smartCEM

Smart connected electro mobility

D2.5 (Technical verification of functionalities)

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Main author	Leandro Guidotti, Daniele Pinotti
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Authors (full list)

Guido Di Pasquale (Pluservice)

Leandro Guidotti, Daniele Pinotti (Unimore)

Oier Iribar (Ennera)

Dorin Palanciuc (Teamnet)

Simon Edwards (Unew)

Michael Hubschneider (PTV)

Josep Laborda (Racc)

Marti Jofrè (Creafutur)

Project Coordinator

Fernando Zubillaga

MLC ITS Euskadi

Clúster de Movilidad y Logística

Centro de Negocios CTVi, Oficina 1, 3-A

Lermandabide, 8. Polígono Industrial Júndiz

01015 Vitoria-Gasteiz

Tel.: +34 945 10 80 88

Email: fzubillaga@mlcluster.com

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Abbreviations

Abbreviation	Definition
3G	3rd generation of mobile telecommunications technology
AD	Activity Diagram
API	Application programming interface
APP	Application (software)
BD	BlueDash
BEV	Battery Electric Vehicle
CAN	Controller Area Network
CIP	Competitiveness and Innovation Framework Programme
CS	Charging Station
CSV	Comma Separated Values
CYC	Charge Your Car[1]
DB	Data base
DOD	Degree of Discharge
EV	Electric Vehicle
FC	Functionality
FTP	File transfer protocol
FTS	Forensic Telecommunications Services
GPRS	General packet radio service
GPS	Global Positioning System
GTFS	General transit feed specification
GUI	Graphical user interface
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
ICE	Internal Combustion Engine

[1] CYC in North East England forms the infrastructure for the operation of smartCEM's UK pilot site [1].

Abbreviation	Definition
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport Systems
IVR	Interactive Voice Response
KPI	Key Performance Indicators
LTE	Long term evolution
MCB	Miniature Circuit Breaker
MSDU	MAC Service Data Unit
NC	Network classes
OBU	On-Board Unit
OCPP	Open charge point protocol
O-D	Origin-Destination
OSM	Open street map
PAYG	Pay as you go
PHEV	Plug-In Hybrid Electric Vehicles
POI	Point Of Interest
PT	Public transport
PS	Pilot Site
RCB	Residual Current Breaker
RCD	Residual Control Device
REST	Representational state transfer
RFID	Radio Frequency Identification
RQ	Requirement
SaaS	Software as a service
SC	Speed classes
SDK	Software development kit
SH	Stakeholder
SIM	Subscriber Identity Module
SMMT	Society of Motor Manufacturers and Trader

Abbreviation	Definition
SMS	Short Message Service
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SOC	State Of Charge
TCP/IP	Transfer Control Protocol/Internet Protocol
UC	Use Case
UCAP	Ultra capacitors
UMTS	Universal Mobile Telecommunications System
UN	User Need
UNEW	Newcastle University
VPN	Virtual Private Network
WDM	Workflow and Demand Manager
WiFi	Commercial name of the wireless communication standard IEEE 802.11b
WP	Work Package
WSDL	Web Services Description Language
XML	eXtensible Mark-up Language

Table 1: Abbreviations

Executive Summary

This document is the main outcome of the work performed within Task 2.5, *verification of functionalities*. The main focus of the work within this task was on checking and technically verifying the functionalities of the developed platform and adapted applications. Functionalities were verified against the specifications and requirements defined in Task 2.1 and were also tested in pilots. This task mainly deals with technical functionalities as part of the Pilot Site integrated smartCEM platform, therefore a technical validation of the hardware/software components was out of the scope of this deliverable.

Use Cases lists were updated for each Pilot Site according to the functional changes which occurred during the development of the smartCEM platform. Starting from this revised list, a Test Case Scenario was developed in order to proceed with the operational validation and check the functionalities. This document can be regarded as the end of WP2 (Implementation) and the introduction of WP3 (Operation).

1 Introduction

This deliverable reports the technical verification of the functionalities of the smartCEM services and its components, performed at each of the Pilot Sites at the end of the implementation period. The document is the outcome of Task 2.5: *Verification of the functionalities*. The available services, ICT solutions and the adaptation to be performed in order to implement the new dedicated EM services through the smartCEM project were verified. According to the Task 2.4, the adaptation and integration of existing software platforms the smartCEM framework will be verified, including both shared and dedicated functionalities, as reported in D2.2 and D2.4.x.

Evaluation can be divided in 3 levels:

1. Technical verification
2. Operational verification
3. Validation

The focus of Task 2.5, and consequently of this document, is on the second level of verification taking into account that the technical verification (software debugging) is done in-factory by the technology providers and assessing the satisfaction of the end user's needs is addressed by WP4 and it is beyond the scope of this Task, as explained with more detail in chapter 2.

1.1 Purpose and scope of D2.5

This document is meant as a bridge from WP2 (Implementation) to WP3 (Operation). In D2.1 the Reference Architecture was described: in this Task, instead, the workflow of the smartCEM integrated platforms was verified for all Pilot Sites, in order to ensure that the intended service was provided to the user.

Throughout the whole technical verification process, it was important to avoid any overlapping with WP4, as the purpose of Task 2.5 was not to validate if user needs had been satisfied, but if the smartCEM applications have been technically integrated.

1.2 Structure of the document

The document is structured as follows: chapter 2 describes the methodology followed for the verification and the different levels for the validation of the services; chapter 3 presents the full list and description of smartCEM services implemented at each Pilot Site; in chapter 4 the technical verification is reported, highlighting the successfulness of the different steps of the Test Cases, including pictures taken during the verification process; finally chapter 5 concludes this deliverable by summarizing the reports from all the Pilot Sites and collecting the

lessons learnt during the validation.

In Appendix a brief description of the applications which constitute the smartCEM platform, as well as an updated list of Use Cases for each Pilot Site, can be found.

