Deliverable 1.4

Case Study Design & Development (Santander)

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Contents

1. Summary

This deliverable deals with designing and implementing the solutions for the Santander case study phase 1. The system design phase will be followed by a development phase, where the design is concretized and deployed, by customising services and technologies offered by the other work packages, as shown in Figure 1. Data will also be collected and integrated into the SETA architecture (WP6).

Specifically this deliverable gathers different technologies from SETA work packages WP2 WP3 and in addition the requirements from SETA App and the Decision maker's tool developed by WP5. These requirements will be implemented and evaluated in phase 1 in Santander City as a living laboratory (WP7).

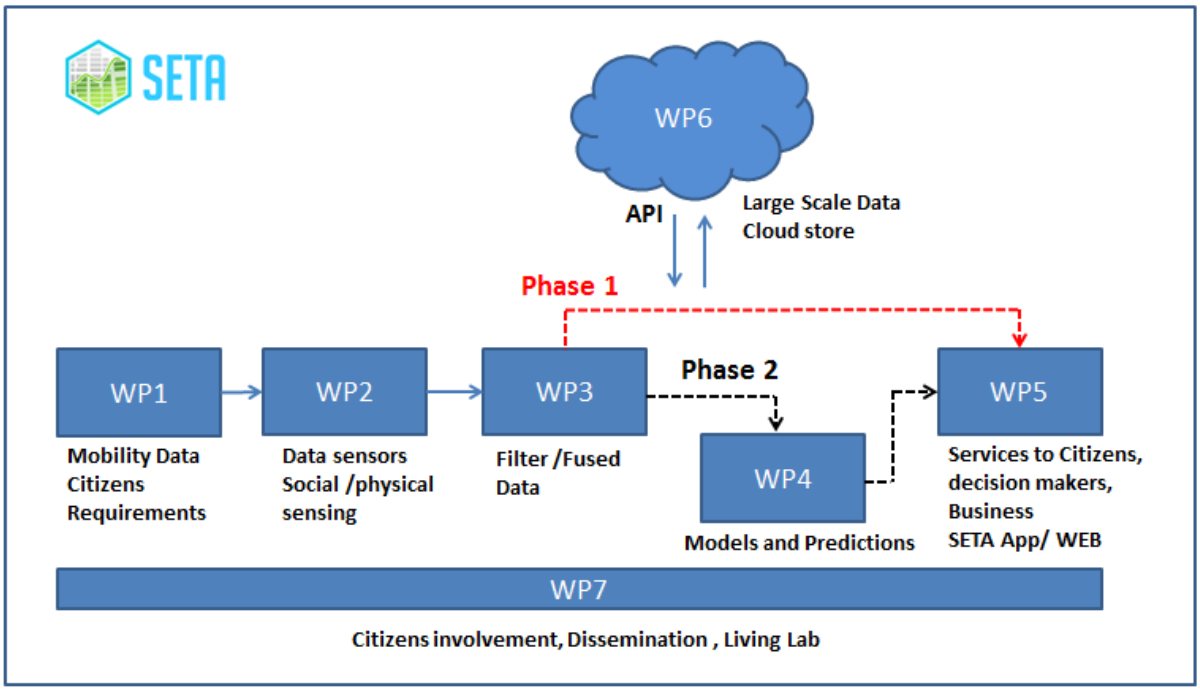

Fig 1 - SETA workflow

2. Glossary of Terms

Annex I	Otherwise known as the DoW
CA	*Consortium Agreement*
DoW	*Description of Work*
GA	*Grant Agreement*
WP	*Work Package*
SUC	*Santander Use Case*
CBD	*Central Business District*
TUS	*Transportes Urbanos de Santander (Urban Transit of Santander)*
QoS	*Quality of Service*

3. Santander Case Study

Santander is the capital of the autonomous region of Cantabria. With nearly 180,000 inhabitants, trade and services provide employment for more than 70 percent of its active population. The urban area of the bay of Santander is located in the centre of the region of Cantabria. It is 108 kilometres from the metropolitan area of Bilbao and 393 Kilometres from the metropolitan area of Madrid.

The city is characterized by its linear structure which has adapted to the terrain it was built on. Santander City has a urban center where main traditional shops are located, and in the periphery several commercial centers and residential zones of diverse population densities. The west-east linear configuration of Santander channelizes the traffic along longitudinal roads, the most important is the central corridor which passes through the entire central business district (CBD) and varies from 2-3 lanes in each direction, connected by a series of transversal streets. At rush hour, about 40,000 car journeys are made, along with 4,500 trips using public transport.

According to the last mobility survey carried out in 2012, 50% of daily urban mobility is through walking, nearly 41% by car (driving or passenger) and 7% by bus (TUS). The remaining 2% is via taxi and cycling. The public transport proportion of the motorised trips has increased to 13% since 2012. This mode share has already been reported in D1.1 and is shown in Figure 2.

