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Pilot scenarios and evaluation methodology

Work package 7
Pilot demonstration and evaluation

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Annexes

No	File name	Title
1	*Annex A (included in this document)*	Questionnaires for citizen inquiries

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1 Executive summary

This deliverable describes the pilot scenarios for each one of the different pilot sites involved: all actors of a future MobiS commercial service are identified: private and professional end users (known as "citizens" in MobiS nomenclature, See deliverable D2.1), service providers/transport operators, content providers and transport authorities. Private citizens are actively involved in the pilot tests, and the pilot sites have access to data from content providers in varying degree. The pilot scenarios and the various test cases they entail are presented for each pilot site:

- An intra-city scenario will be experimented in the frame of the Greek site (Thessaloniki case) and will consider *Car modal trip plan & Traffic information to users* as one scenario and *Assisting traffic operation to traffic managers and knowledge extraction from traffic experts* as a second one;
- An inter-city scenario will be experimented in the frame of the Slovenian site and will consider *Travelling on predefined routes from point A to B* and *Travelling inside Ljubljana Motorway ring* as its two scenarios.
- An inter-city scenario will be experimented in the frame of the Swedish site and will consider three scenarios: *Commuting citizens travelling between the Hudiksvall or Stockholm municipality* and *Home automation*.

Moreover the evaluation methodology is described and will be focused on the following steps:

- Before the pilot operations start,
- During each pilot operation,
- At the end of each pilot operation.

The tools needed to evaluate the pilot tests are defined, using the key goals of the MobiS project and those specific to task 7.1 as a scope, as specified in *the Description of Work* (respectively *B1.1.5 Scientific and technological objectives* and *B1.3.5.7 WP7 – Pilot operation and evaluation*). Key Performance Indicators are defined in three categories:

- Indicators for the technical performance of the service, groups of KPI are defined, characterising:
  - The response time from an initial citizen request for a MobiS service to the proposed action;
  - The response time from receiving a traffic event to proposing rerouting actions;
- Indicators for the traffic behaviour of private citizens under normal and abnormal conditions (a condition is deemed abnormal when the trip duration is larger than average by a predetermined amount):
  - The change in travel time for trips under normal/abnormal conditions;
  - The change in energy consumption under normal/abnormal conditions;
  - The change in CO_2 emission under normal/abnormal conditions;
- Indicators for user experience of private citizens:
  - How easy is it to plan a new trip using the MobiS terminal application?
  - How easy is it to react to event updates during a trip?
  - How would you grade the ergonomics of the application?
  - How satisfied are you with the general experience of the service?
  - How stressed do you feel at the prospect of starting a new trip planned with MobiS?
  - Do you have comments or suggestions that you wish to share with us?

The measurement methodology for each indicator is detailed. It entails logging in the terminal application and gathering user feedback using a web questionnaire, focus group meetings and/or personal interviews. Some of these indicators need a base line measurement prior to the pilot tests.

This base line is obtained prior to the start of the pilots, for some indicators by having the citizen travel with a terminal equipped with logging software and for some indicators by directly inquiring with the citizen (using a questionnaire, focus groups of individual interviews).

2 Terms and conventions used in the document

The following acronyms and abbreviations are used in the present document:

TERM	DEFINITION
B2B	Business to Business
B2C	Business to Customers
KPI	Key Performance Indicator

3 Introduction

3.1 Objectives of the document

The objectives of this document, as defined in the *Description of Work*, are:

- To define the pilot scenarios for each one of the different pilot sites involved;
- To define the evaluation methodology for the pilots;
- To define key performance indicators that clearly set the goals and targets for the pilot tests. These indicators will be used to evaluate the impact of the MobiS service on citizens.

3.2 Results documented in the Deliverable

This deliverable documents the work performed to prepare the pilot tests at the three sites in Slovenia, Greece and Sweden: For each site, the main actors (citizens, businesses and authorities) are identified, the pilot scenarios are documented along with the various test cases they imply.-

The document describes the methodology used to evaluate the pilot tests. Using the key goals of the MobiS project and those specific to task 7.1 as the scope for the task, a set of Key Performance Indicators (KPI) is identified. Each indicator is explicitly defined and linked to a project goal. The measurement methodology that should be applied to obtain the indicator is then detailed.

4 Pilot stories

This chapter presents the context of each pilot story and the criteria to take into account when building and evaluating the MobiS system. An extensive description of the pilot stories can be found in chapter 5 of deliverable D2.1 *User and system requirements*.

The first section presents the context of the pilot stories. The second section introduces the various actors with stakes in the MobiS system. Then follow three sections describing the actors involved in the pilot tests of the three sites.

4.1 Context of the pilot stories

The pilot tests that will be set up in MobiS will take place in 3 sites: an intra-city case in Greece in the city of Thessaloniki, and two inter-city cases: between Stockholm and Hudiksvall in Sweden, and between Maribor, Ljubljana and Koper in Slovenia.

4.1.1 Pilot story in Greece

Thessaloniki is the second-largest city in Greece and the capital of the region of Central Macedonia in the northern part of Greece. . The city district encounters major traffic problems due to the inefficiency of the road infrastructure, on-going activities in the city centre for building public transport infrastructures and the population increase. Thessaloniki intra-city case scenario concerns also the urban area of the city (city district) and the major road exits and entrances to/from Chalkidiki area which is very popular and touristic destination especially during the summer period.