2 Validation Scheme

2.1 Verification Levels

As defined in the deliverable D2.1, two main flows are considered during the smartCEM services development. The first flow has been accomplished during the implementation process. First of all user needs and requirements were defined. Afterwards different use cases were specified for the different services expected in the Pilot Sites, which derived in the description of functionalities and requirements. Last of all having the final specification of the expected services, the implementation process started.

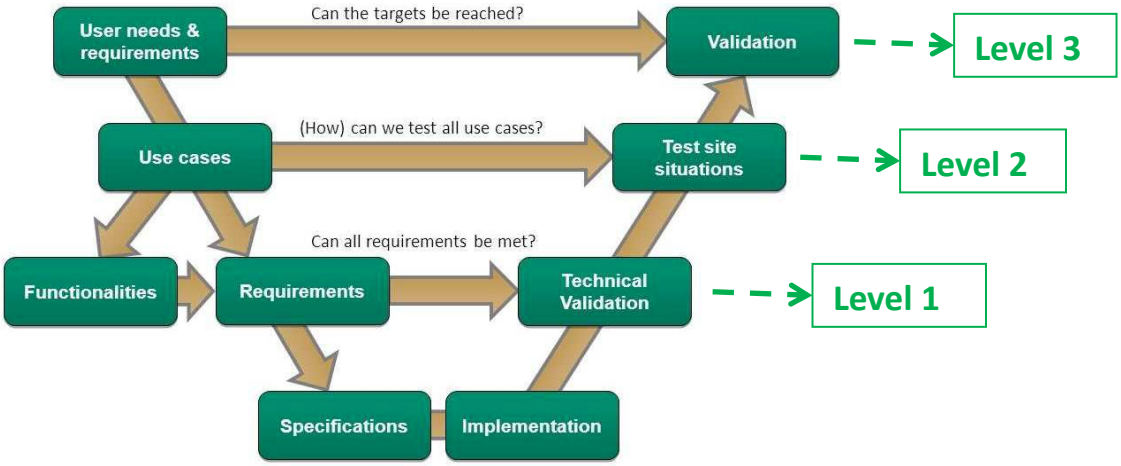


Figure 1: Verification levels

Once the services have been implemented, validation process has started. According to the chart, three different levels of validation exist.

1. **Level 1: Technical Validation (technical verification of functionalities).** Focused in the analysis of the correct functioning of the developed projects (for example, in terms of software this would refer to unit tests to validate the code and its different functions). The execution of this validation totally corresponds to technology providers involved in the development process of the different blocks/parts for smartCEM services. This validation process will not be represented within this document, as it is assumed that any software or product release is always accompanied by previous technical verification (software debugging) made by companies at lower level (coding).
2. **Test site situations (Operational Validation).** It refers to the functional verification for the different use cases that can be expected from end-users. At the end of the day, each of the services implemented in the Pilot Sites can be divided in different functionality branches, known as use cases.

These use cases were pre-defined within deliverable D2.1 prior development. The project has undergone changes from initial specifications, as some of the goals expected haven't been accomplished and some others have changed. This document will report the validation process, for the new and final use cases.

3. **General Validation.** It corresponds to the final and complete validation of the services, focusing in the satisfying of end-user needs. While use cases identify separate functionalities, this attempts to include the whole smartCEM service concept. This approach will be extracted as the conclusion of the whole project and will be the main focus of WP4.

2.2 Methodology

Before proceeding with level 2, the Operational Validation, a common verification methodology had to be agreed between all the Pilot sites, so that all the outputs could be clearly gathered together in order to assess the successfulness of the smartCEM platform implementation at each Pilot Site.

At first, the Use Cases and the services description had to be reviewed and updated by the pilot leaders, as the project has undergone some changes during its evolution (please refer to chapter 3). Based on these, a full Test Case was planned by the Service Providers, comprising a list of steps to assess:

- description of verification procedure and test use cases;
- expected output;
- results from technical verification (outcome only: uninterpreted and objective);
- comments/open issues;
- lessons learnt.

Then, the actual verification took place and the test cases tables were filled by the pilot site testers: this report is presented in chapter 4.

3 Description of Functionality

This chapter presents the final list of smartCEM services which were implemented in each Pilot Site and the different functionalities based on use cases, updating the Architecture description provided in D2.1, D2.4 and D2.4.x. A revised list of use cases for each PS was added as an Annex at the end of the document.

3.1 Barcelona Pilot Site

3.1.1 Test site in brief

The Barcelona pilot site is mainly about a flexible one-way sharing scheme with electric scooters. This is substantially innovative compared to traditional round-trip sharing schemes, where trips must start and end only at given charging stations. With the smartCEM EV-Sharing, the user has many more levels of freedom to request availability for a given trip, starting at 'A', ending at 'B', where 'A' and 'B' are not (necessarily) charging stations. Or, otherwise, the user can rent an electric scooter for a given period of time, with no fixed destination / drop off location. The so called "Motit"[2] service is operated by Going Green, with smartCEM partner Creafutur having implemented the core part of the EV-Sharing management service. In particular, Creafutur has developed the "Workflows and Demand Manager" software component (WDM), which interacts with the back-end server managed by Going Green under a Saas ('Software as a Service') scheme. In brief, smartCEM has upgraded a (previously existing) traditional round trip sharing system into a one-way sharing scheme. The WDM implements all the business logic to manage the fleet of shared electric scooters under an "open" scheme, meaning that users can freely use the electric scooters without the need to start and end trips at given charging stations. WDM also takes care of re-distributing the fleet (by anticipating the expected demand of vehicles, or incentivizing users to drop off scooters at certain locations), assigns vehicles to users and monitors the SOC. Users of the "Motit" service have turn-by-turn navigation advice provided by smartCEM partner PTV through the EV-Navigation service. This service runs locally on the Android tablet that is attached to the electric scooter handlebar. Whenever a user makes a reservation of an electric scooter for a certain predefined trip, the on-board navigation service will provide routing. As SOC is remotely monitored by the WDM, only electric scooters with more than sufficient SOC are assigned to users, so that users do not have to care for recharging (if, for whatever reason, the electric scooter runs out of battery, Going Green will send someone on site to do a battery swap, so that the user can continue the trip). This is the reason why the EV-Charging Station Manager has not been (yet) implemented, although smartCEM ensures a future "plug-and-play" implementation whenever this is needed (i.e.

