Frequency Identification (RFID), Near Field Communication (NFC), Dedicated Short Range Communications (DSRC), and camera and sensor-based technologies are the most important ICT options to collect travel data.
- For the time-being GNSS/GPS technology is the most promising ICT option in travel data collection. It provides large amounts of travel information at relatively low cost. However, they can be used for some certain measures and together with traditional surveying techniques until widespread usage by all population segments.
- For urban areas, also mobile device localisation technologies could be useful in collecting travel data, although this option should also be combined with conventional survey techniques.
- RFID/NCF/DSCR technologies, as well as camera and sensor-based technologies, could be useful for collecting data on specific types of transport, e.g. public transport; travel data from (multimodal) personal travel information systems and journey planners could also be additional sources of information.
- When using ICT for travel surveys, some general disadvantages of these options should also be considered: people who are less familiar and unable to access ICT or people with high privacy concerns may not be captured sufficiently in the survey compared to other groups. This may result in comparability and representation inconsistencies with respect to (earlier) transport surveys.

Recommendations on data items in NTS to be covered by ICT

- A number of data items in NTS could be collected using ICT. The type of data that could be collected with ICT includes: trip frequency, trip duration and trip length,
- In addition, travel data about public transport could also be collected through the use of ICT for those passengers that use smart cards/mobile phones. These are, frequency of public transport use, trip length, trip duration, public transport modes used, station use, occupancy rates, delay times.

Recommendations for a travel survey at European level

- In order to remove data gaps in transport policy analysis, the priority should be given to harmonization of NTS because of the several benefits listed. However, specific Europe-wide travel surveys separately designed for some certain policies or policy groups can also help to eliminate numerous data gaps in travel behaviour.
- The two previous Eurobarometer surveys, designed with a short questionnaire to measure passenger preferences in some certain policy areas, can be seen as a starting point for the survey design. There might be several surveys, each of them collecting appropriate data items for individual policies or policy groups described within the White Paper on Transport.
- Considering the emerging data needs, a Europe-wide travel survey today could focus separately on the following three transport domains: transport demand, to identify trends in lifestyles that affect transport activity; transport quality, to define obstacles and areas

for improvement in transport infrastructure or in services; and transport technology, to estimate potential changes that new technologies may bring.

Demand and supply factors for passenger transport and mobility patterns – status quo and foresight

A research framework including key drivers, relevant aspects and trends influencing mobility patterns and transportation was developed giving an overview on the relevant aspects of the transportation system and their interconnectivities. The research scheme provided an understanding of the complex system and served as a guideline for interpreting research results according to their relevance inside the transportation system.

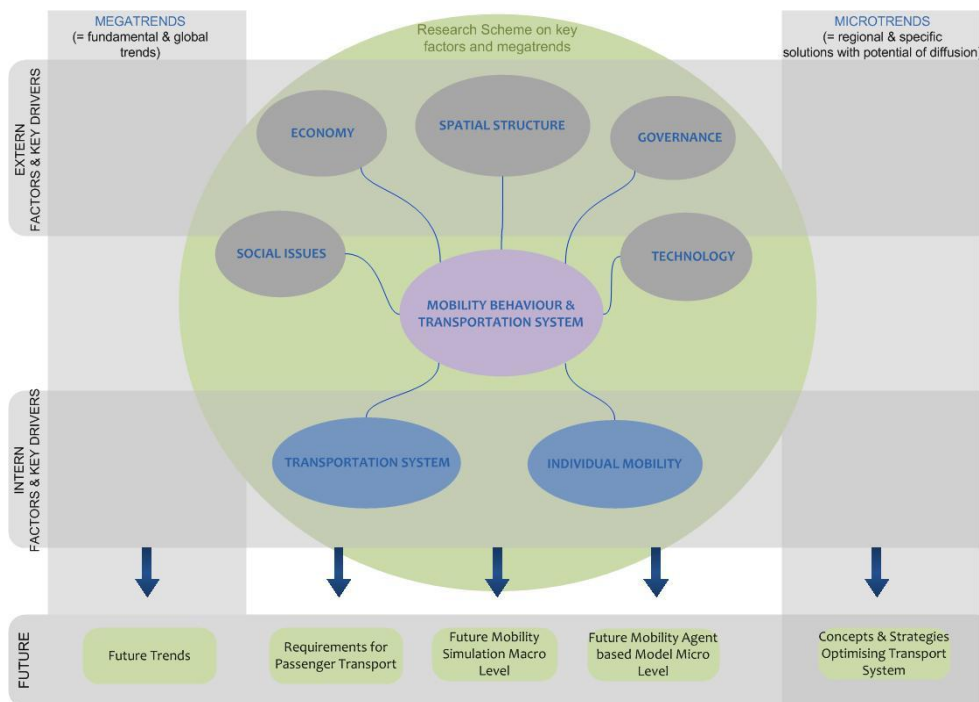


Figure 3: OPTIMISM research framework

According to the scheme key factors, their trends and causal patterns of the passenger transport system were identified based on a literature review. The identification of key factors and their trends is of fundamental importance for the definition of OPTIMISM scenarios. These scenarios were modelled to assess the implementation of co-modality ICT based strategies aiming to optimise the passenger transport systems – the main objective of OPTIMISM. The information collected mainly provided qualitative trends and quantitative forecasts in some cases.

Beside the system itself, external drivers with future relevance also affect the transportation system and need to be considered in strategies of optimization. Thus potential Megatrends which are likely to impact the transport systems in the future were identified. Megatrends are large dynamic trends with long-term, global or international character. They do not only affect the transport systems directly, but also have indirect impacts on the system by causing fundamental changes in the fields of technology, economy, society and policy. The identified Megatrends permit OPTIMISM to include factors with long lasting direct or indirect effects on transport systems, since the modelling horizon is 2030 and 2050.

Eleven megatrends were identified on the basis of a literature analysis combined with project partners' experience covering all dimensions of sustainability: economic, social and environmental. The megatrends were classified as 'recent' if being already observable for the last years or decades and as 'prospective' if they are likely although characterised by some uncertainty. They also include issues related to technology, cohesion and mobility. The megatrends were discussed, assessed and ranked by experts with regard to their potential impact on the future transportation system. As a result a recent megatrend "Urbanisation" and a prospective megatrend "Shortage of Resources" were estimated to have the highest impact. The full list of identified megatrends including their estimated impact from high to low and the time horizon consists of eight recent trends and three trends with more prospective character:

Impact	Megatrend	Time horizon
high	1. Urbanisation	recent
	2. Shortage of Resources	prospective
medium	3. Globalization 2.0	recent
	4. Climate Change and Environmental Ethics	recent
	5. Technology Change	prospective
	6. Mobility crisis & European Policy Reaction	prospective
	7. World Population Growth	recent
	8. Demographic and Social Change Europe	recent
	9. European Market Deregulation	recent
low	10. Increase of Inter- / Intra-national Social Disparities	recent
	11. Knowledge Society and -Economy Europe	recent

The identified megatrends were integrated in a Delphi survey aimed at the definition of scenarios to be modelled. The modelling had the goal to assess the impacts of co-modality ICT-based strategies for the optimisation of future passenger transport systems.

The OPTIMISM Delphi survey proved to be useful for finalising the OPTIMISM scenario building process and led to the identification of the two most relevant key factors in terms of their uncertainty and impacts on future passenger transport systems: energy (oil) prices and support of sustainable mobility policies.

As to "support of sustainable mobility policies", two separate groups of measures were considered:

- policy measures specifically aiming at co-modality and integration of passenger transport systems, which were developed in WP5;
- other transport policy measures (which only "indirectly" contribute to co-modality and integration).