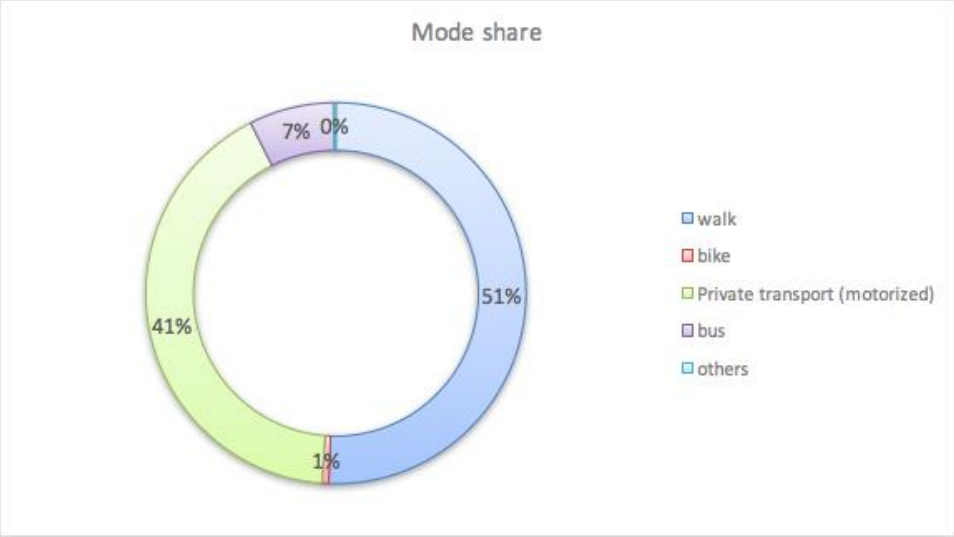

Fig 2 - Mode share of daily trips

3.1. Case Study Requirements

SETA adopted from the beginning of the project a user-centred design approach gathering the necessary understanding of the users and their needs in order to formulate an initial list of requirements. The full methodology used is described in D7.1.

In order to fulfill the end user requirements, SETA use cases have adopted the following methods:

- Questionnaires were kept relatively short in order to maintain engagement of the respondent and to make the best use of time in the evaluation session.
- Focus groups were adopted as means for carrying out structured discussions with the identified stakeholders.

As a result of those activities three categories were identified for the Santander Case Study:

	Categories	Categories Id
1	Mobility Information	I
2	Mobility Management	M
3	Fragile categories	FC

Id	Cat	Type	Data Requirements	Description
SUC-I1	I	Traffic information	Models Traffic Demand Data and Traffic Counts (5 years) Traffic Control Plan Transit vehicles GPS tracking data Traffic cameras (under development)	Short term traffic prediction: Tool to predict and visualise (web/APP) the level of traffic in the city. Short term forecasting
SUC-I2	I	User Information System	Models Traffic Demand Data Transit vehicles GPS tracking data Traffic cameras (working on it) GTS (under development)	Route planner: define all possible transport modes to address a route by OD: Analyse all possible connections from an origin to destination point and give information to citizens
SUC-I3	I	Traffic information	Models Traffic Demand Data	Traffic information on Variable Message Signs (VMS) located at the entrances to the city
SUC-I4	I	Traversal mobility	Models Traffic Demand Data and Traffic Counts (5 years) Traffic Control Plan Transit vehicles GPS tracking data Mobile environmental sensing data Traffic cameras (working on it)	Information of pollution levels and occupancy of the tunnels in the city in real time and short term forecasting

Table 1- Mobility Information Category Use Cases

Id	Cat	Type	Data Requirements	Description
SUC-M1	M	Traffic management	Models Traffic Demand Data and Traffic Counts (5 years) Traffic Control Plan	Real time traffic incident detection and planning in case of emergency (accident...)

			Transit vehicles GPS tracking data Traffic cameras (working on it)	
SUC-M2	M	Public transport management	Models Traffic Demand Data and Passenger Counts (5 years) Transit vehicles GPS tracking data	Number of people who are on a bus; calculation of bus occupancy in real time

Table 2- Mobility Management Category Use Cases

Id	Cat	Type	Data Requirements	Description
SUC-FC1	FC	Support to Fragile Categories	accessibility GIS layer	Define all possible routes compliant to disability problems solution.

Table 3- Fragile Categories Use Case

All the Santander Use Cases (SUC) described above need to be carried out to be able to translate the abstract requirements into concrete descriptions that feed directly into the technologies and the prototypes needed.

In order to harmonize all the uses case from the three pilot cities, a common framework was created where it is possible to group together similar use cases while also including singular use cases specific to each city.

In the Table 4 we can see the expected planning of the use cases and how they will be tackled in the different phases of the project (Table 5). (Please refer to Deliverable D1.1 for specific details).

Finally, Table 6 and Table 7 summarize the relationship between the Santander Use cases and the common framework referred above.

SCENARIO	USE CASE		PHASE
Personal **Mobility Decision Support**	**SETA-UC1**	**Real Time Mobility Portal**	**1**
	SETA-UC3	SETA Personal Journey Assistant	2
Decision Makers **Dashboard**	**SETA-UC2**	**Real Time Mobility Dashboard**	**1**
	SETA-UC-4	Decision Makers Planning Plaftorm	2

Table 4- Use Cases - Common frame Overview

	Requirements Analysis	Design and Development	Deployment	Evaluation
Phase 1	M1-M6	M6-M15	M15-M16	M16-M18
Phase 2	M19-20	M20-M33	M33-M34	M34-M36

Table 5- Use Cases - Common frame chronogram

Scenario	Personal Mobility Decision Support	
UC	Real Time Mobility Portal	**SETA-UC1**
Features		*Ref.*
	Traffic Info - Real Time	SUC-I3
	Pollution and tunnels occupancy	SUC-I4
	Unique portal for Real Time communications	TUC-I1
	Reporting Mobility Issues (comments, opinions)	
	Citizens observation - concerns	
	Private bike Parking Info	BS-P2

Table 6- Santander Use Cases integration in SETA UC1

Scenario	Decision Makers Dashboard	
UC	Real Time Mobility Dashboard	**SETA-UC2**
Features		*Ref.*
	Real time incident detection	BS-PM4 / SUC-M1
	Dashboard for decision-makers to use historic and current data about people movements and environmental conditions (e.g. pollutions) to inform citizens about environment status	BS-PM6 / SUC-I4
	Real Time Public Transport Management	TUC-P4 / SUC-M2
	Real Time Traffic management	TUC-P5 / SUC-M2
	Short Term Traffic Prediction	SUC-I1 / SUC-I3
	Information Sharing with citizens and staff	TUC-I1

Table 7- Santander Use Cases integration in SETA UC2

In this report therefore, we describe SETA **UC1** Real Time Mobility Portal and **SETA UC2** Real Time Mobility Dashboard that will be implemented and evaluated in Phase 1 in Santander city. The remaining use cases will be developed in Phase 2.