[2] www.motitworld.com/eng

integration between PTV's EV-Navigator and Teamnet's EV-Charging Station Manager services has been fully tested in other pilot sites, and is not dependent on technical details of local implementations).
Post-trip statistics on the driving performance of the users will be provided, through a web based application, by the EV-Efficient Driving service implemented by the UNEW.
The EV-efficient driving service for the post trip analysis of the driver's performance has been fully implemented and tested for Newcastle pilot site and it is still under adaptation for Barcelona pilot site.

3.1.2 EV-Services

SERVICE: EV-SHARING	
Developer	CREAFUTUR
Partners involved	CREAFUTUR
Technological Provider	CREAFUTUR, GOING GREEN
Hardware components involved	OBU (datalogger) EV-Sharing Service Management Server User's personal PC/smartphone
Software components involved	EV-Sharing Service Management Database + Communication Manager + Service Platform (former Going Green SW components) + WDM Client EV-Sharing web application Client EV-Sharing iPhone / Android application smartCEM common app
Communications	3G/GPRS/WIFI from the Client EV-Sharing iPhone / Android application to the EV-Sharing Server (sign in, reservation, cancellation, notification of incidents) 3G/GPRS/WIFI from the Client EV-Sharing iPhone / Android application to the OBU (check-in, check-out)

	Internet connection to access the client web application for EV-Sharing 3G/GPRS connection between the OBUs and the EV-Sharing server
Comments	WDM is the core component of the flexible one-way sharing scheme (smartCEM EV-Sharing service)
User for verification	CREAFUTUR (Martí Jofre)
Verification	Real-life verification of all the use cases involved in interacting with the "Motit" service from a user perspective, from booking, to approaching the booked electric scooter, checking-in, driving and checking-out

Table 2: EV-Sharing BAR

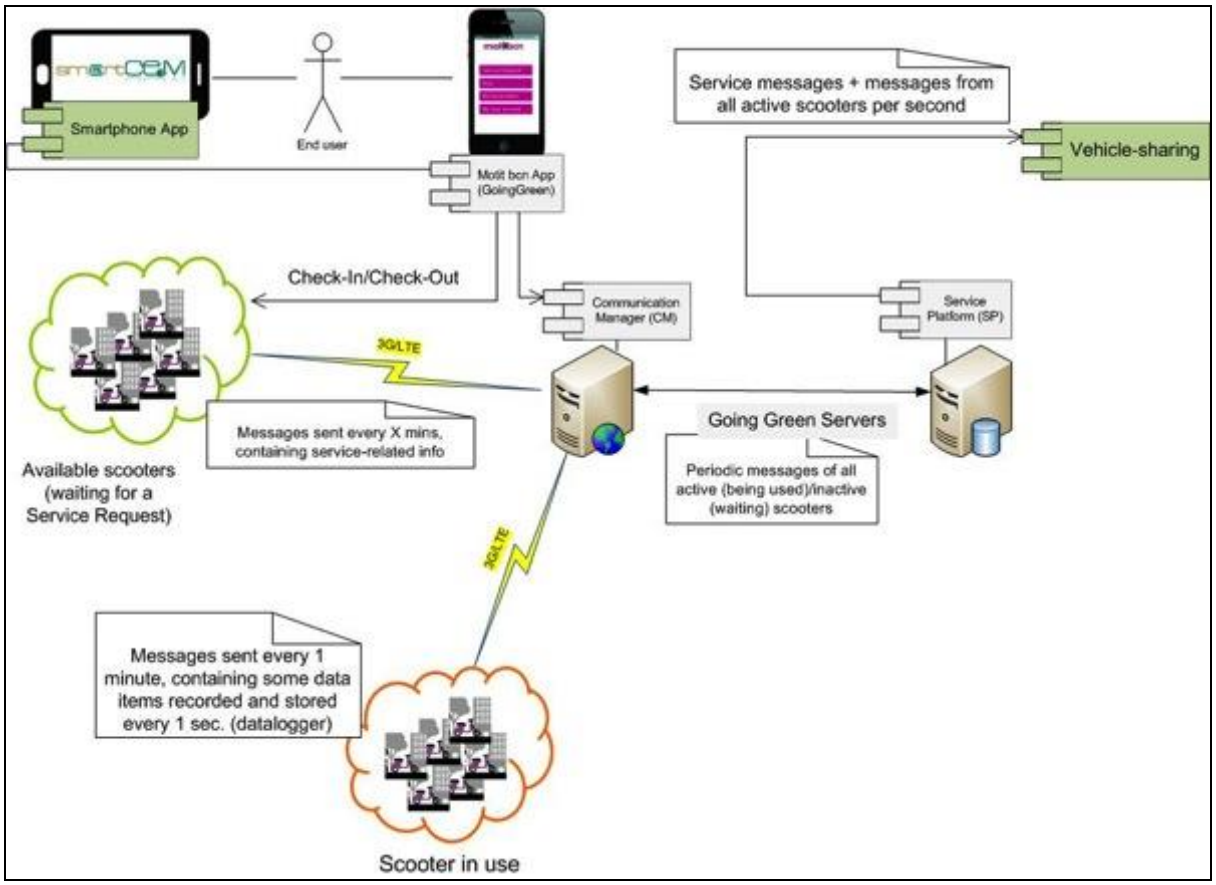


Figure 2: BCN - EV-Sharing management service

SERVICE: EV-NAVIGATION	
Developer	PTV
Partners involved	PTV
Technological Provider	PTV, GOING GREEN
Hardware components involved	On Board Tablet Going Green Server (running the PTV software)
Software components involved	EV-Navigation application, OBU User Interface
Communications	GPRS/3G communication between Going Green server and On Board Tablet
Comments	PTV's SDK had to be used in order to integrate the EV-Navigation service into the OBU User Interface, where other data is displayed (SOC, km driven, etc.)
User for verification	CREAFUTUR (Martí Jofre)
Verification	Real-life verification: the user makes a trip-based booking, and the EV-Navigation service provides turn-by-turn indications on the OBU