The first group of measures was identified within OPTIMISM in terms of ICT-based co-modality strategies. As for the second group, it was decided to consider the transport policy measures identified in the most recent transport White Paper and which have been assessed in the Impact Assessment study, because they are the most likely to be implemented in the future. In order to focus on the most likely to be implemented, it was decided to ask experts' opinion to assess the likelihood of these policy measures. The third round of the Delphi study

(Second Expert Online Questionnaire) was designed and implemented to collect such information.

On the basis of the two scenario variables energy price and policy measures, four OPTIMISM scenarios were identified, along with the reference scenario which was based on the EC studies:

- SC0 – Reference scenario
- SC1 – Baseline trend for oil price /”Do-as-today” for co-modality
- SC2 – “Global Action” trend for oil price/”Do-as-today” for co-modality
- SC3 – Baseline trend for oil price/”Do-maximum” for co-modality
- SC4 – “Global Action” trend for oil price/”Do-maximum” for co-modality

The identified four scenarios and the reference scenario were used for the OPTIMISM modelling activities with a time horizon of 2030. The transport activity indicators for each of the policy scenarios were estimated with TRANS-TOOLS-S Demand Module (TDM) and these estimations on transport demand were then fed into the TREMOVE System Dynamics (TSD) to estimate environmental impacts of the policy scenarios. At the end, the policy scenarios and the reference scenario were compared with each other to explore the potential impacts of different trends in fuel prices and implementation of OPTIMISM policy measures.

Based on the results of scenario simulations, the following conclusions should be underlined. As of 2010, the share of private cars in passenger transport is 74% and it is expected to reduce to 70% by 2030. It is also expected that the modal shares of rail transport will increase from 7.7% to 9.3% and aviation from 8.2% to 11.3% by 2030. The results of the simulations show that the OPTIMISM policy measures may have significant impacts on existing mobility patterns through a substantial modal shift from private car to public transport. More specifically, with the implementation of OPTIMISM strategies/policy measures in an increasing (baseline) fuel price environment:

- The modal share of private cars may decrease by 1.7% whereas the modal share for public road transport and rail transport may increase by 8.3% and 6.9% respectively,
- Travel per person by private cars and motorcycles may decrease by 1.7% while travel per person by public road transport and rail is increasing by 7.5%.

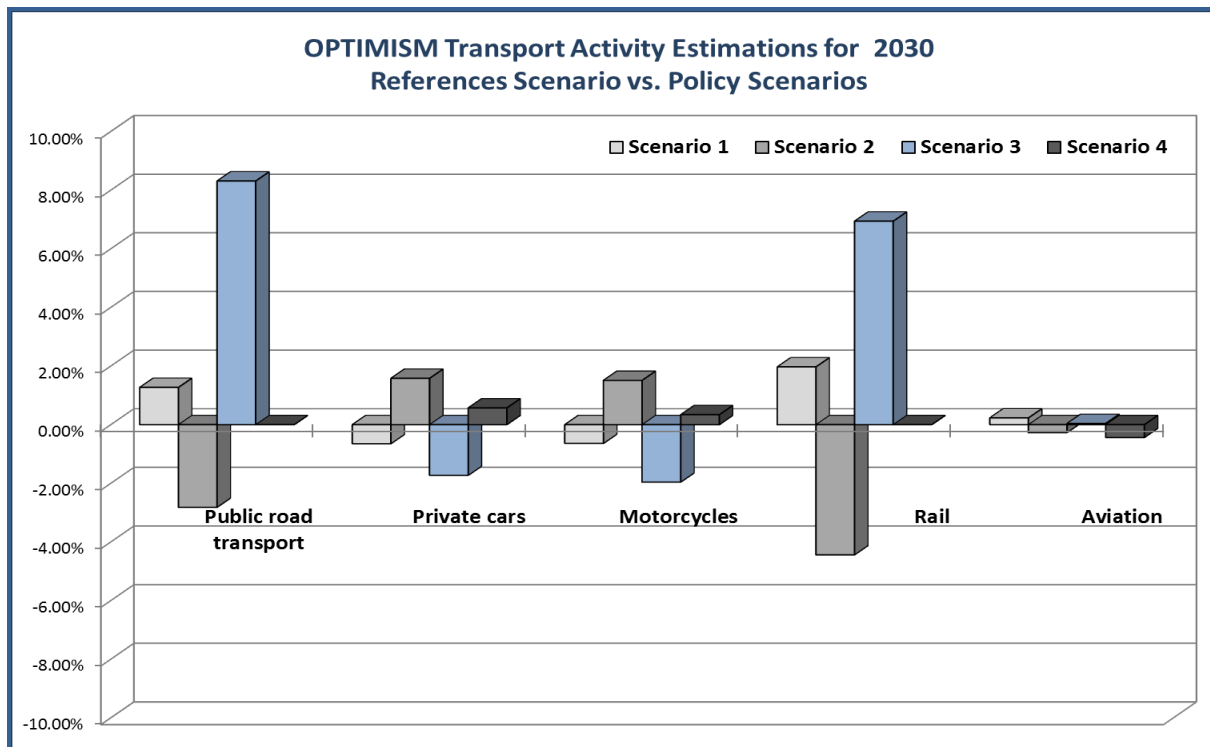


Figure 4: OPTIMISM simulation results - impacts of the policy measures

No significant change in total transport demand is however foreseen with the implementation of OPTIMISM policy scenarios. It is obvious that the selected policy measures will increase public transport shares both for the road and rail transport and decrease the share of private cars and motorcycles. Considering the potential impacts of the OPTIMISM policy measures without the impact of fuel prices (comparison of policy scenarios 1 and 3), the travel per person by public road transport and rail increases by 5.9% and travel per person by private cars and motorcycles decreases by 1.1%. Whilst the percentage changes in car use may appear small they need to be assessed against the higher overall proportion of car use in total travel. A small percentage of a large share may outweigh a larger percentage of a smaller starting share.

According to the reference scenario for 2030, transport emissions will keep increasing and road passenger transport will be responsible for 65% of the total CO₂ transport emissions and 54% of the total NO_x transport emissions. The modelling exercise indicates that it is very difficult to shift this trend. With the best policy scenario including strategies to support co-modality and integration, only slight differences can be achieved in the transport emissions.

The modal shift from passenger cars to public road and rail transport may still result in positive environmental impacts. Combination of OPTIMISM co-modality and internalisation measures represented in the policy scenario 3 may reduce the CO₂, NO_x and PM10 transport emissions in 2030 by 1.3%, 0.1% and 0.4% respectively.

Different trends in fuel prices may also have important impacts on mobility patterns. Lower fuel prices without any policy on internalization of road transport costs, as in the “Global Action” trend, are not able to reduce the share of private cars in total transport activity. With lower fuel prices and without an internalization policy, travel per person by public road

transport and rail is estimated to decrease by 5.3% while travel per person by private cars and motorcycles may increase by 2.3%.

As a conclusion, OPTIMISM strategies/policy measures supporting co-modality and integration have positive mobility and environmental impacts. These positive impacts are more noticeable particularly in higher fuel prices environment and with internalization of external costs of road transport. The results show that the implementation of OPTIMISM strategies has positive environmental impacts, but they are not, on their own, sufficient to reach EU targets for reducing transport emissions. The OPTIMISM strategies mainly comprise ICT-based policy measures and only include passenger transport excluding freight, hence their impact on transport emissions is rather small.