3.2. Use Cases / features list

The requirements gathered in Santander through questionnaires and focus group reported in

D1.1 have been translated to features which will be developed for Phase 1. In addition available data from Santander Open Data Portal[1] will be integrated into the SETA architecture.

The next table (Table 8) summarizes the features of Santander case study to be developed in Phase 1

Santander Case Study Phase 1	Use case name	Technology	Visual information in Mobile App for citizens	Visual information in Web App for decision makers
SETA-UC1 Personal Mobility decision support	Private bike parking	Crowdsourcing	x	
	Incident detection	Crowdsourcing	x	x
	Public bus occupancy	Crowdsourcing	x	
	bike journeys	APP mobility tracking	x	x
	walking/running activities	APP mobility tracking	x	x
	Car driving/public buses journeys	APP mobility tracking	x	x
SETA-UC2 Decision Makers Dashboard	Public bus occupancy	Bluetooth/wifi devices detection		
	Quality of Service of public transport	Beacon detection/APP online survey		
	Pollution in tunnels	Mobile environmental sensing	x	x
	Congestion in tunnel	Loops sensing and Video analysis	x	x

Table 8- Santander Case study Phase 1

The following sections describe the specific use cases related to the common SETA-UC. For each use case, the five-stage approach to living lab proposed in D7.1 will be followed. These five stage can be summarized as follows:

1. Contextualisation, in which different research methods are employed to understand the context in which the living lab will take place (stakeholders, environment) and the possible technical innovation is grounded in the state of the art. The outcome of this process will be understanding what is technically possible and matching it with what is socially possible/acceptable/interesting.
2. Selection, in which participants to the living labs are chosen, not necessarily in an equal way across all categories of stakeholders but choosing participants that have a specific purpose/aim related to the case study.
3. Concretisation, in which the specific chosen users are observed/measured to understand their typical behaviour and attitude before the introduction of the new technologies.
4. Implementation, in which direct and indirect user analysis techniques are adopted to monitor the usage of a new technology
5. Feedback, in which post-measurements are collected and recommendations are drafted on the basis of the experience.

[1] http://datos.santander.es/
Santander Open Data Portal includes a catalog of more than 75 datasets ,among them transport and traffic.

4. Personal Mobility Decision Support: SETA-UC1

4.1. Unique Portal for Real Time Communications – Mobile App

4.1.1. Description

SETA App will be the main actor of the evaluation of SETA project. The App will be used to collect data from the users about habits, means of transport and reports.

4.1.2. Implementation

Details about the Methodologies and technologies for SETA App are further described in section 4 of *D5.2 "Initial methodologies and tools for Visual Analytics and Decision support system"*.

4.2. Citizen observatory of mobility: Crowdsourcing

4.2.1. Description

This use case addresses the promotion of sustainable mobility and the public's participation in mobility in their city through the use of the SETA App. By applying this app, using the technique known as crowdsourcing, the citizen can report on:

- **Private bike parking availability:** report on the levels of occupancy of bicycle parking facilities throughout the city which are not part of the public bicycle rental system.

- **Incident detection:** The mobile app will enable citizens to provide information when an incident occurs. The type of incidents can be road obstruction, traffic incidents, badly parked cars and so on. Users will also be able to provide images via the app, and Citizens observations will be reported also in the decision makers dashboard as a results of citizens activity. The application promotes a participative environment in which citizen sending information, can contribute voluntarily to reflect the state of the traffic in the city.

- **Public bus occupancy:** The mobile app will enable citizens to provide information about the occupancy of public buses.
  No images of the inside of the bus will be used, due to the legal restrictions within Santander in terms of publication of personal data in accordance with national Spanish legislation on data protection issues.

4.2.2. Contextualization

- **Private bike parking availability:**
  Santander currently uses a real time system to report on the levels of occupancy of the parking slots at facilities belonging to the municipal bicycle network *TusBic* based on sensors installed at the bicycle anchoring points. The users of this system are

used to having this information available through the city's *SmartSantanderRA*[2] App. However, this is not the case for the private bicycle parks located in the city making this information a new characteristic provided by the SETA App.

- **Incident detection:**
  Santander currently uses a real time system for reporting incidents through the *elpulsodelaciudad*[3] application. A great diversity of incidents are covered by this app according several categories such as, beaches, parks and gardens, transport, public road, culture, sports, ...). The SETA App will also have this capability, oriented to mobility issues, and therefore, the end users will find the specific information related to traffic and mobility in Santander.

- **Public bus occupancy:**
  The Santander Municipal bus operator can only provide data about the number of passengers boarding the buses at each stop, this information comes from the on-board ticket validation.
  Public transport users are asking to have this information along with existing information about arrival times of the next bus at each stop in order, to be able to make decisions about their journey.

4.2.3. Selection

The choice of participants is aimed at the potential users of the SETA App. The selection process will include holding workshops with SETA stakeholders along with other friendly users who have experience of testing applications. The number of users will be gradually increased by disseminating activities of the SETA App. These activities are described in section 6.