Table 3: EV-Navigation BAR

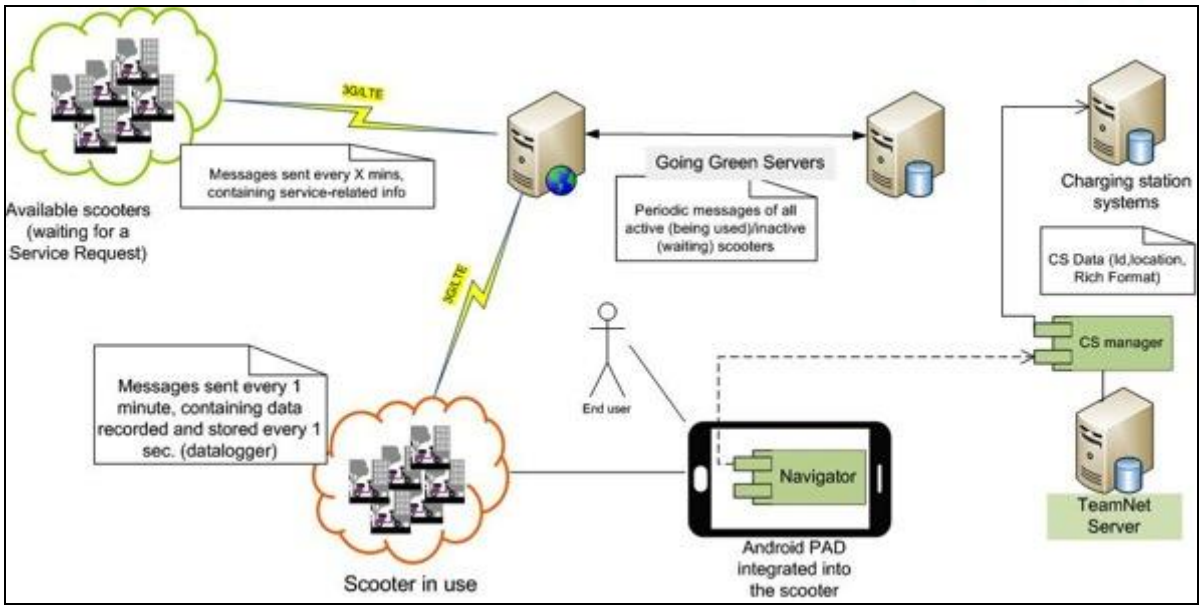


Figure 3: BCN - EV-Navigation service

SERVICE: EV-EFFICIENT DRIVING	
Developer	UNEW
Partners involved	UNEW, IDIADA
Technological Provider	UNEW, IDIADA, GOING GREEN
Hardware components involved	On Board datalogger IDIADA Data acquisition Server (Local Data Base) UNEW Efficient Driving Server User's PC
Software components involved	Data acquisition module (on the OBU - datalogger) Web-based application (user performance feedback) Communication software
Communications	FTP from dataloggers to IDIADA's local database Internet connection to access the web application for EV-Efficient Driving

Comments	Default data acquisition logic in the datalogger had to be modified in order for some parameters needed for efficient driving feedback to be taken (on a 1 second basis, instead of default 1 minute-basis), and sent to IDIADA's local DB
User for verification	CREAFUTUR (Martí Jofre), ACASA (Josep Laborda)
Verification	The system is a post-trip analyser where drivers can access their own driving data based on vehicle id and user id. The tool will provide driving behaviour feedback. Drivers will provide user acceptance information through questionnaire-based feedback.