Finally, the OPTIMISM strategies aiming to support co-modal and integrated passenger transport should be supported by other policies in vehicle and fuel technologies and with infrastructure improvements, road charging, taxation and traffic restriction policies in order to be able to achieve better results for sustainable passenger transport.

Analysing measures for decarbonisation of transport

OPTIMISM provided a broad overview of ICT options supporting co-modality, based on a review of existing and planned ICT-related projects in Europe, a review of available literature (including relevant FP6 and FP7 projects) and interviews with relevant stakeholders. In total 15 types of ICT options were identified, which are categorised in three main categories: travel information services, mobility services and transport management systems; these 15 options are:

- Travel information services:
 - Static route planners;
 - Dynamic and real-time route planners;
 - Personalised travel information;
 - Infrastructure bounded travel information for public transport;
 - Infrastructure bounded travel information for road transport;
 - In-vehicle travel information.
- Mobility services:
 - E-ticketing;
 - Mobile phone ticketing;
 - Multimodal smart cards;
 - Mobile phone payments;
 - Bicycle (bike) sharing services;
 - Car sharing services;
 - Demand Responsive Transport systems.
- Transport management systems:
 - Public transport management systems;
 - General transport management systems.

These 15 ICT options were broadly assessed on mobility, environmental, social and cost-related criteria. Therefore, for all ICT options some specific projects/programmes are qualitatively assessed and scored on these criteria. Based on these results aggregated scores

for the 15 options were calculated. The results of this assessment are shown in **Error! Reference source not found.** Some of the main results include:

- Most ICT options result in a shift from private car to public transport (and bike); most effective options in this respect are car sharing services and personalized travel information.
- Impacts on travel demand are in general low and should be considered as rebound effects. Since some transport modes have become more attractive due to the ICT options, people will travel more frequently.
- Some options may have a positive impact on congestion reduction, e.g. real-time route planners and personalised travel information.
- Almost all ICT options are expected to result in lower emission levels, which is mainly the result of the shift from the car to public transport.
- All ICT options require significant investment costs, ranging from very moderate (e.g. personalised travel information services) to high (transport management systems). Additionally, for most of the options there are significant operational costs (except for the long run operational costs of multimodal smart cards and mobile phone payments).

ICT options	Macro mobility impacts			Other mobility impacts				Environmental impacts			Costs		Transferability	Total
	Transport demand	Modal shift	Travel time	Safety	Congestion	Accessibility	Reliability	CO ₂	Air pollution	Noise	Investment costs	O&M costs		
Travel information														
Static route planners	0,6	1,0	1,0	0,2	0,0	0,0	0,6	1,0	0,4	0,2	-1,0	0,0	2,0	5,4
Dynamic and real-time route planners	0,4	1,2	1,3	0,2	0,7	0,9	1,0	1,0	0,5	0,2	-0,9	-1,0	1,8	7,0
Personalized travel information services	0,4	1,4	1,6	0,0	1,2	0,6	0,8	1,0	0,4	0,0	0,0	0,0	1,8	8,8
Infrastructure-bounded travel information public transport	0,0	0,0	1,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	-1,0	-1,0	2,0	2,0
Infrastructure-bounded travel information road transport	0,0	0,0	1,0	-1,0	1,0	0,0	0,0	0,0	0,0	0,0	-1,0	-1,0	2,0	1,0
in-vehicle information	0,0	0,5	1,3	1,0	1,0	0,0	0,5	0,5	0,5	0,3	-0,5	-0,5	1,8	6,3
Mobility services														
e-ticketing	0,8	1,3	0,0	0,3	0,3	0,3	1,0	1,0	0,8	0,3	-1,5	-0,5	2,0	5,0
mobile phone ticketing	0,5	1,0	0,5	0,5	0,0	1,5	1,5	0,5	0,5	0,0	-1,5	-1,5	2,0	5,0
multi-modal smart cards	1,0	1,2	1,1	0,1	0,6	1,4	0,8	0,9	0,8	0,0	-1,1	0,6	1,8	8,1
Mobile phone payments	0,8	0,8	0,8	0,0	0,6	1,8	0,6	0,6	0,6	0,0	-0,2	0,6	2,0	8,2
Bicycle sharing services	0,0	1,0	1,0	-0,8	0,4	1,0	1,0	0,9	1,0	0,2	-1,0	-0,9	2,0	5,8
car sharing services	-1,0	2,0	-1,0	1,0	1,0	1,0	1,0	2,0	1,0	0,0	0,0	1,0	2,0	11,0
DRT	0,7	1,1	0,3	0,0	0,0	1,6	1,3	0,6	0,6	0,1	-0,6	-0,1	1,9	6,7
Transport management systems														
Public transport management systems	0,5	0,5	1,5	0,0	0,5	1,5	1,0	0,5	0,5	0,0	-1,0	-1,0	2,0	6,0
General transport management systems	0,6	1,0	1,8	0,8	1,9	0,6	0,9	1,0	1,1	0,1	-1,4	-1,1	1,0	7,6

Table 3: Summary of the results of the broad assessment of ICT options

Based on the results of the broad assessment three best practices were chosen for further research. These were the three options with the highest total scores:

- Personalised travel information services (PTI)
- Car sharing services (CSS)
- Mobile payment devices (MPD): both multi-modal smartcards and mobile phone payments.

Mobility impacts of best practices

For the three best practices the mobility impacts were estimated based on verifiable quantitative data (absolute or relative effects on mobility) collected from previous work within the OPTIMISM project, scientific literature, project information, workshops, etc. These impacts were estimated for one exemplar country (UK for PTI and MPD, Germany for CSS). Next to the mobility impacts, the long-term market penetration rates for the options are estimated. The main results are summarized in **Error! Reference source not found.**

Option	Transport demand	Modal shift (relative change in pkm)		Long-term market penetration	Reference Country
		From	To		
PTI Personal Travel Information	Car: 0 % Bus: 0 % Train: 0 %	Car: -3 % to -11 %	Bus: 78 % Train: 22 %	2015: 20% 2020: 30% 2025: 50% 2030: 75%	UK
		Bus: -1.7 %	Car: 90 % Train: 10 %	Market penetration: expected % of population that make use of system	
		Train: 0 %	Car: 0 % Bus: 0 %		
CSS Car Sharing Schemes	Car: 0 % Bus: 0 % Train: 0 %	Car: -1.65 % to -2.48 %	Bus: 90 % Train: 10 %	2020: 0.5 % 2030: 1-1.5 %	Germany
		Bus: 0 %	Car: 0 % Train: 0 %	Market penetration: expected % of population making use of system	
		Train: 0 %	Car: 0 % Bus: 0 %		
MPD Mobile Payment Devices	Car: 0 % Bus: 0 % Train: 0 %	Car: -1 % to -2.4 %	Bus: 92 % Train: 8 %	2015: 20% 2020: 40% 2025: 70% 2030: 100%	UK
		Bus: 0 %	Car: 0 % Train: 0 %	Market penetration: expected % of population that make use of system	
		Train: 0 %	Car: 0 % Bus: 0 %		

Table 4: Mobility impacts and long-term market penetration rates

All three options result in significant modal shift impacts and hence support co-modality. The largest effects are expected for PTI: about 3% - 11% reduction in car use due to a shift to public transport. It should be noticed that these mobility impacts are based on a rather small selection of empirical evidence and hence are quite uncertain. For that reason we presented ranges of impacts instead of point estimates. Two sources of uncertainty are the lack of evidence on the impacts on transport demand (rebound effect) and the assumed uniformity of passenger kilometres (pkm) among all transport modes. The latter implies that 1 pkm shifted from car equals 1 pkm added to bus. By applying these assumptions we may slightly overestimate the emission reduction, because passengers typically have to cover a larger distance when traveling by public transport than by car which allows driving directly without detours to the individual destination.