4.2.4. Concretization

Data provided by crowdsourcing described under in section 4.2.1 will be collected via the SETA App and will be further analysed to understand various user activities.

4.2.5. Implementation

This use case is based on crowdsourcing by using the SETA App.

4.2.6. Feedback

User satisfaction surveys will be performed in order to improve the SETA App. Furthermore, the user can give their opinion throughout the google play store and iTunes. An analyse of these opinions will be performed too.

- Type measurement and evaluation-> activity report monitoring

[2] SmartSantanderRA APP is an augmented reality application developed under the research SmartSantander project. Through this it is possible to have access to information and location of tourist points of interest, beaches, museums, exhibition halls, commerce, cultural events agenda, transport, parking, etc in the city of Santander. https://play.google.com/store/apps/details?id=es.unican.tlmat.smartsantanderra&hl=es

[3] The PulsodelaCiudad application promotes a participative environment in which citizens contribute to reflect the Pulse of the City of Santander. The citizen can contribute, voluntarily sending information, using any of the type categories (beaches, parks and gardens, transport, public road, culture, sports, ...), inserting images, including comments, date of the event, expiration date, etc. The events related to the urban services of the city are reported to these as incidents for their resolution, and users can know the status of the same at any time.
https://play.google.com/store/apps/details?id=com.eu.smartsantander.participatorysensing&hl=es

- Measurement and evaluation technique-> activity report of the APP, workshops with friendly users.
- Metrics to be used -> Scalability, number of users, user satisfaction, counting the number of reports shared by users.

4.3. Non motorized and Motorized mobility : APP mobility tracking

4.3.1. Description

Non-motorised mobility refers to healthy mobility, such as bike journeys and walking/running activities, and **motorized mobility** refers to car driving/public buses journeys. Data coming from these modes of transport will be collected via the SETA App, which will be further analysed to understand various activities of users:

- **Bike journeys:** The mobile app will be used for data collection to track bike journeys
- **Walking/running activities:** The mobile app will be used for data collection to track walking/running activities.
- **Car Driving/public buses journeys:** The mobile app will be used for data collection to track Car Driving/public buses journeys.

Finally, the tracking will be used to generate the Origin-Destination Matrix, which is a powerful tool for mobility planning. These mobility patterns will be shown in the decision makers portal too.

4.3.2. Contextualization

Due to its size, the city of Santander does not have any distance related barriers to making daily internal journeys and, as explained in the introduction to section 3, this has resulted in about 50% of trips being made on foot. Over recent years travelling on foot has been encouraged by the city authorities who have supported it by making important changes to the city's streets, such as pedestrianising major roads and carrying out an ambitious accessibility plan which has seen electronic escalators, ramps and lifts installed at many strategic locations around the (see Figure 3) city to overcome many of the steep slopes which were a major barrier to certain sectors of the population.

Fig 3 - Escalators, elevators and moving walkways in Santander

Santander has never been a traditional bicycle city for making daily journeys which are unrelated to leisure. There is a public bicycle rental scheme (TusBic) and the network of bike lanes has grown considerably to 26 kilometers. However, either for cultural reasons, the steep terrain or the climate, this mode of transport has never been widely used by the residents of Santander which also means there is an opportunity in its potential for growth.

The last mobility survey conducted in 2012 registered that 5% of the internal urban journeys made by car at rush hour were less than 1.5 km long. According to the mobility data presented in section 3 this means that around 900 journeys could easily be made using a more suitable mode of transport for that distance.

One of the guidelines of the Sustainable Mobility Plan [4]refers to the promotion of non motorized modes of transport. Therefore, investments made in infrastructure need to be accompanied by promotional campaigns encouraging the public to make healthier journeys.

Data coming from these modes of transport will be collected and visualized in the SETA App looking to influence a behavioural shift towards sustainable mobility. The SETA App will include key behavioural factors such as, calories, steps, distance, active time, other people's behaviour, exposure to pollutants, CO2 saving and saving in travel costs. Those factors will be visualized in order to influence the citizens' decision as to what personal transport they should have to chose in their daily journeys in the city.

4.3.3. Selection

The choice of participants is aimed at the potential users of the SETA App. The selection process will include holding workshops with SETA stakeholders who have already collaborated in the focus group carried out at the previous phase, along with other friendly users who have experience of testing applications. The number of users will be gradually increased by disseminating activities of the SETA App. These activities are described in section 6.

[4] Suatainable Mobitiy Plan Review (2013) (http://santander.es/servicios-ciudadano/areas-tematicas/movilidad%20sostenible/seguimiento%20del%20plan%20de%20movilidad

4.3.4. Concretization

Data provided by crowdsourcing described under the section 4.2.1 will be collected via the SETA App and will be further analysed to understand various user activities.

4.3.5. Implementation

This use case is based on the app mobility tracking.

4.3.6. Feedback

User satisfaction surveys will be carried out in order to improve the SETA App. Furthermore, the user can give their opinion throughout the google play store and iTunes. An analyse of these opinions will be performed too.

- Type measurement and evaluation-> surveys, interviews
- Measurement and evaluation technique-> user satisfaction survey, workshops with friend users.
- Metrics to be used -> Scalability, number of users, user satisfaction.

5. Decision Makers Dashboard: SETA-UC2

5.1. Unique Portal for Real Time Communications – Web App

5.1.1. Description

To support decision-makers a set of tools that allow visualising mobility information has been created:

- ✓ SETA Citizens Observatory a web app for viewing all the reports submitted by Citizens using the SETA app and for sending notifications to all citizens using the app.
- ✓ a web app for analysing and visualising data gathered by SETA app from citizens (OD Matrix)
- ✓ a web app visualising routing engine and simulation on traffic model base.