Thessaloniki pilot is about providing real-time car-route planning and traffic information to travellers who are moving with private or professional vehicles, assisting traffic managers regarding the traffic status of the road network, as well as enhance and/or update the traffic status situation based on transport operators' knowledge and view especially for the interurban road network of Chalkidiki area.

4.1.2 Pilot story in Sweden

The Swedish intercity-case scenario concerns the area located between the cities of Hudiksvall and Stockholm. It is characterised by long distances through vast, sparsely populated rural areas. It starts, ends and passes both large and small transport links, roads, motorways, tunnels and bridges, local urbanized areas which are densely populated.

The Swedish pilot is about assisting inter-city and intra-city travel by providing a choice betweens bus, train, subway, commuter train, car sharing and the user's private vehicle or a combination of those.

4.1.3 Pilot story in Slovenia

Slovenia is a small country that lies in the centre of two main transport corridors, which induces specific mobility patterns. Three main traffic modes are observed: a daily migration from urban areas to main cities, transport and tourists crossing Slovenia on the northeast (HU) - southwest (IT) and southeast (CRO) - northwest (AT) routes in Europe, and tourist travels.

There is currently no routing and mobility planning service that will gather existing information and plan the route based on the real traffic conditions and historical data. The most used applications are those that come together with GPS and smart phones that are using only two criteria for planning: fastest route or shortest route.

The pilot is about planning mobility routes throughout the country using any means of transport available.

4.2 The MobiS environment and its actors

When looking at MobiS as the global service that we want it to become, many actors can be identified with a stake in the platform. MobiS maintains Business to Customer (B2C) relationships with end users, and Business to Business (B2B) relationships with others are businesses and public authorities.

4.2.1 MobiS actors

The various actors of MobiS are in figure 4 (section 6.2) of deliverable D2.1 *User and system requirements*, which is reproduced below.

Actor	Description
User	User refers to anyone who makes use of MobiS. Could be a citizen, a traffic expert, traffic operator, etc.
Citizen	Is the one who has a mobility plan and requests proposals from MobiS. The citizen maintains a profile on MobiS with information that the system could use every time for route calculation. The citizen has a plan that can either be inserted manually and/or through his/her calendar application. The citizen monitors information on the traffic and takes actions proposed either by MobiS or upon request to the application.
Traffic expert	Traffic expert is the one who monitors the traffic situation in a city/region. The traffic expert is a role specified in Thessaloniki case and monitors information from external sources on events in traffic and illustrates/communicates those events to citizens through specific media (map, notifications, etc.).
Social media	Provide the necessary functionality through which the citizens can inform or be informed on any traffic event (e.g. Twitter, Facebook, etc.). Through social media the citizens also can share experiences on the mobility plans they have used.
Smart home applications	Smart home applications can be triggered by MobiS upon agreement of the citizen. This actor is specific for the Sweden case.

Citizens are characterized by the fact that they travel and interact with the MobiS service through the user console. They can be split further into two categories, based on the type of relationship (B2B or B2C) that MobiS maintains with them. MobiS users who are citizens encompass:

Professional citizens: They are citizens who travel as their professional occupation. They are for example bus, taxi or truck drivers. MobiS impact can be large as they spend their working time on the road and some of them are flexible in their itinerary.

Private citizens: They are citizens who do not have travel as their professional occupation. They are consumers of the service going to work, university or travelling for leisure. They have more flexibility in their travel and can be convinced to switch transportation means (car, car sharing or pooling, and public transportations).

MobiS users who are not citizens are a larger, more varied group. They encompass:

Service providers/transport operators: These are companies that provide a public or private transport service such as public busses and subways, trains, or good delivery using trucks. They typically employ professional users of MobiS. Whereas the professional drivers use MobiS for immediate itinerary guidance, service providers can use MobiS in no small part to plan their business and dimension the service they offer.

Content providers: These are companies that provide information used by MobiS to offer its service. Traffic information can for example be provided by provider of the transport service (schedule, disturbances), by local authorities and by brokers (companies that access the raw data and add a service to it). This category regroups traffic experts, social media as well as providers of other types of content such as weather forecast or the environmental impact of a journey.

Transport authorities: These are the authorities overseeing transport, either at the local or national level. They are for example the municipalities that delegate public transport to service

providers, or national authorities in charge of the road and railway infrastructures. For them, MobiS can be a service to plan the future by dimensioning infrastructures and influence or transport habits.

Each of these businesses has a specific role in the value chain of the MobiS environment

4.2.2 Target audience of the pilot tests

The pilot tests will be small scale deployments. As such, they will not involve all types of users mentioned above. The pilot tests also involve some of the players in a non-commercial way, as is common in such a situation: MobiS gets free access to content under a number of (non-commercial) agreements. When MobiS is deployed as a commercial service, the relationship with these content providers will change. The target audience of each pilot site is described in the next sections.