EU27 wide decarbonisation potential

The EU27 wide decarbonisation potential of the three ICT options (compared to the baseline) are presented in the figures below:

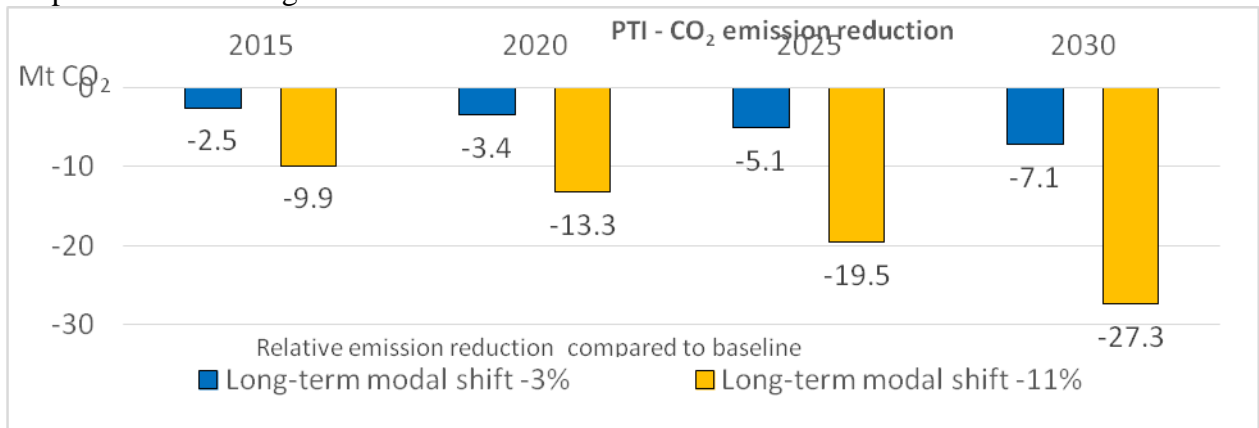


Figure 5: CO₂ emission reduction potential of PTI compared to baseline

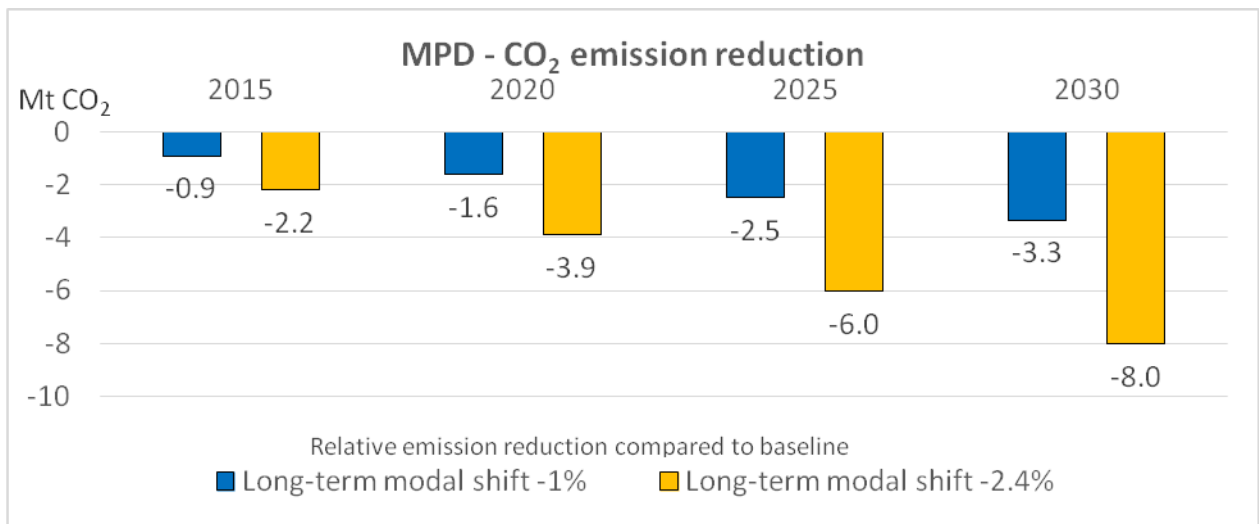


Figure 6: CO₂ emission reduction potential of MPD compared to baseline

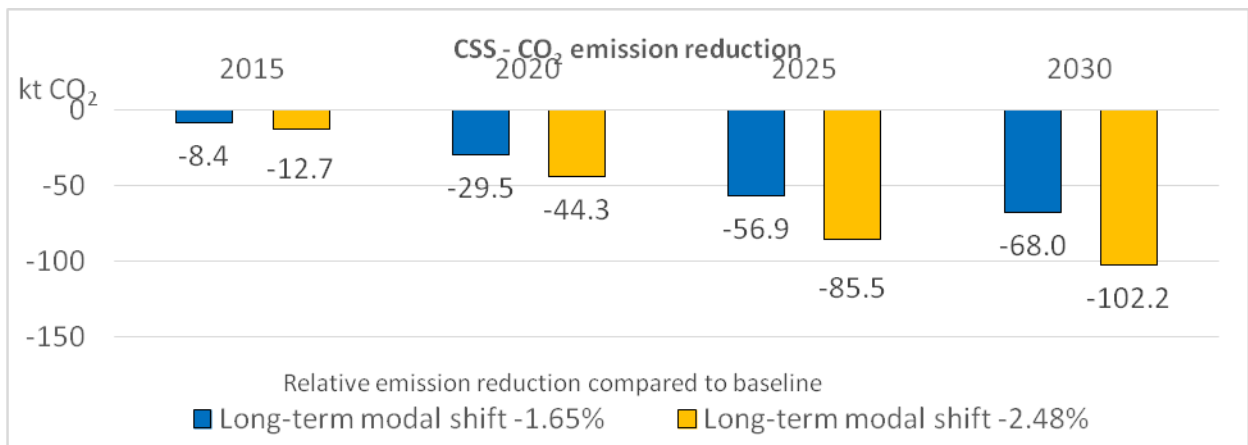


Figure 7: CO₂ emission reduction potential of CSS compared to baseline

As a result of the strong modal shift and an expected high market penetration, PTI have the largest decarbonisation potential of the three selected information technologies. In 2030, between 0.97% and 3.70% of passenger transport emissions could be avoided compared to the baseline scenario. MPD could contribute an emission reduction between 0.45% and 1.08%. CSS have a fairly low market penetration and also facilitate a small modal shift, so the decarbonisation potential is expected to be only around 0.01% in 2030 (note that the unit of emissions for CSS is kilotonnes, not Megatonnes.)

Figure 8 illustrates the geographical distribution of the decarbonisation effects of PTI (in the best case). As expected, the major decarbonisation share results from Germany, the UK, France Spain and Italy, accounting for 72% of the reduction. In the baseline scenario, these countries are responsible for 69% of CO₂ emissions in 2030. The reason for this is that, due to the characteristics of these countries, the ICT options are more effective (in terms of shifting people from the car to public transport) than in the EU as a whole (e.g. because average GDP/capita is higher in these countries than in the EU27, which provides travellers more opportunities to invest in goods like personalised travel information devices. However, other country-specific aspects such as vehicle emission factors play a role as well.