The SETA decision-maker dashboard will be used by the city council for daily and long term decision making and planning. In particular the dashboard will be integrated in the traffic laboratory of the University of Cantabria. The Transport System Research Group (GIST) of the University of Cantabria is the traffic and mobility advisor of the Santander city council.

The SETA solution will be used to integrate existing infrastructure data with new transport data.

5.1.2. Implementation

Details about the Methodologies and technologies for decision support of this Web App are further described in section 5 of *D5.2 "Initial methodologies and tools for Visual Analytics and Decision support system"*.

5.2. Public bus occupancy: Bluetooth/wifi devices detection

5.2.1. Description

The main goal of this use case is to obtain information about the occupancy of the city's buses, how full the vehicles are, to provide additional information for planning fleet resources and improve the information given to the customers.

5.2.2. Context

Information about vehicle occupancy will be provided by the bluetooth/wifi detection apparatus developed at WP2 by the University of Sheffield (see D2.2). This will be found by correlating the value reported by the sensor with the ticket validation data provided for each bus stop by the operator. Furthermore, this will be correlated with ITS data to determine the exact location of the vehicle and the stop where passengers are boarding and alighting.

At the moment the public transport operator only has data about the numbers boarding the vehicles at each stop, based on the ticket sales/validations or the payments made. However, this information is incomplete as without the numbers getting off the buses it does not provide the current level of occupancy of the vehicle, and, therefore, not enough information is available about the remaining capacity in the system, an important variable to know if extra vehicles are required on a determined line. Another advantage of having this data available is it enables improvements to be made to the processes of estimating public transport trip matrices. An example of how important this use case is comes from the focus groups held with stakeholders and users, which both concluded that having data available about vehicle occupancy was one of the most important variables (see D1.1).

A system has recently been tested[5] which is based on artificial vision which uses door cameras to count passengers alighting at each stop. When checked against the passenger boarding data this information provides the vehicle occupancy. The proposed SETA system has the advantage of having a much lower cost than the installation of cameras (at least 2 per vehicle to cover all the doors) and is also less intrusive. The environmental sensor already developed by the University of Cantabria will be used to provide this information on the vehicles where it is already fitted.

5.2.3. Selection

The choice of participants is obviously aimed at both the operator and the users of public transport. On the one hand the operator is the main beneficiary of the obtained data and, on the other hand, the users of public transport will have more information to be able to make better informed decisions about their journeys, so they also need to be involved. The selection process will be carried out through holding a mobility specific focus group, the members of which will all be users of public transport.

5.2.4. Concretization

The information provided by the sensor will be integrated in the mobile app. As well as on the public transport operator server to be analysed in order to support the operation planning.

[5] http://www.visualcounter.com.es/web_en/products/vctransit/

5.2.5. Implementation

As stated earlier, the environmental sensor developed by the University of Cantabria (WP2) will be used to detect this data on the vehicles where it is installed. The final design of the detection equipment provided by the University of Sheffield (WP2) will be used on the remaining vehicles where the sensor has not been installed.

5.2.6. Feedback

Given that the data do not come from any user participation activity, the case will be followed by, on the one hand, the quantitative evaluation of the values reported by the sensor, as well as its failure rate, comparing the results with those from the data provided by the operator, as well as with data from random test counts. On the other hand, a satisfaction survey will be asked to the passengers to obtain their valuation of how exact the information they are receiving is with respect to their aspirations.

- Type measurement and evaluation-> activity report monitoring
- Measurement and evaluation technique-> validation with on board ticketing and manual counts.
- Metrics to be used -> RMSE (Relative Mean Square Error) and Mean Absolute Percentage Error (MAPE)

5.3. Quality of Service of public transport: Beacon detection/APP online survey

5.3.1. Description

This use case proposes to obtain user perception about the quality of the public transport services either daily or over shorter time periods. The use of a beacon based detection technology inside the buses is planned to disseminate perceived quality surveys via smartphones and other digital devices.

5.3.2. Contextualization

Currently, both the perceived quality and the service quality of urban public transport are measured annually to monitor performance. Both types of quality are valued in accordance with the certification UNE-EN 13816 and have to be assessed on an annual basis. In addition, the measurement of the perceived and provided service quality is required in the performance-based contracts in which the transport companies are encouraged to reach minimum quality levels in their services.

The perceived quality can only be obtained by conducting surveys with users, which is an expensive and not very frequently used technique (in the best cases it is organised once per year). In this use case, a new concept of service quality and perceived quality are proposed that allow the evolution of the quality indicators to be monitored in real time or in shorter time intervals than the actual ones.

5.3.3. Selection

One of the main issues of this use case is the selection bias in the sample because not all the users will have a smartphone or other digital devices. In addition the people who are willing to answer the survey can sometimes be more critical of the system.

5.3.4. Concretization

This use case will be integrated in the mobile app (the online survey) and the results will be available to be analysed by the public transport operator.

5.3.5. Implementation

As mentioned previously, the idea is based on the use of beacons placed inside the buses: A mobile service detects and responds to the presence of the Bluetooth signal, launching a QoS survey.

5.3.6. Feedback

The online surveys results are the best feedback from users perspective.

- Measurement and evaluation-> surveys, interviews.
- Measurement and evaluation technique-> standard quality of service surveys.
- Metrics to be used-> standard quality of service qualification.