Table 4:EV-Efficient Driving BAR

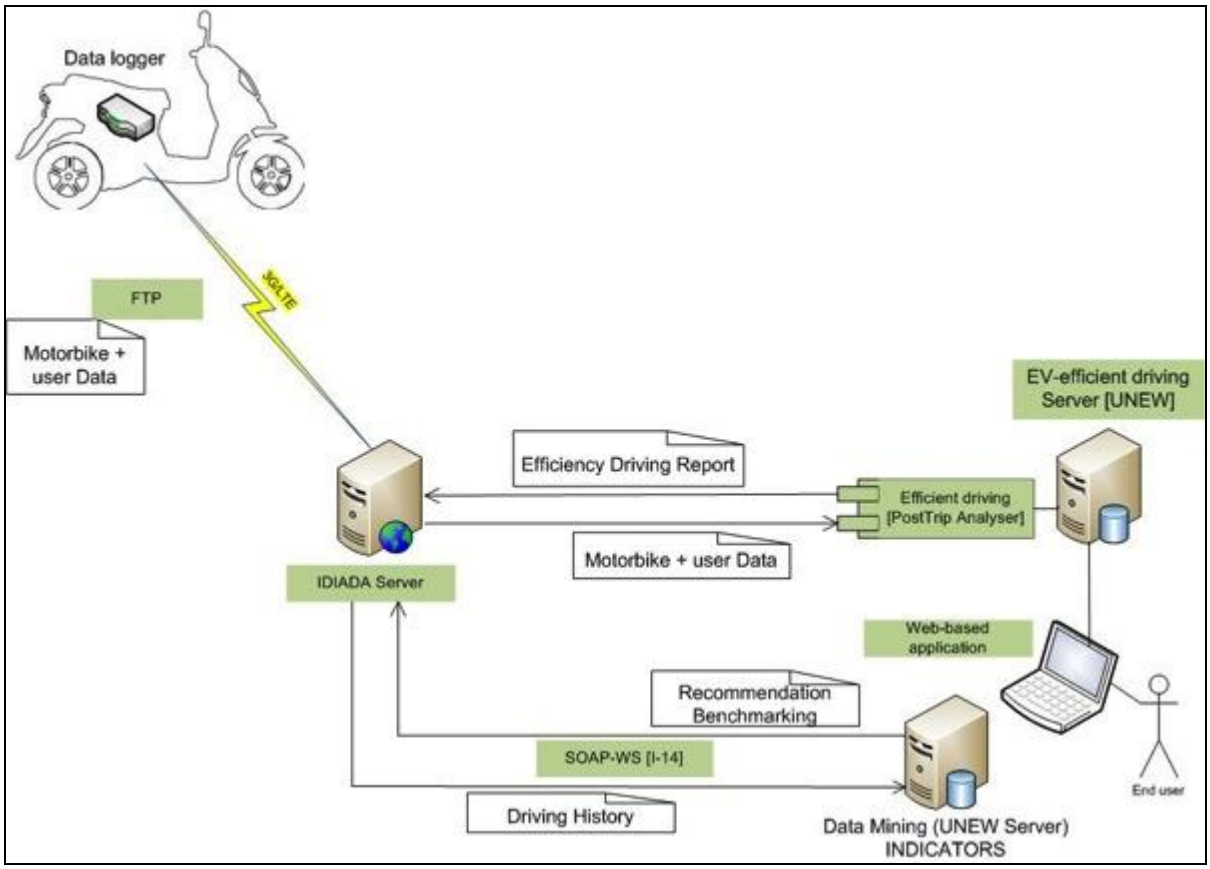


Figure 4: BCN – EV Efficient Driving

3.1.3 Functional Changes

Operating a one-way sharing service with electric scooters is very challenging. As the number of users grows it gets more complicated to efficiently manage the fleet (location of the electric scooters at every time, monitor the SOC, etc.) and ensure a good service level (meaning that electric scooters should be available, most of the time, to cover the mobility needs of the registered users). Growing the fleet (adding more electric scooters) and the user base is in the operator's business plan, but the way to achieve a pure one-way sharing service has required making up an intermediate approach, where users must pick-up and drop-off scooters only at a some predefined service areas, where most of the users (and their mobility needs) are concentrated:

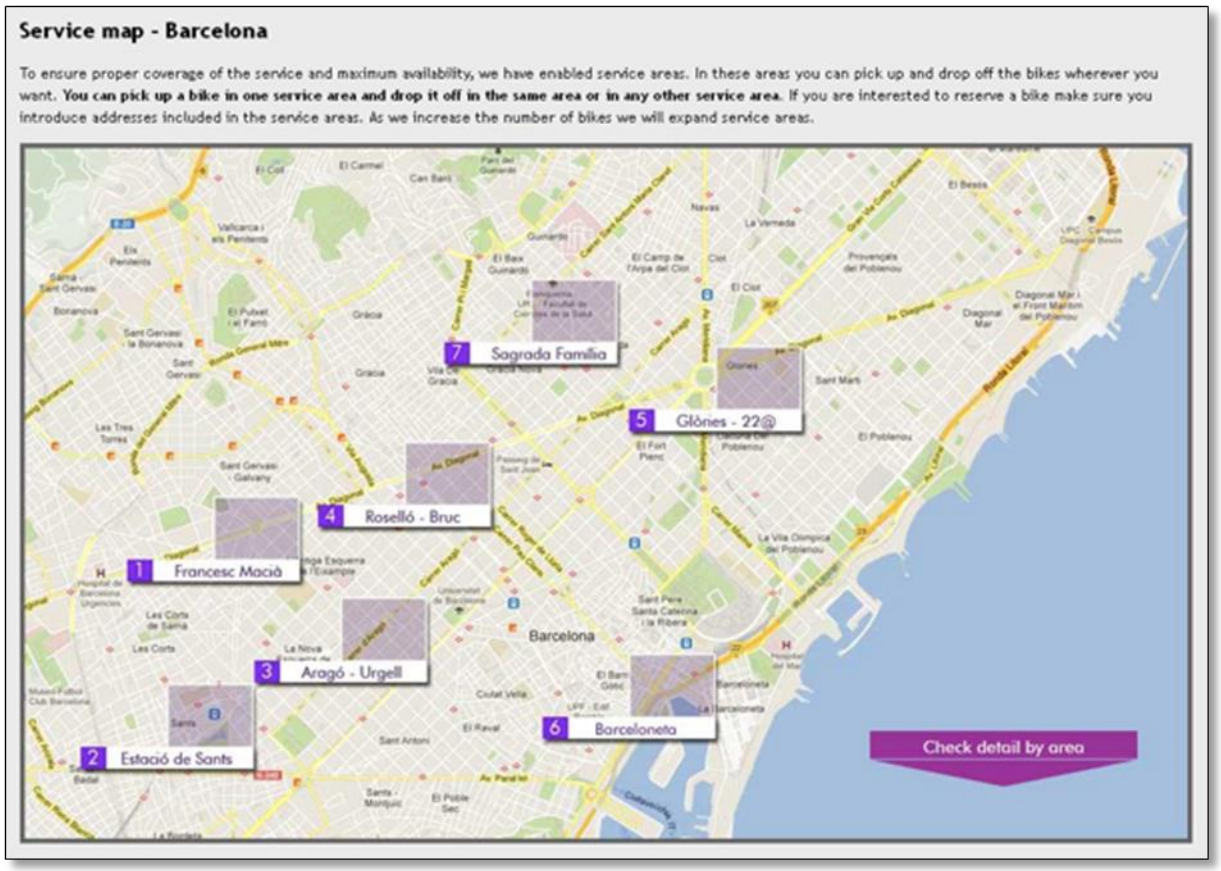


Figure 5: "Motit" Service map in Barcelona

Service areas will expand, and new service areas will be added, as the number of users grows, and so does the number of electric scooters, until the city is fully covered by the service. Moreover, location of the electric scooters has proved to be problematic in some cases where the GPS coverage is poor, and some technical improvements have been implemented in the GPS receiver of the electric scooters in order to improve its accuracy.