4.3 Users and pilot scenarios of the Greek pilot test

4.3.1 Users

- Commuters, either professionals or private citizens who are driving within the city district.
- Commuters, private citizens who are travelling either from or to Chalkidiki area
- Traffic managers who are responsible for the traffic management policy of an urban network of the city
- Traffic experts who have a well structured knowledge of the traffic status of the road network
- Data providers
    - Ambient data coming from
        - Loop detectors
        - Bluetooth devices
        - Floating Car Data
    - Crowdsourcing data coming from:
        - Journalistic data (mainly through Websites)
        - Social Networks (Facebook, Twitter)

4.3.2 Pilot scenario A: Car modal trip plan & Traffic information to users

The scope of this scenario is to facilitate the mobility of residents and visitors in urban areas. The users of the service have access to a web portal through which they can find an optimum route from an origin to a destination using car transport mode while they can also obtain traffic information that may be useful for their trips. The same information may be downloaded in mobile devices too. The scenario contains two core test cases:

4.3.2.1 Test case A1: Car-modal real time trip planning: this test case delivers car-modal routes (combining car and pedestrian) via a MobiS web and mobile application taking into consideration real-time traffic conditions which are calculated based on the enhanced traffic information (traffic information coming from infrastructure such loop detectors, bluetooth sensors and crowdsourcing info coming from websites and social media).

4.3.2.2 Test case A2: Traffic Information: this test case presents traffics flows, travel times and road incidents on map via web & mobile applications. Especially for road incidents will be generated either from social media sources (websites, Twitter, Facebook) or official reports announced by authorities and MobiS sends a notification to citizen.

4.3.3 Pilot scenario B: Assisting traffic operation to traffic managers and knowledge extraction from traffic experts

The scope of this scenario is to be provided enhanced traffic information to traffic managers and either positive or negative confirmation of traffic situation, extracted by MobiS, will be provided by traffic expert. On one hand Traffic manager retrieves MobiS traffic feed on news about traffic situation in the city. MobiS will read and make a knowledge extraction from that news and on the other hand Traffic

expert will confirm or not if MobiS knowledge conclusion is correct or not, based on his traffic experience and network knowledge.

4.3.3.1 Test case B1: Assisting traffic manager regarding the traffic status of road network especially for Chalkidiki area. Based on historical content, the number of scheduled trip plans and real time traffic information, the predicted traffic situation will be extracted. The predictive traffic status of road network will help traffic manager to better estimate the status of the transportation system in Chalkidiki area and support his policy making process.

4.3.3.2 Test case B2: Knowledge extraction from traffic experts especially for commuters going to or coming from Chalkidiki area. Based on the number of scheduled trip plans the predicted traffic situation will be extracted through MobiS, a traffic expert will confirm or reject the predicted traffic status. In case of negative confirmation then MobiS system will be updated based on the provided feedback (in qualitative format) from traffic operator.

4.4 Users and pilot scenarios of the Swedish pilot test

4.4.1 Users

- Private citizens living and working in the greater Hudiksvall;
- Private citizens living and working in the greater Stockholm.
- Private citizens who live in either Stockholm or Hudiksvall and who commute to work.
- Various data providers that the MobiS service has access to:
    - Samtrafiken
    - ResRobot
    - Trafikverket
    - SL
    - Resihop
    - Volvo Commute Greener
    - Swedish Transport Administration
    - City of Stockholm
- Some services created from the ground up by MobiS partners.

4.4.2 Pilot scenario A: Commuting user travelling between the Hudiksvall and Stockholm municipalities

The scope of this scenario is to provide travel assistance within the municipalities and along the axis between them. The citizen is proposed several choices for its journey, using various means available: personal car, car sharing or public transportation: bus, subway, commuter train, or a combination thereof.
Possible journeys are ordered considering the criteria of interest of the citizen (time, and environmental impact) and taking into account the weather and traffic conditions.
This scenario contains several test cases:

4.4.2.1 Test case 1: The citizen chooses to travel by car

MobiS monitors the status of the journey and informs the citizen in case of traffic events such as congestions and accidents. When such an event occurs, the citizen receives an alert; journey updates are proposed if necessary.
Adapters to real-time traffic data from traffic cameras (trafikverket) are used. Furthermore, the communication layer used, MediaSense, supports crowdsourcing and will allow client applications to share information in real-time (see for example the *Description of Work B1.1.2.2, B1.1.2.3, B1.1.3, and B1.3.2.2*). This capability will be used to gather and provide traffic information to MobiS citizens.

4.4.2.2 Test case 2: The citizen chooses to travel by public transports

MobiS monitors the status of the journey and informs the citizen in case of planned traffic perturbations. If a connection is expected to be missed, due to a delay, the citizen receives an alert and new and updated journeys are proposed.
Adapter to data sources from municipal public transports (in Stockholm and Hudiksvall) and from the national train are used.

4.4.2.3 Test case 3: The citizen chooses to travel by car sharing

A adapter will be developed to let MobiS interact with a 3rd party car sharing services. Through this adapter, citizens will be able to take part in car sharing, either as a passenger in someone else's vehicle or by offering a ride to a potential passenger. During the trip, MobiS will provide the same service as with test case 2.
An extra adapter will be used to connect to the 3rd party car sharing service.

4.4.3 Pilot scenario B: Home automation

The scope of this scenario is to provide energy savings through a home automation service connected to MobiS. When the citizen leaves home, the MobiS terminal connects to the home automation terminal and sends the AWAY signal. Lightning and temperature settings are adjusted accordingly. When the citizen is on her way home (determined either by geo-location or by specifying home as the destination of the journey), the MobiS terminal connects to the home automation terminal and sends the HOME signal. Lightning and temperature settings are adjusted accordingly.