5.4. Pollution in tunnels:Mobile environmental sensing

5.4.1. Description

The aim of this use case is to measure the pollution levels inside urban tunnels which pedestrians are allowed to walk through in order to inform the public so they can decide whether to enter or choose another route. The system could also be used as a variable for activating different power settings on the ventilation systems.

5.4.2. Contextualization

There are two tunnels in Santander which allow both traffic and pedestrians to pass through. The first, known as the Tetuan Tunnel, is 680 metres long and channels a high proportion of the city's transversal movement communicating the northern zone, the university campus and leisure areas with the city centre. The second tunnel, the "Pasaje de Peña", is 200 metres long and connects the city centre with the area where the stations are located (train, bus, airport shuttle, ferries, etc). Both tunnels, therefore, have intense traffic flows as well as an important pedestrian flow which together with their length means that pedestrians have to walk for some time in an unhealthy environment.

Devices designed by the University of Cantabria (WP2) will be used to obtain the emissions levels inside the tunnels. This equipment could either be fixed to the tunnel ceiling or be installed on a vehicle to take readings at different points located around the city. The sensor was designed to be fitted onto the roofs of the buses. As the buses have fixed routes the sensors provided readings along the entirety of the main urban corridors as well as along the full length of the tunnels when their route passes through them, rather than readings obtained at certain points where the sensors are at fixed positions.

5.4.3. Selection

The selection of participants is obviously geared towards the decision-maker. So we will select stakeholders involved in this issue who have already collaborated in the focus group carried out at the previous phase.

5.4.4. Concretization

This use case will be integrated in the mobile app and also on the decision-makers web site. The measurement will be displayed on the decision makers web site, and, these measurements will be converted to a qualitative scale (i.e. low, mid, high) in order to be visualized by users on the SETApp.

5.4.5. Implementation

As stated previously, the environmental sensor developed at the University of Cantabria (WP2) will be used.

5.4.6. Feedback

Given that the data does not come from any user participation activity, the case will be followed by, on the one hand, the quantitative evaluation of the values reported by the sensor compared with data from random test measurements, as well as its failure rate.

5.5. Congestion in tunnel: Loops sensing and Video Analysis

5.5.1. Description

Measurement of traffic congestion in the main tunnel in the city center

5.5.2. Context

The hilly terrain on which the city was built has meant that there is a distinct lack of transversal connections.
Cutting a north-south transverse section across the length of the city clearly shows the complex terrain made up of two valleys, as displayed in Figure 4 and Figure 5.

Due to the terrain shown in Figure 5 the road network is generally arranged along the following longitudinal axes connecting the city in an East-West direction (Figure 6):

1. The port axis Castilla-Hermida (access from Bilbao).
2. The central corridor (Hospital-Puertochico).
3. Paseo del Gral. Dávila.
4. Avda. de Los Castros.
5. S-20.

However, there are only 3 transversal routes (South-North):

1. C. A. Vega-Casimiro Sainz.
2. Tetuán tunnel.
3. Distribuidor de la Marga

Fig 4 - Locations of sections across the city.

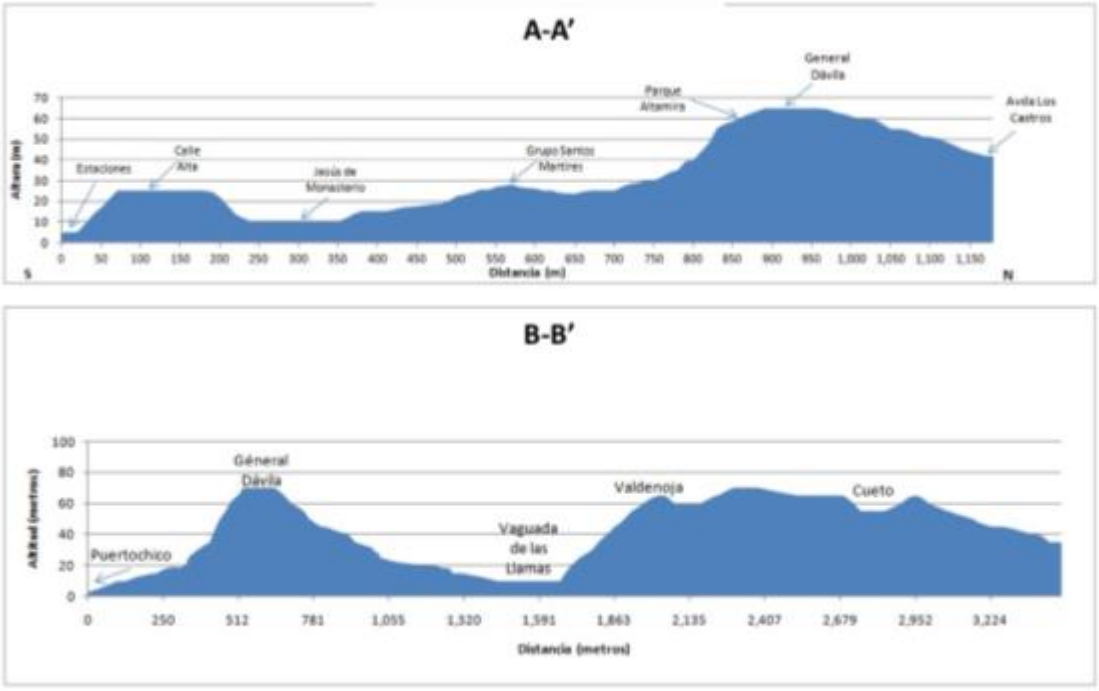

Fig 5 - Cross sections.