Regarding the EV-Navigation service, it does not (yet) integrate Charging Station information, as the users are not requested to recharge their electric scooters

(thus this information is not needed, for the moment). Management of the battery SOC is remotely done by the WDM, so that users do not have to care about recharging. In case of running out of battery (during a trip) or the battery level is too low (after a trip) a battery swapping strategy is defined. If this strategy proves not to be efficient, then charging stations will be uploaded to the EV-Navigation service, and the WDM might implement incentives - discounts (when needed) so that users drop off electric scooters at charging stations (instead of their intended destination).

Data acquisition logic of the dataloggers was initially set at a 1 minute basis. In order to be able to implement the EV-Efficient Driving service, some parameters (speed, throttle position, bus current) had to be taken in a 1 second basis. Furthermore, in order not to increment the amount of data to be sent too much, it was decided to store data in the datalogger and send it (compressed) when the electric scooter comes back to the idle state (after a trip).

3.2 Gipuzkoa Pilot Site

3.2.1 Test site in brief

Gipuzkoa Pilot site mainly covers two types of sustainable transport options: EV Sharing and Public Transport (Hybrid BUS). Both services have been developed further during the smartCEM project, adding some functionality and adapting existing ones.

The car-sharing service EMUGI located in Elgoibar municipality has undergone an update of the already existing EV-Sharing Management platform reworking the service, with the addition of an android application, that lets users make and manage their vehicle bookings using personal smartphones or tablets. SmartCEM service platform has also included an EV Navigation system as trip aid for drivers, as well as a Charging Station Manager that reveals the station's location over the navigation maps.

The Hybrid BUS lines in San Sebastian have included an Efficient Driving application for their drivers, which evaluates driving efficiency and gives alerts to avoid bus bunching.

An application has been developed to join both services for user's trip plans. The Multimodal Trip Planner developed by Pluservice informs the users about the different public transport options that could be used to complete the desired trips.

3.2.2 EV-Services

As a conclusion of the previous description these are the EV-Services added for smartCEM in Gipuzkoa that have been tested during the verification of the test

cases:

SERVICE: EV-SHARING	
Developer	ENNERA
Partners involved	ENNERA
Technological Provider	ENNERA
Hardware components involved	OBU EV-Sharing Service Management Server User's personal PC/smartphone/tablet
Software components involved	EV-Sharing Service Management Database Web application for the administrators Client EV-Sharing web application Client EV-Sharing android application
Communications	3G/GPRS/WIFI from the Client EV-Sharing android application to the EV-Sharing Server. Internet connection to access the administrator/client web applications for EV-Sharing. 3G/GPRS connection between the OBUs and the EV-Sharing server.
Comments	This service is settled over the already existing and operative car-sharing service platform. The EV-Sharing smartCEM android application interacts with the main service platform.
User for verification	TECNALIA (Arkaitz Urquiza)
Verification	As they are complementary, when verifying EV-Sharing for smartCEM, the test cases will evaluate the functioning of both the already working service platform and the specific smartCEM EV-Sharing android

	application.

Table 5: EV-Sharing GIP

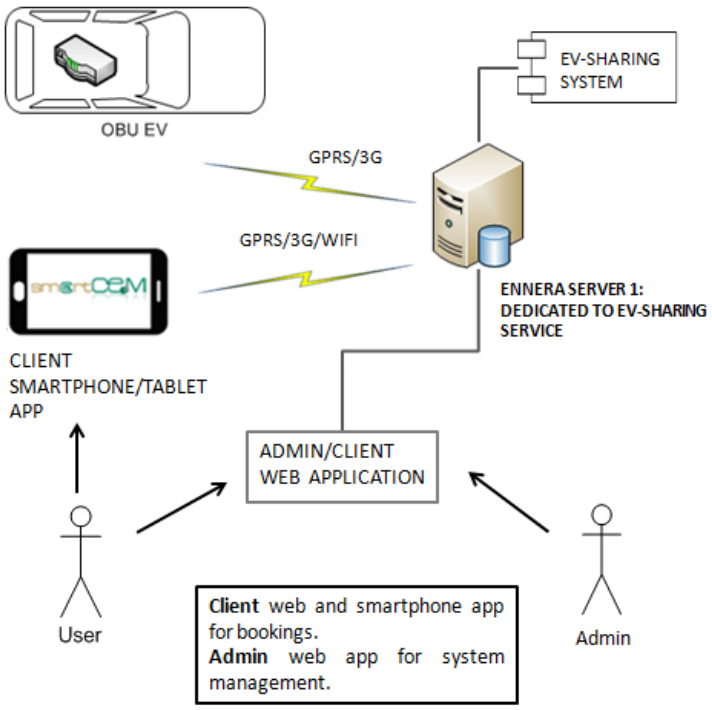


Figure 6: GIP - EV-Sharing management service

SERVICE: EV-NAVIGATION	
Developer	PTV
Partners involved	ENNERA, PTV, TEAMNET
Technological Provider	PTV
Hardware components involved	On Board Tablet PTV Server TEAMNET Server TRAFFIC INFO Server
Software components involved	EV-Navigation application

Communications	GPRS/3G of Wifi communication between On Board Tablet and Internet Charging Station -locations and attributes are being maintained into the Teamnet CSManagement Service. Location and attributes are being made available to xServer via web-service interface
Comments	In those cases where access to the CAN BUS was denied by the manufacturer and the service provider (EMUGI case) the EV-Navigator has been implemented, working based on manufacturer's vehicle specifications.
User for verification	TECNALIA (Arkaitz Urquiza)
Verification	Verification will take into account things like the navigation service accuracy, usability, responsiveness, etc. Changing any CS attribute in the Management Console should be visible in Navigator