4.5 Users and pilot scenarios of the Slovenian pilot test

4.5.1 Users in Slovenian case

- Commuters, private citizens who are travelling between Slovenian cities – special to commuters to or from Ljubljana.
- Commuters, either professionals or private citizen who are driving inside the Ljubljana Motorway ring

4.5.2 Pilot scenario 1: Travelling on predefined routes from point A to B

The scope of this scenario is to facilitate the mobility of commuters and tourists from or to Ljubljana. MobiS citizens have access to a web portal or mobile application provided by MobiS, through which they can find an optimum route from an origin to a destination using any means of available transport (Car, Bus, Train and Carpooling). All the relevant information (Cost, Time, Weather info) is taken into consideration. The scenario contains two core test cases:

4.5.2.1 Test case 1: Citizen selects predefined route and MobiS will give citizen multiple results to choose from (Cost, Time, ECO, etc ...)

4.5.2.2 Test case 2: Citizens gets automatic alert to their mobile phone (through an app, an SMS or an Email) based on schedule. (Start your trip now if you don't want to be late)

4.5.3 Pilot scenario B: Travelling inside Ljubljana Motorway ring

The scope of this scenario is to provide commuters or professional drivers best way of travelling inside Ljubljana Motorway ring. Here we will also use additional information (parking, bicycle network, public transport (mainly Ljubljana Bus network)).

4.5.3.1 Test case 1: Citizen arrives to Ljubljana and he wants best possible route to destination inside Motorway ring

4.5.3.2 Test case 2: Routing inside Motorway ring for professionals (Taxi, Delivery, etc ...) using car with support for journey updates and automatic re-routing based on traffic flow.

4.5.3.3 Test case 3: Routing inside Motorway ring for commuters (going to and from work inside Ljubljana Motorway ring) using any travel means available.

5 Tools to evaluate the pilot tests

This chapter is organised as follows: the first section presents what aspects of the MobiS and its impact we want to evaluate, in relation to the *Description of Work*. The second section describes the methodology that we use to do so. Finally, the third section analyses the set of KPI chosen to evaluate the pilot tests.

5.1 Key goals of the MobiS platform

The overarching goal of MobiS, as stated in the *Description of Work, B1.1.5 Scientific and technological objectives (table 4)*, is to improve journey planning compared to tools available today. The key objectives with their associated success criteria/metrics used to evaluate this improvement are shown in Table 1

Table 1 List of objectives and associated criteria used to evaluate the improvements provided by MobiS. Ref in column 2 refers to the sub-objective number in Table 4 of the Description of Work.

Criterion	ref	objective	Key success criterion/Metrics
1	2.2	Design and implementing MobiS modelling and prediction capability	MobiS modelling and prediction prototype saves energy consumption on a pilot scale by >10%
2	2.2	Design and implementing MobiS modelling and prediction capability	MobiS modelling and prediction prototype decreases the pollution on a pilot scale by > 7%
3	2.3	Design and implementing MobiS reasoning and decision function	MobiS reasoning and decision function prototype provides the increase of successful planned routes by >15%
4	2.3	Design and implementing MobiS reasoning and decision function	MobiS reasoning and decision function prototype provides accurate explanation of selected routes for >85% accuracy.
5	4.4	Assessment of MobiS results	If fully deployed in the pilot areas, MobiS aims to reduce average travel time by 5% to 15% on user basis.

Criteria 1, 2 and 5 refer to the general modelling and prediction capabilities of MobiS, and they can be measured from the user experience. The way to evaluate them is described in this document.
Criteria 3 and 4 are stated here for completeness, but they belong to the MobiS reasoning and decision module of the platform. They will be defined once the scalable techniques are developed and MobiS reasoning engine is enabled.

Furthermore, key elements that we need to monitor with the MobiS pilots are stated in the *description of work* for task 7.1. MobiS needs to provide a service with suitable technical performance, ensuring security and privacy for its users, and the service has to prove valuable and improve users' mobility.
The key areas that we need to evaluate are:

The technical performance: We need to ensure that the provided service is technically working.

Security and privacy: We need to ensure that the communication between citizens and the MobiS service is secure and that personal information is dealt with appropriately. This matter is discussed in chapter 6.

Impact on mobility: Ultimately, MobiS success depends on whether or not MobiS adds value to our citizens. How MobiS impacts citizens can be observed in several ways:

Traffic behaviour: Do citizens change their traffic behaviours when using MobiS? And is this new behaviour more efficient, in terms of travel time, energy efficiency and CO_2 emissions?

User feedback: Beside what we can measure directly, what do MobiS citizens have to say about the service?

5.2 Evaluation methodology

In order to evaluate the impact of the MobiS service on citizens, metrics of interest, KPI, need to be defined that describe the performance of the MobiS service. These KPI are obtained either by direct inquiry with the citizens or from measurements related to the trips they perform (see section 5.3).

To allow that evaluation, monitoring of citizens' travel details is necessary. A reference value is also needed, which describes the state or the metric before MobiS was used. The following evaluation methodology will therefore be used:

- Before the pilot operations start, the travelling habits of the citizens will be monitored for a period of time in order to gather a base line that can be used to compare with. This point in time will also be used to perform direct inquiries with them.
- During each pilot operation, adequate monitoring of citizens' travelling habits and trips will occur.
- At the end of each pilot operation, the gathered data will be analysed to extract the KPI. KPI will be calculated using the base line as a reference. KPI will also be calculated using the result of the previous pilot operation, when applicable.