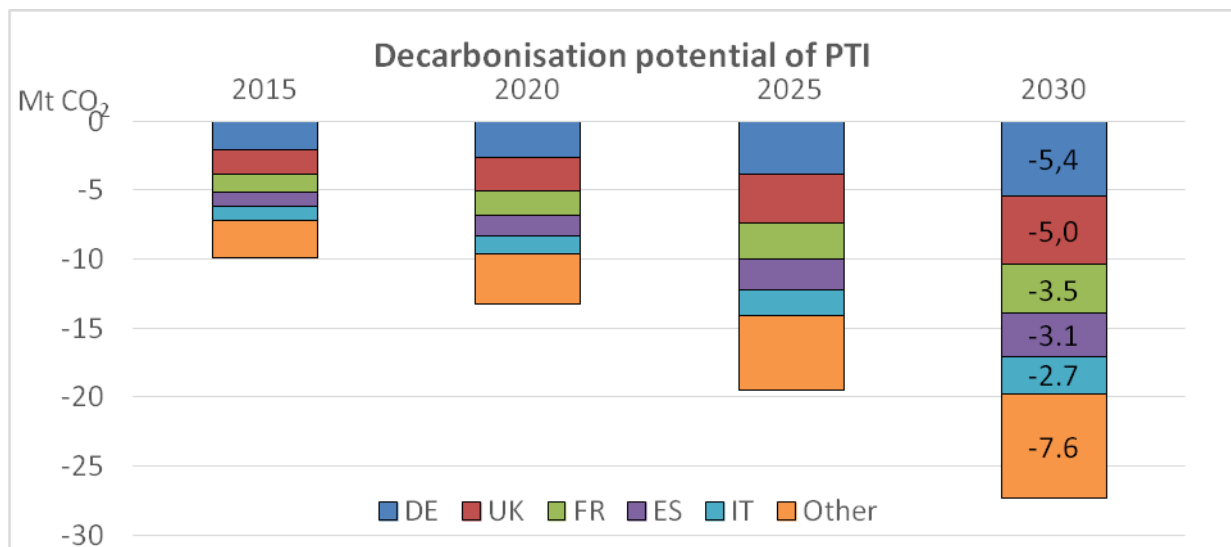


Figure 8: Maximum decarbonisation potential of PTI in different countries

Reductions in NO_x and PM emissions

The expected reductions in NO_x and PM emissions are presented in tables below. NO_x emissions are expected to increase compared to the baseline scenario. All three ICT options result in a major modal shift towards buses, which have higher specific NO_x emissions (g NO_x/person-kilometre) than cars. As a result, NO_x emissions will increase by 0.7% - 2.6% with PTI, 0.3% - 0.8% with MPD and about 0.01% with CSS. However, total NO_x emissions will still be well below 2010 levels.

PM emissions will decrease by about 0.8% to 3.0% with PTI, 0.4% to 0.9% with MPD and 0.01% with CSS compared to the baseline scenario.

	Range	2015	2020	2025	2030
PTI	Min. potential	363	1,622	4,603	8,722

	Max. potential	1,455	6,295	17,719	33,422
CSS	Min. potential	1	14	52	84
	Max. potential	2	21	78	126
MPD	Min. potential	141	779	2,281	4,083
	Max. potential	339	1,871	5,474	9,800

Table 5: Potential effect on NOx emissions by selected ICT (in tonnes)

	Range	2015	2020	2025	2030
PTI	Min. potential	-384	-493	-707	-986
	Max. potential	-1,476	-1,887	-2,693	-3,750
CSS	Min. potential	-1	-4	-8	-9
	Max. potential	-2	-6	-12	-14
MPD	Min. potential	-135	-230	-344	-456
	Max. potential	-324	-552	-826	-1,095

Table 6: Potential effect on PM emissions by selected ICT (in tonnes)

Other co-benefits

Other co-benefits under consideration were transport safety, decongestion and reduction of traffic noise. ICT are associated to all of these, but the effects are expected to be small or negligible and no quantification was possible.

Recommendations

- The study found a positive impact of the three selected ICT measures (PTI, MPD, CSS) on co-modality and CO₂ emissions. This analysis should be expanded to a larger set of technologies which have been identified in D4.1. But also non ICT-based measures should be considered (e.g. introduction of road charging/congestion charge) to develop a comprehensive set of transport policy options.
- The data availability regarding long-term rebound effects and co-benefits (e.g. traffic safety) of ICT in transport is very limited, resulting in a high uncertainty. Therefore more research comprising ex-ante, intermediate and ex-post evaluation studies on the introduction of ICT measures is recommended. This would allow for the quantification of the magnitude of the effects (e.g. traffic impacts such rebound effects, reduction of congestion and environmental externalities) and provide further evidence for cost-efficiency analysis of ICT measures.
- WP4 focused on quantifying the effect of single actions. However, there are significant synergies and interdependencies between different ICT options, which should be analysed in more detail. Therefore a methodology how to combine and aggregate the separate effects will be required.
- Based on the outcome of these assessments a holistic strategy should be developed how to implement and facilitate the use of innovative ICT options in Europe. A contribution towards this strategy is presented in D5.1 which defines roadmaps for integrating and optimizing transport systems.

Elaborating on strategies for integrating and optimizing transport systems

In order to assess the synergy effects of the simultaneous implementation of different ICT-based co-modality measures, OPTIMISM has defined a number of strategies. OPTIMISM strategies are “a combination of different measures fulfilling one or more co-modality related policy objectives”. These strategies not only consider ICT-based co-modality measures, but also those non-ICT-based measures addressing specific technical and organisational issues concerning co-modality (e.g. infrastructure interventions for the integration of modes), as well as those enabling/encouraging the deployment of ICT-based and non-ICT-based measures by improving the legislative, political and marketing framework (supporting measures). The defined strategies included:

- Seamless international travel: improving the planning and organisation of international trips, including an enhanced integration between national legs of international trips. Measures included are: provision of (tailor-made) travel information, integrated ticketing, improvement of mobility services at local level, etc.
- Seamless regional/national travel: improving the planning and organisation of regional/national trips, including an enhanced integration between trip legs at the local, regional and national level. The same kinds of measures as in the first strategy are implemented, but focussed on regional/national transport.
- Integrated urban and metropolitan transport: improving the planning and organisation of urban trips and enhancing the integration of different passenger transport modes. The same kinds of measures as in the first two strategies are implemented, but focussed on urban transport.
- Integrated and personalised information: providing travellers easy to access, reliable, integrated and affordable information. Measures included are: multimodal route planner, personal travel information provision, information improvements at interchange points, etc.
- New mobility paradigm based on public means of transport: encouraging the use of public individual (e.g. taxis) and collective modes in order to reduce aggregate car use. Measures included are: integrated ticketing, car sharing schemes, demand responsive transport, improvements of infrastructure and services at interchange points, etc.

These strategies pursue the following co-modality-related policy objectives: passenger travel integration at different jurisdictional levels of increasing complexity (urban/metropolitan, regional/national, and international); integrated and personalised travel information systems; the efficient use of different modes on their own and in combination. A roadmap was also developed for each defined strategy outlining how its full deployment might be achieved by 2030 in order to provide decision-makers and relevant authorities with information on the actual feasibility. Starting from the vision of the functioning and the services provided by the envisaged configuration of the transport system from the passenger’s point of view, each roadmap provided information on various aspects such as problems and users’ needs

addressed, enabling technologies, barriers to the deployment and suggested actions/recommendations.