Table 6:EV-Navigation GIP

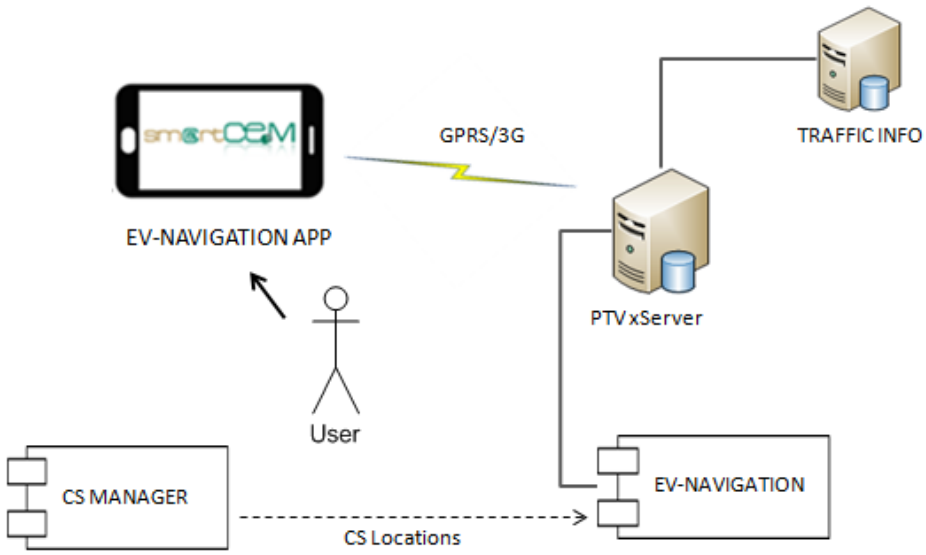


Figure 7: GIP - EV-Navigation service

SERVICE: CS MANAGEMENT	
Developer	TEAMNET
Partners involved	TEAMNET, ENNERA, PTV
Technological Provider	TEAMNET
Hardware components involved	TEAMNET CS Management Service On Board Tablet (HMI)
Software components involved	SmartCEM CS Management web-service. SmartCEM Management Console (web application) CS Management Android application
Communications	3G/GPRS connection of the On Board Tablet to the Internet.
Comments	When updating CS data in the Charging Station Management Database (by using SmartCEM Management Console), the changes are automatically made available in the CS Management Service. The CS Management Android application running on the On Board Tablet can verify if it has the current version of the database, and it will automatically synchronise if the case .
User for verification	TECNALIA (Arkaitz Urquiza)
Verification	Verification should take into account the proper refresh of the data, both in the CS Management service database, as well as in the Android CS Manager application.

Table 7: EV-CS Management GIP

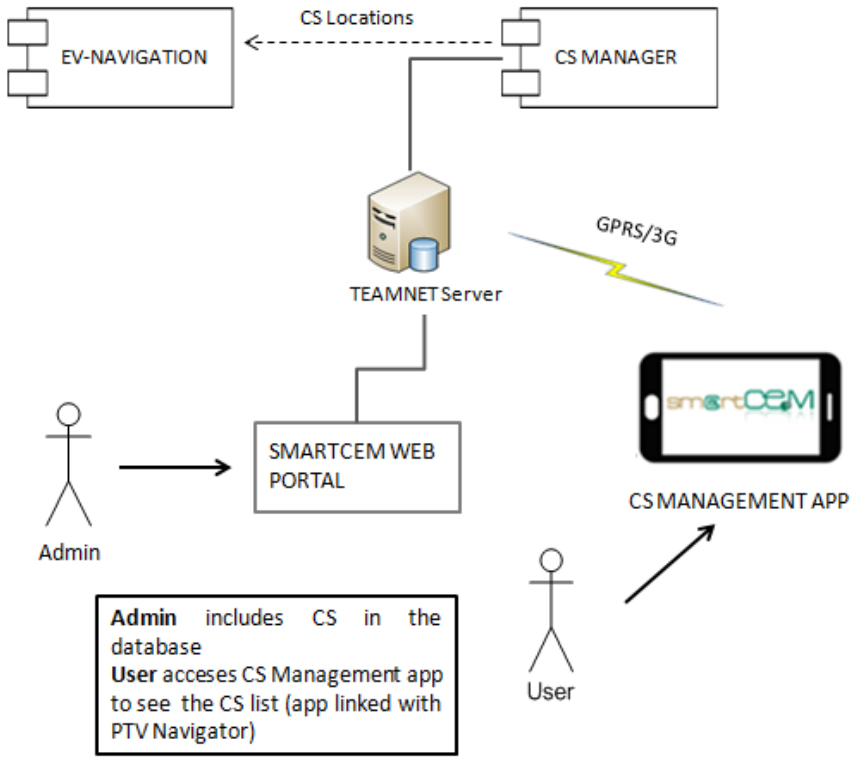


Figure 8: GIP – CS Management service

SERVICE: MULTIMODAL TRIP PLANNER	
Developer	PLUSERVICE
Partners involved	PLUSERVICE, ENNERA
Technological Provider	PLUSERVICE
Hardware components involved	EV-Sharing Service Management Server PLUSERVICE Server DBUS Server DFG Server (Public Transport data)
Software components involved	EV-Sharing Service Management Database Interfaces between EV-Sharing Service Management Server and PLUSERVICE server Multimodal Trip Planner web application Multimodal Trip Planner android

	application
Communications	GPRS/3G/WIFI communication between android application and PLUSERVICE server SOAP Web Services between PLUSERVICE server and ENNERA EV-Sharing Service Management Server GTFS communication between PLUSERVICE server and DBUS and DFG servers to get public transport data.
Comments	Public Transport Data is updated according to the 2014 timeschedule of DBUS and Operators of the Gipuzkoa Province. Both in Web and mobile applications, the End user can select the transport modes s/he prefer to use to plan the journey: “EV+Bus” or “Only Bus”.
User for verification	TECNALIA (Arkaitz Urquiza)
Verification	Verification should take into account the little number of Cars available. Since only two car stations are involved in the system, the multimodal travel engine often cannot find suitable solutions. This applies both for the web and the Android-Mobile based Applications.