In addition, it may be relevant to consider various groups of users or trips:

- Some of the metrics are interesting at the level of a pilot site: for example, the project goals in terms of decrease in energy consumption, pollution and reduction in travel time are on a pilot scale.
- For some pilot sites, citizens may have the possibility to specify their priority when planning a trip: shortest time or lowest environmental footprint. It can be expected that there is a compromise between these choices and that the fastest route is not necessarily the cheapest and the most environmental friendly. In pilot sites where it is relevant, the chosen priority will be logged for each trip, and relevant KPI will also be calculated per priority group using only trips with the corresponding priority.
- When assessing the impact of MobiS, not all citizens start on an equal foot: some of them may have been using a trip planner of some kind, which will affect their baseline. It is therefore of interest to define groups of citizens using their previous trip planning tool as the common point, and to calculate the relevant KPI for the groups that previously used a planning tool that we want to compare to MobiS.
- Finally, it may be important to be able to provide feedback to the citizen and have arguments to convince them of the impact of the MobiS service. Therefore, relevant KPI will also be calculated at the citizen level for all their trips and, where relevant, by group of trips.

So each KPI of interest can be declined into a family of 12 indicators, depending on how citizens and trips are grouped, as summarised in the table below.

Table 2 Family of key performance indicators, depending on which groups of citizens and trip priorities are considered: The first column indicates the priority selected when requesting the trips; the first row indicates how the group of citizens was selected.

	All citizens of the pilot site	**All citizens who used a given trip planning service s**	**Single citizen**
All trip priorities	$KPI_{pilot\ site}^{global}$	KPI_{s}^{global}	$KPI_{citizen}^{global}$
CO_2	$KPI_{pilot\ site}^{CO_2}$	$KPI_{s}^{CO_2}$	$KPI_{citizen}^{CO_2}$
Energy consumption	$KPI_{pilot\ site}^{En}$	KPI_{s}^{En}	$KPI_{citizen}^{En}$
Travel time	$KPI_{pilot\ site}^{t}$	KPI_{s}^{t}	KPI_{s}^{t}

5.3 Key performance indicators

5.3.1 Scope

In order to measure the performance and impact of the service that we are putting in place, we have chosen to put in place Key Performance Indicators (KPI) [1] as our metric: a small, carefully chosen number of parameters that are quantifiable and representative of the goals that we want to achieve.

The goal of Key Performance Indicators is to provide feedback on all aspects listed above of the MobiS platform, in order to evaluate its success and limitations [2].

For technical aspects of the service such as the technical performance and the impact on traffic behaviour, *quantitative* indicators should be used when possible, as they are best suited to provide an objective evaluation. For aspects related to citizens, a mix of *qualitative* and *quantitative* indicators should be used. In particular feedback and suggestions should be gathered as part of our effort to evaluate the pilot tests.

5.3.2 Key Performance Indicators

Some performance indicators have an intrinsic meaning: for example, the response time of the client application to citizen input characterises how reactive the service is. Many indicators, however, characterise a change and are interesting when compared to a reference or base line.

As far as citizens are concerned, many indicators characterize a change compared to before MobiS was used (for example the transportation habits). In such cases, a baseline has to be measured for such indicators before the citizens start using MobiS. Whenever possible, the baseline should be measured in the same way as the indicators gathered later when using the MobiS service.

A baseline for the citizens will be gathered in the client application and by inquiring with the citizen using a web questionnaire, a focus group and/or personal interviews:

- For indicators gathered by the client application (for example traffic habits), a terminal gathering the relevant indicators is provided to them during a predefined period of time before the pilot tests start. When the MobiS service is ready to be provided, the terminal is updated with the proper app providing the service.

- For indicators obtained on the citizens' habits through an inquiry, a simplified version of it (containing only the questions that are relevant before MobiS has been used) should be performed at the start of the pilot tests.

KPI will be exploited in the following way: There will be 2 iterations of pilot tests on each site, providing respectively intermediate and final indicators: the first iteration of pilot operation will take place during months M19-M23. The second iteration will take place during months M26-30 (see *Description of Work, description of WP7*). When baseline indicators are available, both intermediate and final indicators should be compared to the baseline to provide an estimation of how MobiS affected the situation. The intermediate and final indicators should also be compared to show how the MobiS service evolves.

While there would be many KPI of interest in a full-blown MobiS service, we have identified a small set of indicators that are relevant already in our small scale pilot tests. These KPI are grouped into the following categories: Indicators for the technical performance of the service, traffic behaviour of private citizens, and user experience. They are summarized in Table 3.

5.3.2.1 Indicators for the technical performance of the service

The technical performance for the service will be assessed in the terminal application using two groups of indicators:

1. The response time from an initial citizen request for a MobiS service to the proposed action.
2. The response time from receiving a traffic event to proposing rerouting actions.

The first group contains two quantitative indicators: the average response time $\boldsymbol{\mu t_{user}}$ and the standard deviation $\boldsymbol{\sigma t_{user}}$. Likewise, the second group contains two quantitative indicators: the average response time $\boldsymbol{\mu t_{event}}$ and the standard deviation $\boldsymbol{\sigma t_{event}}$. These indicators illustrate how responsive the service feels.