Sustainable transport policies imply the efficient use of resources. ICT-based measures can significantly improve the efficiency in collecting, processing, storing, and delivering information, but for their successful implementation, it is recommendable:

1. To define suitable standards for ICT systems at the European level, which enable the integration of individual systems developed by the Member States;
2. With reference to the enabling technologies, to carry out research studies aiming at identifying critical factors and conditions (e.g. incentives, standards, training, awareness campaigns, compulsory adoption of specific systems such as on board units for monitoring traffic) for the creation of a market for these technologies and for their mass spreading;
3. To find solutions for the safe and secure management of the huge flows of sensitive data and information;
4. To develop methods and software for ensuring the reliability of information (e.g. traffic information).
5. To accompany the implementation of ICT-based measures with the infrastructure interventions aiming at providing efficient connection between transport modes (e.g. interchange points) and improving the performances of the more sustainable ones (e.g. railway infrastructure).
6. To find appropriate ways (policy tools, incentives, compulsory measures, mechanisms to encourage voluntary involvement, etc.) of overcoming lack of co-operation between main stakeholders (authorities, transport operators, service providers, etc.).
7. To put further effort into the analysis and development of appropriate business models for the successful implementation of the OPTIMISM strategies.

The main impacts of the five OPTIMISM strategies defined above to realise an integrated and optimised passenger transport system are assessed. The long-term (2030) mobility, environmental, and social impacts as well as the implementation costs of an EU-wide implementation of these strategies were analysed in a qualitative way. Additionally, a quantitative assessment was carried out for a comprehensive strategy covering all the measures included in the five individual strategies, based on the results of the model runs by REMOVE and TRANSTOOLS

The main results of the impact assessment of the OPTIMISM strategies can be summarized as following (Table 7):

Strategies	Mobility impacts	Environmental impacts	Social impacts	Implementation costs
Seamless international travel	Significant modal shift from car to public transport and/or aviation	Change in GHG emissions depends on size of modal shift to aviation. Drop in PM emissions, change in NO _x emissions uncertain.	Small, but positive impacts on congestion levels and traffic safety.	Very high capital (billions of euros) and operational costs (around one billion euro per year).
Seamless regional/national travel	Significant modal shift from car to public transport	Reduction in GHG and PM emissions. Reduction in NO _x emissions smaller or	Small, but positive impacts on congestion levels and traffic safety.	Very high capital (billions of euros) and operational

		even negative.	Impacts may be slightly larger as for international travel strategy.	costs (around one billion euro per year).
Integrated urban and metropolitan travel	Significant modal shift from car to public transport. Size of impacts are expected to be smaller as for previous strategy	Reduction in GHG and PM emissions. Reduction in NO _x emissions smaller or even negative. Impacts are smaller as for regional/national travel strategy.	Small, but positive impacts on congestion levels and traffic safety. Impacts are expected to be smaller as for previous strategy.	Very high capital (billions of euros) and operational costs (around one billion euro per year).
Integrated and personalised information	Significant modal shift from car to public transport. Smaller impacts as for previous two strategies are expected.	Reduction in GHG and PM emissions. Reduction in NO _x emissions smaller or even negative. Smaller impacts as for previous two strategies are expected.	Small, but positive impacts on congestion levels and traffic safety. Impacts are expected to be smaller as for previous strategies.	Capital costs are roughly estimated at € 500 - € 800 billion, operational costs at € 70 million /year
New mobility paradigm based on public means of transport	Significant modal shift from car to public transport. Smaller impacts as for first three strategies are expected.	Reduction in GHG and PM emissions. Reduction in NO _x emissions smaller / negative. Smaller impacts as for regional/national and urban travel strategies are expected.	Small, but positive impacts on congestion levels and traffic safety. Impacts are expected to be smaller as for first three strategies.	Very high capital costs, operating costs are expected to be modest.
Comprehensive strategy	About 1% decrease in travel per person by car and 6% increase in travel per person by public transport. No significant impact on total travel demand.	About 1% decrease in CO ₂ and PM emissions, a 0.3% drop in NO _x emissions is estimated.	Small, but positive impacts on congestion and traffic safety are expected.	Capital costs are very high (in the order of several hundreds of billion euros); operating costs are significant (more than 1 billion per year).

Table 7: Impact Assessment of the OPTIMISM Strategies

At final step of the project, it was aimed to set guidelines to advice policy-making in order to promote and encourage changes in passenger mobility behaviour to support sustainable mobility. In order to support decisions based on principles of sustainable mobility with regard to the dimensions of environment, economy and society a four step approach was developed as follows:

1. As a basis, principles and criteria for sustainable mobility have been identified. The principles and criteria serve as a foundation for the identification of indicators which will be used for the assessment.

2. A decision making framework has been developed. It provides a Multi-Criteria Assessment method to support and integrate the identified criteria for sustainable mobility into the decision making process – to assess technology and policy options and includes

- indicators for sustainable mobility based on the principles and criteria which decision makers could use as a rating scale to assess different ICT and policy options according to their impact on sustainability
- an assessment matrix for rating the impact of different options in the process of decision making enabling the comparison of options has been developed

3. A Forward Looking Market Analysis gives an overview of conditions relevant for mobility to go beyond the focus on ICT solutions.

4. Policy Recommendations and a guideline for policy makers and transport planners for to adopt the MCA and to support sustainable mobility is formulated.

During the analysis, the tested measures turned out to have a positive impact on the transportation. New technologies in Information and Communication have the potential to support co-modality and sustainable mobility. In addition, the results show a rather moderate impact which would be insufficient to meet the ambitious goals of the European Commission. Much more effort is needed not only to optimize but to transform the current transportation system into one serving the future needs with limited impact on environment, ensuring inclusive mobility for society and sustaining economic competitiveness. One of the key points is that the future challenges faced by the European transportation system creates a need for solutions on a broad view and a long-term perspective. Thus awareness of the system as a whole must increase, a context perspective has to be developed and ways to integrate different stakeholder perspectives and interests in practice have to be found. The results and recommendations elaborated in OPTIMISM are providing solutions related to this main question. Some of the key recommendations included:

- Support the implementation of
 - Provision of travel Information
 - Integrated tickets and innovative ticketing
 - Improvement of luggage transport and passenger check-in
 - Innovative local mobility services
 - Improvement of mobility service at local level
 - Improvements at interchange points
 - Transport system infrastructure and rolling-stock improvements
- Suitable standards for ICT systems. These standards would enable a coherent integration of ICT systems in the Member States.
- OPTIMISM strategies should be implemented in combination with other policy measures, for instance vehicle regulation, road charging or tax measures; collaboration between relevant stakeholders is required for creating an integrated, co-modal transport system. Policy tools such as incentives, compulsory measures or mechanisms encouraging voluntary involvement are needed to overcome the lack of co-operation between main stakeholders
- Pan-European cooperation in the implementation of uniform transferable technologies should be the aim

Dissemination and Awareness

Fundamental for a European Research Project, and especially for the EC, is the dissemination activities that raise awareness about the results of EU funded projects. Therefore, we ensured that the project's practical outcomes are widely disseminated to the appropriate target communities, at appropriate times, via appropriate methods, and that those who can contribute to development, evaluation, uptake and exploitation of the OPTIMISM project outcomes can be identified and encouraged to participate.

A number of dissemination activities performed by the partners including development of OPTIMISM newsletter and website , attendance in conferences, publications, press releases,

organisation of workshops, social media, direct emails and phone calls with key stakeholders and finally the delivery of the final conference.