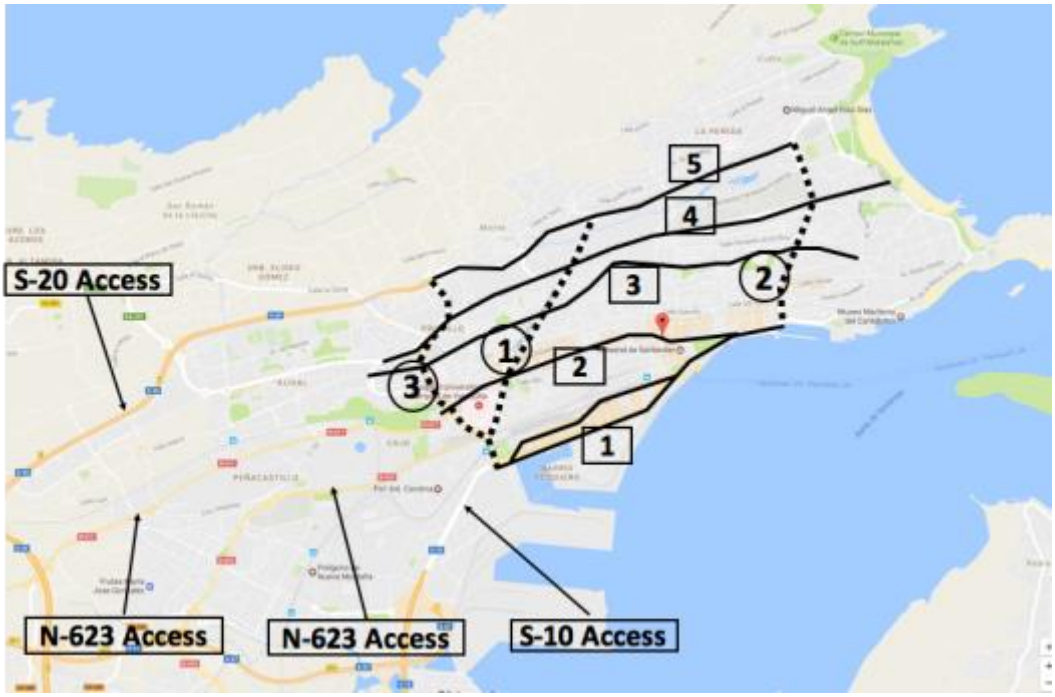

Fig 6- Road network and accesses

This means that the city's north-south (transversal) traffic is almost all channelled along these three axes with the tunnel having the least capacity, resulting in congestion inside and sometimes along its entire length (500 metres).

The aim of this use case is to create suitable tools which are able to advise the users when the tunnel is saturated so they can take alternative routes and reduce overall congestion in the area.

There are currently magnetic traffic counters installed on both lanes of the tunnel to measure volume and occupancy (% of time that the counter is occupied). However, these counters are located too close to the stop line at the south entrance which means that the readings are often erroneous and don't correctly reflect the true state of traffic inside.

5.5.3. Selection

The selection of participants is obviously geared towards the decision-maker. So we will select the stakeholders involved in this issue who have already collaborated in the focus group carried out at the previous phase.

5.5.4. Concretization

This use case will be integrated in the mobile app and also on the decision-makers web site. The measurement will be displayed on the decision makers web site, and, these measurements will be converted to a qualitative scale of traffic congestion(free flow, moderated and congested) in order to be visualized by users on the SETApp and to be displayed on the already existing Variable Message Signs panels (VMS).

5.5.5. Implementation

To estimate the levels of congestion inside the tunnels, the data from the traffic counters will be supported by data from the cameras presently located inside the tunnels. The information from the cameras is currently in the process of being transferred to the technology members

of the project. If the images are not received in time this use case will be performed by improving the existing estimation from the traffic counter data with GPS data from the bus lines passing through the tunnel and the cameras will not be used during Phase 2 of the project.

5.5.6. Feedback

Given that the data does not come from any user participation activity, the case will be followed by the quantitative evaluation of the values reported by the sensor as well as its failure rate.

6. Plans for Evaluation

Santander has been characterized by its eagerness to provide a more efficient city management closer to the citizens through the use of Information and Communication Technologies. Santander is in the vanguard of innovation when talking about smart cities. The city is trying to consolidate this position, convinced that high levels of innovation will generate positive results for businesses and contribute to the growth of our economy.
The General Plan for Innovation 2020[6] has been elaborated, potentiating the model of Santander as an integral Smart City and favouring an open innovation ecosystem in which citizens, entrepreneurs and local businesses participate.

In this context, all the activities developed in Santander relating to european projects and others innovative initiatives follow a common strategy which is in line with Santander Smart City Plan as a whole.

Being aware of the gap between technology and citizens daily life, Santander is working to reduce this gap through participation and the engagement of the citizens using a co-creation approach. The objective of the co-creation process is to gain more insights in the needs of multiple stakeholders regarding to the context of the underlying use cases.
Specifically in SETA, stakeholders are involved in all phases of the project using an iterative user-centred design approach.

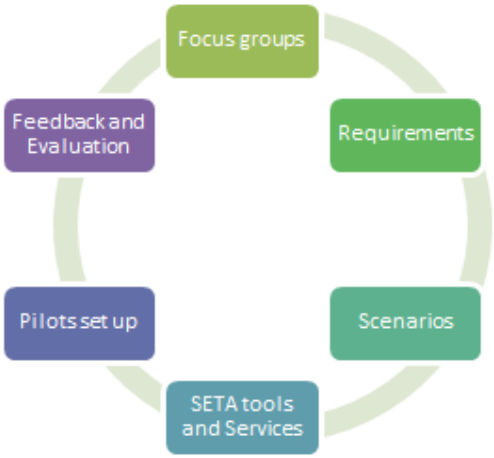

Fig 7 SETA Involvement Process

SETA is an iterative user-centred design project with two phases of design, development and evaluation. At the end of Phase 1 the outcome of the evaluation will be used to re-analyse and refine the requirements for Phase 2.