The average $\boldsymbol{\mu}$ and standard deviation $\boldsymbol{\sigma}$ of a given set $\mathbf{x_i}$ of $\mathbf{n}$ measured values of $\mathbf{x}$ is obtained by the following formulas:

$$\boldsymbol{\mu} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{x_i}$$

$$\boldsymbol{\sigma} = \sqrt{\frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} (\mathbf{x_i} - \boldsymbol{\mu})^{\mathbf{2}}}$$

These indicators are not influenced by the type of planning tool that the citizen used prior to MobiS. There is therefore no reason to calculate them for such groups. On the other hand, response times may be influenced by the complexity of the query sent, which may depend on the priority chosen for the trip. Response times may also be influenced by the network bandwidth, which can vary with the location of the citizen. Therefore, these indicators should be also calculated using priority groups as well as individual citizens.

Measurement methodology: For each citizen request, the time laps from the moment the citizen sends a request until the moment trips are proposed is measured and stored in the terminal application as $\boldsymbol{\delta t_{user}}$. This log is later retrieved from all user terminals to calculate $\boldsymbol{\mu t_{user}}$ and $\boldsymbol{\sigma t_{user}}$ off line.
Similarly, for each event update received by the terminal, the time laps from the moment the terminal receives an event update until the moment trip updates are proposed is measured and stored in the terminal application as $\boldsymbol{\delta t_{event}}$. This log is later retrieved from all user terminals to calculate $\boldsymbol{\mu t_{event}}$ and $\boldsymbol{\sigma t_{event}}$ off line.

5.3.2.2 Indicators for the traffic behaviour of private citizens

The traffic behaviour of private citizens will be assessed by measuring the gain in travel time, consumed energy and released carbon dioxide. To do so, the traffic behaviour of the citizens needs to be assessed before the pilot tests begin.

Measurement methodology: Before the pilot tests begin, the travel behaviour of the citizens will be measured during a selected period of time. Citizens will be equipped with terminal applications that measure their travel habits to provide a base line. For each trip, the application will record:

1. The point of origin;
2. The point of destination;
3. The start time and duration;
4. The distance travelled;
5. When necessary, the transportation means.

Point number 5 is only relevant for the Swedish site, where several means of transportation are considered.

Other important data points will be gathered by inquiring citizens using the questionnaire: which trip assistance device or service they use, if any; and the type of vehicle used, which is necessary to calculate the environmental impact.

The data will be retrieved at the end of the pre-pilot and processed off line. For each citizen, a baseline profile will be obtained, consisting of a list of frequent trips (same origin and destination). For each of these frequent trips, a number of characteristics will be calculated:

- The average travel time $\mathbf{\Delta t_0}$ and standard deviation $\mathbf{\sigma t_0}$, which characterise the particular frequent trip under normal conditions;
- The average travel time $\mathbf{\Delta t_{0abnormal}}$ and standard deviation $\mathbf{\sigma t_{0abnormal}}$, obtained considering trips lasting longer than time $\mathbf{\Delta t_0 + 3\sigma t_0}$ ("3 sigma rule"[3]) which is used to characterise the particular frequent trip under abnormal conditions (a road event such as an accident, unexpected traffic of some kind);
- Using the travel time, the travel distance, the type of vehicle or transportation means and look-up tables (see for example [4]), the average travel energy $\mathbf{E_0}$ and the average CO_2 emission $\mathbf{\gamma_0}$ will be calculated.

During the pilot tests, the terminal application providing the MobiS service will record the same data as the application used to provide the base line. The data will be retrieved from the terminals at the end of the pilot tests and processed off line and processed in the same way as for the base line.

For each citizen, trips observed during the pilot test will be matched with frequent trips recorded for the base line. For each frequent trip of each citizen, **changes in parameters are the key performance indicators providing a quantitative measurement of the impact of the MobiS service**: $\mathbf{(\Delta t_0, \Delta t_{0abnormal}, E_0, E_{0abnormal}, \gamma_0, \gamma_{0abnormal}) => (\Delta t, \Delta t_{abnormal}, E, E_{abnormal}, \gamma, \gamma_{abnormal})}$:

- The change in travel duration for trips under normal conditions $\mathbf{\delta t = (\Delta t - \Delta t_0)/\Delta t_0}$
- The change in travel duration for trips under abnormal conditions $\mathbf{\delta t_{abnormal} = (\Delta t_{abnormal} - \Delta t_{0abnormal})/\Delta t_{0abnormal}}$
- The change in energy consumption under normal conditions $\mathbf{\delta E = (E - E_0)/E_0}$
- The change in energy consumption under abnormal conditions $\mathbf{\delta E_{abnormal} = (E_{abnormal} - E_{0\,abnormal})/E_{0\,abnormal}}$
- The change in CO_2 emission under normal conditions $\mathbf{\delta\gamma = (\gamma - \gamma_0)/\gamma_0}$
- The change in CO_2 emission under abnormal conditions $\mathbf{\delta\gamma_{abnormal} = (\gamma_{abnormal} - \gamma_{0\,abnormal})/\gamma_{0\,abnormal}}$