The OPTIMISM final conference, held in Brussels on the 16th of September, was the ideal forum to present research results and practical experiences of the Consortium, as well as other stakeholders. Furthermore, it was the opportunity for stakeholders to discuss the key challenges and real-world problems regarding transport systems and sustainable mobility and to communicate and discuss between/beyond disciplines. The conference was themed “Towards Sustainable Mobility with OPTIMISM” and had three main subthemes, reflecting the conference sessions’ structure:

- i. Strategies, Technologies and Methodologies for Sustainable Mobility
- ii. Future perspectives on Sustainable Mobility
- iii. Transport and climate change: what the EU needs to do

These themes reflected the issues addressed by the OPTIMISM project and provided a focus for the conference and stimulated dialogue and engagement with the participants outside the Consortium. The conference was attended by more than 100 transport experts.

Impact

On the basis of scientific breakthroughs in recent years, the explosion in the knowledge of transport systems is set to deliver a continuous stream of new applications. OPTIMISM took into consideration previous practices used and work performed by relevant projects and networks. The project acted as a catalyst in shaping the landscape of future transport research and become a strong driving force in building awareness, managing the knowledge generated, coordinating and supporting the RTD area on the future transport field.

OPTIMISM support actions aimed to create a better understanding of the travel choices of European citizens by examining their social behaviour, their travel patterns and business models. The overall objective was to enable future changes in the travel system to take place in a more sustainable way, so people can travel more efficiently, cleaner and safer.

The main impact of the project on the in TPT.2011.2-1 objectives is presented in the table below

Impact	OPTIMISM's activities
<p>Develop strategies, technologies and methodologies for integrating and optimising transport systems for passengers</p>	<p>The ultimate result of the project was a set of recommendations that aimed at the integration and optimisation of transport systems.</p> <p>Activities aimed to define ICT-based co-modality strategies and to outline their roadmaps for implementation. Together with the qualitative/quantitative assessment carried the OPTIMISM strategies provided a deeper insight into how the implementation of co-modality measures can affect the performance of passenger transport systems. The final deliverables of the project included reports/studies on the:</p> <ul style="list-style-type: none"> A. Definition of strategies for integrating and optimising transport systems B Impact assessment of strategies C Recommendations on the principles of sustainable mobility <p>This has an important impact in the field of transport planning and policy making as we provided a number of suggestions on how to shape transport policy in order to meet the sustainable transport objective without compromising mobility</p>
<p>Determine the optimum balance on “trade-offs” between operating cost vs. time headway for each combined transport mode, minimizing access, waiting and transfer times for users and minimizing total costs at the same time</p>	<p>IN OPTIMISM we identified best practices with regards to co-modality and ICT solutions. We took into consideration all costs (investment costs, operating costs) and benefits (less access/waiting/transfer time, less environmental effects, less congestion etc.) directly related to the various case studies By applying this approach a integral comparison was made between the net benefits of the various co-modality and ICT measures and solutions.</p>

	Based on the above, the EU27 wide decarbonisation potential of three ICT options was also indentified.
Model concrete door-to-door transport services according to identified population needs	<p>A number of modelling tools were used in the project:</p> <p>For macro level we used TRANSTOOLS4 & TREMOVE5 models and for micro level we used the JRC Agent Based Model.</p> <p>The results of modelling served as inputs for the development of policy recommendations on optimised transportation systems aiming at sustainable mobility patterns.</p>
Added value for passengers and the carbon-neutral transport objective.	<p>By analysing the measures and identifying the best practice and co-benefits for the passengers and for the environment a 'decarbonisation potential' document was produced taking into account ICT and co-modality options.</p> <p>This work was based on the assessment of co-modality and ICT options and measures and the impact assessment of the best practices on mobility patterns. Evidence from all over Europe was collected for the assessment of the impact of co-modality and ICT solutions including case studies, desk study and consultations of a broad set of stakeholders, including (public) transport operators, policy makers, the ICT industry, transport user associations, independent (scientific) experts, etc. The ultimate result was the estimation of the maximum technical decarbonisation potential which was defined as the reduction in GHG emissions achieved when the option is adopted by the largest number of actors (in Europe) as possible.</p>

OPTIMISM also had an impact on three main horizontal axes:

Societal & economic impact

Sustainable transport and mobility issues are a topic of strategic importance for everyday life, with major impact in the life of the human beings and its quality. One of the biggest challenges is the main contribution of transport to the emissions of GHG that are widely perceived as the main cause of global warming.

⁴ TRANS-TOOLS ("TOOLS for TRansport Forecasting ANd Scenario testing") is a European transport network model that has been developed in collaborative projects funded by the European Commission Joint Research Centre's Institute for Prospective Technological Studies (IPTS) and DG TREN

⁵ TREMOVE 2.52 model has been developed by Transport & Mobility Leuven in a service contract for the European Commission, DG Environment

Although the main results of OPTIMISM targeted policy makers, they had an impact on society too. The project delivered a set of strategies and evolved scenarios which were based on the demand and needs of the passengers. The future trends, drawn in the project, reflected on the demand linking them with the supply factors and thus introducing ideal strategies that meet the society's needs for a more efficient transport system that best serves them.

Furthermore, the project suggested the implementation of certain strategies that should lead to a more integrated and effective transport systems with expected positive effects on economic activities (technological development, cheaper ICT services, etc.), quality of life (more efficient travel implies less wasted time and less congestion, pollution and energy consumption), and social inclusion (the “new mobility paradigm” especially focused on the development of efficient collective transport solutions for all, in particular helping elderly and disabled people to travel more easily).

In order to develop sustainable transport policies and recommendations, a Multi-Criteria Assessment (MCA) was developed to support decision making by providing a framework which can be used as a guideline throughout transport decision making processes. The usage of MCA helped us to keep a balance between the three dimensions of society, economy and environment. On the socio-economic side the use of the method can support social inclusive solutions as well as cost-benefit relations. The transparency of the process further ensures a more democratic and open process of decision making.

The OPTIMISM strategies have some environmental impacts. These were estimated using TREMOVE System Dynamics. One of the scenarios indicates that the exact environmental impacts are:

- CO₂ transport emissions decreases by 1.3% in total and 1.9% for road passenger transport, from 1018 to 1005 and from 662 to 650 (million tons per year),
- NO_x transport emissions decreases by 0.1% in total and decreases 0.3% for road passenger transport, from 3772 to 3768 and from 2032 to 2025 (thousand tons per year),
- PM₁₀ transport emissions decreases by 0.5% in total and decreases 0.5% for road passenger transport, from 167.2 to 166.4 and from 131.2 to 130.6 (thousand tons per year),
- Car fleet size decreases from 255 million to 251 million with 1.8% change and number of cars with LPG/CNG technology increases by 18.2%, from 2.2 million to 2.6 million.

Apart from the environmental impacts of transport, the OPTIMISM strategies are assumed to have positive social impacts. In pursuit of a sustainable mobility system the OPTIMISM strategy targets an efficient, affordable, accessible, equitable, user friendly, safe and secure transport system. Although most of these characteristics have not been included in the modelling exercise, the following social impacts can be expected of the OPTIMISM strategy:

- Reduction in congestion, due to the expected modal shift from private transport to public transport modes. The decrease in the share of private car use (i.e. 5,9%) as a result of the implementation of the comprehensive strategy may probably result in a significant reduction of congestion levels. Particularly the provision of tailor-made travel information and integrated ticketing policies are expected to be important in this respect.
- Improvement of transport safety, due to the expected modal shift from private transport to public transport modes. Since the latter modes are safer (less accidents per passenger kilometre) an (slight) improvement in transport safety is expected. Additionally,

technologically enhanced transport infrastructure may improve transport safety and reduce the number of accidents.