[6] http://santander.es/servicios-ciudadano/areas-tematicas/innovacion/plan-director-de-innovacion

6.1. Evaluation Setting (what, where, how, when)

In the previous sections of the document, we have described the details of the Santander use cases, technology adopted coming from other work packages, stakeholders involved, KPI measures and the expected feedback from the end users. A summary of Santander use cases technologies and measurements is shown in Table 9.

	Technology	Use case name	Measurements/feedback
SETA-UC1 Personal Mobility decision support	Crowdsourcing via APP	Private bike parking	**evaluation**-> activity report monitoring. * **Measurement and evaluation technique**-> activity report of the APP, workshops with end users. * **Metrics to be used** -> Scalability, number of users, user satisfaction,counting the number of reports shared by users.
		Incident detection	
		Public bus occupancy	
	APP mobility tracking	bike journeys	
		walking/running activities	
		Car driving/public buses journeys	
SETA-UC2 Decision Makers Dashboard	Bluetooth/wifi devices detection	Public bus occupancy	***Type measurement and evaluation**-> activity report monitoring. ***Measurement and evaluation technique**-> validation with on board ticketing and manual counts. ***Metrics to be used** -> RMSE (Relative Mean Square Error) and Mean Absolute Percentage Error (MAPE)
	Beacon detection/APP online survey	Quality of Service of public transport	***Measurement and evaluation**-> surveys, interviews. ***Measurement and evaluation technique**-> standard quality of service surveys. ***Metrics to be used**-> standard quality of service qualification.
	Mobile environmental sensing	Pollution in tunnels	***Type measurement and evaluation**-> Closed and quantitative
	Loops sensing and Video analysis	Congestion in tunnel	

Table 9- Santander Use Cases summary

Santander use cases will be visualized by end users through the two main outputs of the SETA project: The SETA mobile application for citizens and the SETA Web application for decision makers. Both applications will be customized for each city, translating them to the original language of each city in order to overcome the barrier of the language to extend them as much users as possible.

- **What?**

Santander's first phase evaluation plan is based on the feedback of end users of **SETA mobile and web applications** as part of the iterative user-centred design process. For that reason it is crucial disseminate SETA tools in the city in order to extend Santander's SETA stakeholder network. Santander has experience in the promotion and dissemination of

Innovative activities in press releases, conferences, TV municipal channel, municipal website, local newspapers and in its Smart City Santander Demonstration Centre.
Specifically for SETA first phase evaluation plan we will disseminate through Municipal website, video on municipal buses, mailing list of interested stakeholders and Social Media.

- **Where?**

The evaluation will be a **city scale level** following the approach of Santander city as a *living laboratory.*

- **How?**

Santander plans on launching the first release of the SETA tools to a few users (20) initially to extend later during the evaluation months (at least 50). A set of **session training or workshops** will be organised in Santander where a set of friendly users will be provided with the SETA mobile/web application depending on their profile, that is, citizens or decision makers.
During these sessions we will use the same methodology used in the focus groups organized at the beginning of the project described in D1.1.
Friendly users are invited to that workshop for 1-2 hours to provide detailed feedback on the app.
The users download the app and provide their email addresses while registration. In addition, users will be included in the SETA stakeholder mail list and they will be contacted with request to provide some feedback in the next months.

- **When?**

All evaluation activities will be happening next 3 month phase 1, around **May - July 2017.**

Santander Case Study Phase 1	may-17				jun-17				jul-17			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
SETA Pilots set up and running												
Living Lab/ Feedback												
Evaluation												

Table 10- Santander activities planning

The evaluation results will be reported in the D1.7 *Case Study Evaluation V1 (STA)* that is planned to be issued on M18 and those results will be taken as new inputs for Phase 2.

7. Appendix 1 - Santander living Lab poster

Santander Living lab

http://setamobility.eu/

Santander Smart City: technology and citizens

Challenge -> reducing the gap between technology and the citizens daily life

Working on ->Participation and engagement of citizens

SETA user involvement

Co-creation->Stakeholders are involved in all phases of the SETA project

- Creating a mailing list of interested stakeholders.
- Focus groups
- City Council Innovation sectorial meetings.
- Roundtables, presentation and networking in Smart City events.
- Local newspaper.
- Municipal website.
- Social Media.
- Video on municipal buses.
- Workshops with citizens.

Gathering Requirements from Stakeholders

After the stakeholders analysis, three focus group were held to gather problems, opinions and perceptions about Santander mobility transport system.

Focus group profiles

- Group 1: Operators, PA and technical staff
- Group 2: Social groups
- Group 3: Citizens

The discussions then resulted in developing a series of scenarios which would then be used to develop **SETA tools and services**

Santander Pilot set up

Training sessions

- Seta Mobile APP for citizens
- Seta web tool for decision makers

Dissemination of Santander Pilot

- Local newspaper.
- Municipal website.
- Social Media.
- Video on municipal buses.

Feedback and evaluation

- Workshops with citizens
- Questionnaires
- Online surveys

To find out more about the Seta project, visit http://setamobility.eu or contact the Project Coordinator Prof. Fabio Cavegna (f.cavegna@sheffield.ac.uk), Department of Computer Science, University of Sheffield, Regent Court, 211 Portobello, Sheffield, S1 4DP, UK.
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