These indicators can be calculated for other data sets than a single frequent trip of a citizen: all the groups considered in section 5.2 can be used. The values of the reference point ($\mathbf{\Delta t_0}$, $\mathbf{\Delta t_{0abnormal}}$, $\mathbf{E_0}$, $\mathbf{E_{0abnormal}}$, $\boldsymbol{\gamma_0}$, $\boldsymbol{\gamma_{0abnormal}}$, $\mathbf{C_0}$, $\mathbf{C_{0abnormal}}$) are replaced by averaging over the data set of **n** frequent trips:

$$\mathbf{\Delta t_0} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{\Delta t_{0_i}}$$

$$\mathbf{\Delta t_{0abnormal}} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{\Delta t_{0abnormal_i}}$$

$$\mathbf{E_0} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{E_{0_i}}$$

$$\mathbf{E_{0abnormal}} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{E_{0abnormal_i}}$$

$$\boldsymbol{\gamma_0} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \boldsymbol{\gamma_{0_i}}$$

$$\boldsymbol{\gamma_{0abnormal}} = \frac{\mathbf{1}}{\mathbf{n}} \sum_{\mathbf{i=1}}^{\mathbf{n}} \boldsymbol{\gamma_{0abnormal_i}}$$

The values of the second point are calculated likewise, and the indicators (change in travel duration, in energy consumption and in CO_2 emission) are calculated as before.

5.3.2.3 Indicators for user experience of private citizens

The **user experience** of private citizens will be assessed by inquiring them all with the ergonomics and ease of use of the service and the terminal interface, the general experience of the service and their stress level. A field allowing free comments and suggestions will also be used to allow more feedback.

Measurement methodology: Before the pilot tests begin, a pre-trial inquiry will be used to evaluate the stress level of the citizens and their level of satisfaction with their current trip planning tool. At the end of each pilot test, citizens will be inquired again. Answers to the questions will be in the form of a grading from 1 to 10 (except for the free comments and suggestions field), to allow an easy, quantitative evaluation.

Pre-pilot inquiry related to user experience:

1. How stressed do you feel at the prospect of starting a new trip? *1..10*

Post-pilot inquiry related to user experience:

1. **EoU1**: Grade how easy is it to plan a new trip using the MobiS terminal application *1..10*
2. **EoU2**: Grade how easy is it to react to event updates during a trip *1..10*
3. **EoU3**: Grade the ergonomics of the application *1..10*
4. **Ex**: Grade your satisfaction with the general experience of the service *1..10*
5. **S**: How stressed do you feel at the prospect of starting a new trip planned with MobiS? *1..10*

6. **CS**: Do you have comments or suggestions that you wish to share with us? *Free form*

Table 3 KEY PERFORMANCE INDICATORS – the table lists per category all the indicators implemented in MobiS, the measurement point (the indicators are calculated off line using the data collected at that point) and whether a base line needs to be collected before the pilot tests start.

Symbol	Category	indicator	Measurement point	Base line
	Technical performance of the MobiS service			
μt_{user}	Response time from user request to proposed action	Average time	Terminal application	No
σt_{user}	Response time from user request to proposed action	Standard deviation	Terminal application	No
μt_{event}	Response time to reroute from initial event to proposed action	Average time	Terminal application	No
σt_{event}	Response time to reroute from initial event to proposed action	Standard deviation	Terminal application	No
	Traffic behaviour of private end users			
δt	Change in travel time	Normal conditions	Terminal application	Yes
$\delta t_{abnormal}$		Abnormal conditions	Terminal application	Yes
δE	Change in energy consumption	Normal conditions	Terminal application	Yes
$\delta E_{abnormal}$		Abnormal conditions	Terminal application	Yes
$\delta \gamma$	Change in CO_2 emission	Normal conditions	Terminal application	Yes
$\delta \gamma_{abnormal}$		Abnormal conditions	Terminal application	Yes
	User Experience			
EoU1	Easiness to plan a new trip		Questionnaire	No
EoU 2	Easiness to react to events		Questionnaire	No
EoU 3	Application ergonomics		Questionnaire	No
Ex	General experience		Questionnaire	No
S	Stress level		Questionnaire	Yes
CS	Comment or suggestion		Questionnaire	No

5.4 Citizen inquiries

Inquiries are used to gather feedback from the citizens. They can take the form of web questionnaires, focus group meetings, individual interviews or a combination thereof. The pre-pilot inquiry is performed before the first pilot test operation. The post-pilot inquiry is performed at the end of each pilot test operation.

The current version of the inquiries is provided in Chapter **Error! Reference source not found.** (Annex A). It may be enhanced before or during the pilot operations, using information available at the time the inquiries are finalised.

6 Security and privacy

The MobiS service needs to ensure that the communication between citizens and the MobiS service is secure and that personal information is dealt with appropriately. This is achieved through several means. The first section discusses security; the second section discusses privacy issues and how they are dealt with in the three pilot sites.

6.1 Communication security

A citizen accesses the MobiS service using either a web service or a client application installed in a terminal, typically a smartphone. Data exchange between the citizen and the MobiS service is considered private communication and should be protected accordingly.
During the pilot tests, standard encryption techniques will be used to protect the communication between the citizens and the MobiS service. The same solution is expected to be usable for the deployment of a commercial service.