It should be mentioned that the societal and economic impact of the OPTIMISM project was further enhanced, as during the final Conference, the OPTIMISM Consortium achieved not only disseminated information about OPTIMISM approaches and results that have a huge impact on society, but also facilitated collaboration and information exchange, to promote the use of the identified good practices, technologies and applications amongst appropriate transport sector communities, and to create two-way communication channels with stakeholders at local, national and EU level for disseminating the project deliverables and conclusions.

Policy impact

One of the main objectives of the project was to frame a solid scientific base which can be used by the policy makers in order to allow them take informed decisions on introducing policies that support sustainable mobility. This objective was tackled in every single work package and deliverable of the project.

As Europe is looking for efficient and innovative solutions for a cleaner, safer and more sustainable (passenger) transport system, several policies and many initiatives have already been developed. Success in these efforts depends particularly on proper analysis of proposed policies and effective monitoring of their impacts. Therefore, availability of high quality, comparable travel behaviour data with minimum required detail is crucial today. The extensive harmonisation of existing and future national travel surveys will reduce inconsistencies when comparing travel patterns among countries. With respect to monitoring the effects of policy measures, only data harmonised on a long-term basis will be appropriate

The recommendations on the **harmonization of National Travel Statistics** mainly address institutions or authorities responsible for the collection of travel data to serve policy driven data requirements, whether at national or European level. Suggestions include both directions in terms of survey design and methodology as well as in terms of data items to be collected. Furthermore, policy makers or researchers in charge of the provision of empirical-analytical or modelling based evidence are provided with references to alternative information sources enabling them to complement genuine, but maybe insufficient travel data with meaningful information.

The **macro and micro level modelling** -which took place within the framework of identifying the right sustainable transport policies- assessed the impacts of co-modality ICT-based strategies and fuel prices for the optimisation of future passenger transport systems. The identified key drivers as well as external, comprehensive megatrends can be used by transport planners as a starting point for a deeper analysis or just for having a brief overview of the relevant key factors, trends and their interrelationships. Activities concerning scenario building have no direct socio-economic impacts, but the built scenarios are used to assess the impacts of policies. Finally, the main potential impact of the modelling exercise and identification of key trends is to serve various bodies of the European Union and European Commission dealing with transport policies and evidence based policy support.

One of the promising groups of innovative technologies in the transport sector is **Intelligent Transport Systems**. Also, in the Transport White Paper, ITS is mentioned as one of the options to improve infrastructure use efficiency and decarbonisation. OPTIMISM provided a broad overview of (a specific type of) ITS options (i.e. the ITS options stimulating co-modality) and their main impacts. This may inform policy makers (both at a European, national and local level) on potentially effective measure to realize a more integrated and sustainable passenger transport system. Particularly, the in-depth assessment of the mobility and environmental impacts of three selected ITS options provides useful data for policy makers that was currently not easily available. Based on this information more informed decisions on policy instruments could be made.

The ultimate goal of the project was to introduce **strategies for integrating and optimizing transport systems**. The OPTIMISM strategies provide a deeper insight into how the implementation of co-modality measures can affect the performance of passenger transport systems. This could assist in the field of transport planning and policy making.

Transport planners and decision makers can use the list of co-modality measures/the five OPTIMISM strategies together with their assessment of mobility, environmental, social and cost impacts as a reference for the update or development of new transport plans in order to achieve more sustainable performances and better integration of local, regional and national transport systems (the seamless international travel strategy can be implemented at the European Level or only partially if two or more neighbouring countries decide to collaborate). Lastly, the roadmaps outlined for each strategy provide policy makers with some useful information for establishing the actual feasibility and for the implementation of the strategies. This information might support them in steering transport policies towards more sustainable solutions.

An important aspect that should be highlighted, it that the introduction of strategies for integration and optimizing transport systems was explicitly presented and diffused during the final conference of OPTIMISM project. Therefore, the final conference acted as a multiplier of the impact on policy, due to the efficient two-way communication between scientific and policy communities.

Research impact

Apart from the direct and obvious impact on research which is the generation of new knowledge produced by OPTIMISM, the project has also tested a number of research methodologies that can be used in other studies in the field of transportation. More specifically, the methodology to test macro scenarios with TRANS-TOOLS and TREMOVE models and the methods and techniques to design a micro mobility system to test user choice determinants with multi-agents might be used in other studies with similar purposes.

Several methodological approaches have been developed and could be used in other studies as well. The assignability factor approach developed to extrapolate the impacts of the ITS option for an individual country to other countries (and over time) could also be used in other research projects studying the impacts of ITS options or other technical options. Also the sound emission model developed could be implemented in other studies on the environmental impacts of technical and organisational measures in the transport sector.

OPTIMISM also supported the exchange of scientific knowledge and the collaborative efforts of scientists through its various activities (workshops, expert consultations, questionnaires, events). These activities stimulated the generation of new research ideas while bringing researchers together into teams around sustainable transport subjects. As an ultimate result, the OPTIMISM conference, which was attended by more than 100 participants, had a major impact into the research community, as the outcomes of research performed during the two years of OPTIMISM implementation were presented in an innovative and interesting way that promoted the scientific dialogue. The final Conference was the effective and direct tool to disseminate and create awareness in the scientific community by well-planned presentation and discussion with the research community. The final OPTIMISM Conference was structured in such a way, that the research outcomes of OPTIMISM project were on the focus by giving the opportunity to be discussed, criticised and screened by experts. Furthermore, during the OPTIMISM Conference the state-of-the-art concepts and expertise was diffused and promoted the discussion on the issues of sustainable mobility towards 2030.

Scientific papers presenting the main findings of the project were published bringing to light experiences and best practices of EU countries and countries non members of the EU

Finally, research gaps and recommendations for future research were identified.

Dissemination & exploitation

A number of dissemination channels were utilised throughout the lifetime of the project. This included the creation of newsletters, press releases, organisation of events, participation in events and publications. Some of the most important dissemination activities included:

- Workshop in Rome (18th September 2012) on ‘development of passenger mobility scenarios for Europe’
- Workshop in Brussels (14th March 2013) on ‘collecting and reporting travel behaviour data’
- Final Conference in Brussels (16th September 2013) entitled ‘Towards sustainable mobility with OPTIMISM’
- Publication of the following papers:
 - Arno Schrotten, Lars Akkermans, Hauke Pauly, Martin Redelbach, The potential of ITS to enhance co-modality and decarbonise passenger transport in Europe, International Journal of Transportation
 - Ahern, A. , Reidelbach, M, Schulz, A and Weman, G., National Travel Statistics: Travel in Europe, ITRN Conference, Belfast 2012
 - Ahern, A. , Reidelbach, M, Schulz, A and Weman, G., National Travel Statistics: Travel in Europe, WCTR conference, Rio de Janeiro 2013
 - Elisabete Arsenio, Passenger travel behavior changes in cities and metropolitan areas: What are the emerging challenges to transport policy in Europe?, TRA2014, Paris
 - Elisabete Arsenio, Research and Innovation Policies to Enhance Uptake of Sustainable Mobility Solutions, to be presented in TRA 2016

- Ahern, A.; Weyman, G.; Redelbach, M.; Schulz, A.; Akkermans, L.; Vannacci, L.; Anoyrkati, E.; Grinsver, A. Van, Analysis of national travel statistics in Europe, JRC Technical Reports
- Akkermans, L.; Maerivoet, S.; Ahern, A.; Redelbach, M.; Schulz, A.; Vannacci, L., Harmonisation of national travel statistics in Europe, JRC Technical Reports
- David Morris, Improving personalized travel information systems: a user perspective, 17th International Conference “Transport Means 2013”, Kaunas

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