6.2 Citizen privacy

The MobiS project will only collect private data in compliance with the EU regulations.

To protect the privacy of MobiS citizens, the first step is to collect only necessary personal information and, if possible, to not connect it with the owner's identity. The citizens will be informed of the data collection, agree to it and to the way it is used. The data will not be used in other ways not agreed upon, and it will not be shared outside of MobiS.

Because of the need to measure the performance of MobiS and evaluate whether the project is reaching its goals, more data will be gathered about the test pilots than would be with ordinary citizens of the service in a commercial scenario. The three pilot sites implement different scenarios. The next three subsections describe how privacy is handled for each pilot site.

6.2.1 Privacy in the Greek pilots

The privacy aspect for the Greek pilot site was fully clear in deliverable *D2.1, section 5.1.5*:
No privacy issues are applied to Thessaloniki pilot site. Regarding floating car data only identification of vehicle (random vehicle ID will be used) and not drivers will be used. European regulation will be followed about personal data and all data (floating car data or MobiS pilot participants) presented shall be made and remain anonymous and not be traceable to any specific person or company.

6.2.2 Privacy in the Slovenian pilots

For the Slovenian pilot, citizens can either access a limited version of the service anonymously (no personal information required) or the full version after creating a users account. When creating an account, citizens have to provide an email and a phone number. Citizens will have the choice between two different client applications: a web application and a mobile application.

The web application provides does not require citizens to log in:

- Anonymous users: citizens who do not log in will be anonymous and have access to current traffic events on the selected route without historical data. No data will be saved anywhere.
- Authenticated users: Citizens who authenticated will have access to everything including their own historical data. They will have the ability to receive updates about their selected routes automatically from the server side (Push notifications via e-mail). All saved user routes and inquiries will be saved to the server. Citizens have the ability to delete that data.

The mobile application requires citizens to log in to access the service:

- Authenticated users: Citizens will have access to everything including their own historical data. They will have the ability to receive updates about their selected routes automatically from the server side (Push notifications via SMS or Mobile alerts). Their GPS coordinates

with their current speed and time mark for selected routes will be saved to their user profile. Citizens will be able to delete that data.

Authenticated citizens will also see data characteristic of their trips saved, to allow the MobiS project to calculate key performance indicators, as described in chapter 5. That data will only be shared after anonymisation, and the identity of the citizens will be deleted from the logged data once it is no longer necessary.

6.2.3 Privacy in the Swedish pilots

On the Swedish site, citizens will see data characteristic of their trips saved, to allow the MobiS project to calculate key performance indicators, as described in chapter 5. That data will only be shared after anonymisation, and the identity of the citizens will be deleted from the logged data once it is no longer necessary.

7 References

[1] http://www.pwc.com/gx/en/corporate-reporting/assets/pdfs/uk_kpi_guide.pdf
[2] http://en.wikipedia.org/wiki/Performance_indicator
[3] http://en.wikipedia.org/wiki/68-95-99.7_rule
[4] http://www.trafiklab.se/api/calculate-co2-emission

8 Annex A: Questionnaires for citizen inquiries

8.1 Pre-pilot inquiry (base line)

Table 4 Pre-pilot inquiry (base line).

We need to know a little more about you!	
1. Which trip assistance device or service for your trips on a daily basis?	
A standalone GPS device (TomTom, Garmin or equivalent)	☐
A GPS service from a smartphone	☐
Google Maps as a trip planner before starting my trips	☐
Another trip planner before starting my trips	☐
Paper maps	☐
Something else:	☐
What is it?	……
I don't use a trip assistant to plan my trips	☐
2. How stressed do you feel at the prospect of starting a new trip?	1 2 3 4 5 6 7 8 9 10
3. We need to know more about your vehicle! What is the size of your usual vehicle?	
Ultracompact personal car: Toyota Aygo, Citroën C1 or equivalent	☐
Small-sized car: Volkswagen Polo, Open Corsa or equivalent	☐
Compact car: Volkswagen Golf or equivalent	☐
Mid-sized car: Ford Mondeo or equivalent	☐
Mini bus: Renault Trafic or equivalent	☐
4. What is the engine displacement?	
1.2L	☐
1.4L	☐
1.6L	☐
1.8L	☐
2.0L	☐
2.5L	☐

3.0L	☐
4L or above	☐
Electrical engine	☐
5. What type of fuel does your car use?	
Gasoline	☐
Diesel	☐
Biofuel	☐
Gas	☐
Hybrid	☐
Electrical	☐

8.2 Post-pilot inquiry (pilot evaluation)

Table 5 Post-pilot inquiry (pilot evaluation).

Thank you for volunteering as a MobiS test pilot! **We would like to get feedback about your experience so far.**	
Grade how easy is it to plan a new trip using the MobiS terminal application:	1 2 3 4 5 6 7 8 9 10
Grade how easy is it to react to event updates during a trip:	1 2 3 4 5 6 7 8 9 10
Grade the ergonomics of the application:	1 2 3 4 5 6 7 8 9 10
Grade your satisfaction with the general experience of the service:	1 2 3 4 5 6 7 8 9 10
How stressed do you feel at the prospect of starting a new trip planned with MobiS?	1 2 3 4 5 6 7 8 9 10
Do you have comments or suggestions that you wish to share with us?	
…… …… …… …… …… ……	