Table 8:EV-Multimodal Trip Planer GIP

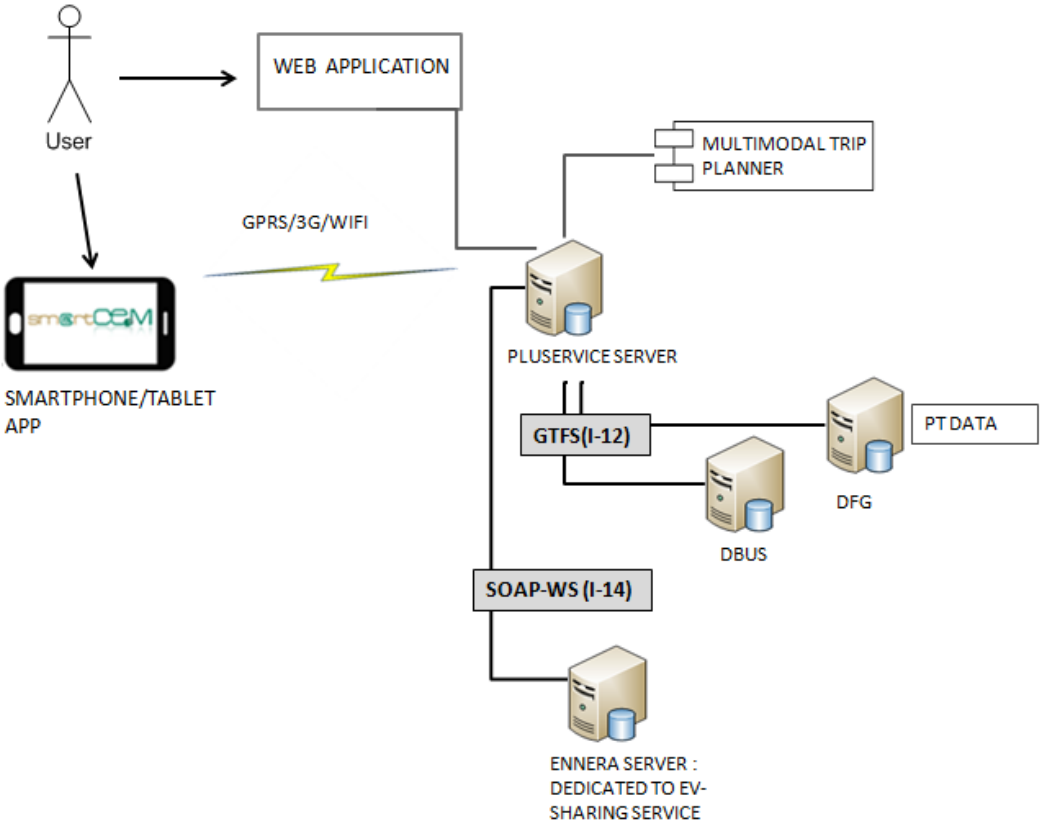


Figure 9: GIP – Multimodal Trip Planner service

SERVICE: EV-EFFICIENT DRIVING	
Developer	DBUS
Partners involved	DBUS
Technological Provider	DBUS/DATIK
Hardware components involved	DATIK Data acquisition Server On Board data logger On Board tablet (HMI) Bluetooth connector
Software components involved	Eco Assist interface software application (HMI) Communication software

Communications	WIFI communication between the tablet (HMI) and On Board Computer (Fleet Management System) GPRS/3G communication between On Board Computer and DATIK Server Bluetooth communication between On Board data logger and the tablet (HMI)
Comments	CAN BUS data acquisition is mandatory in order to obtain reliable data to provide correct eco assist indications.
User for verification	Hybrid BUS driver (DBUS)
Verification	Verification will take into account real service conditions and if the advices provided to the BUS driver are useful to improve his eco-driving skills.

Table 9:EV-Efficient Driving GIP

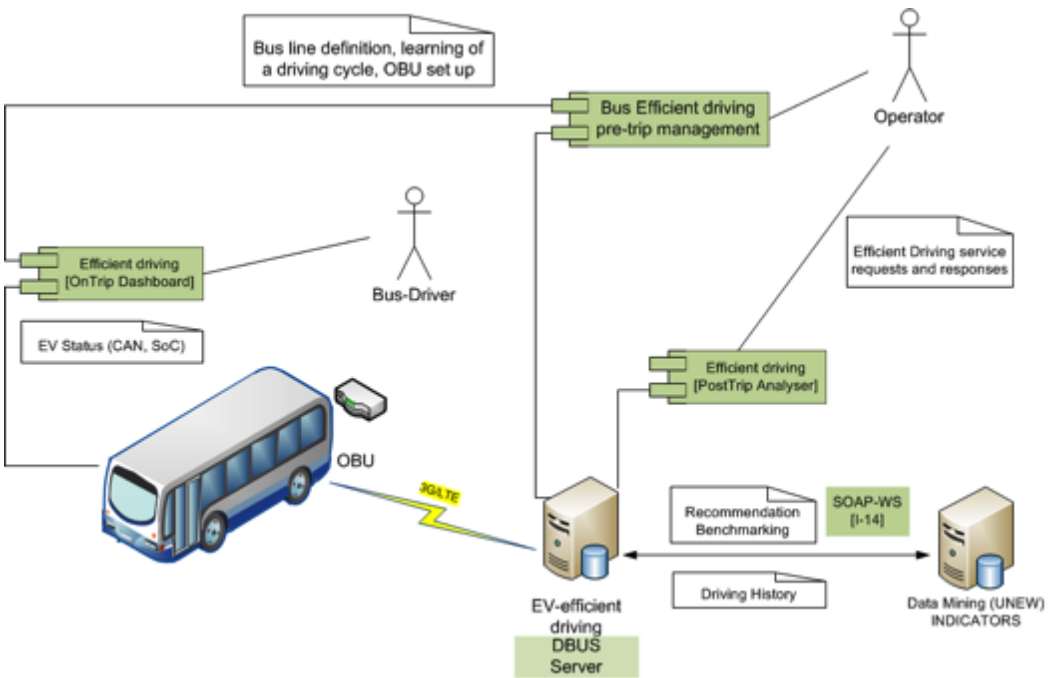


Figure 10: GIP – EV Efficient Driving

3.2.3 Functional Changes

The project has evolved in Gipuzkoa Pilot Site, where some of the functional services have changed from the initial proposals. Those changes are mainly related with these aspects:

1. **Car Sharing service operation:** Although ideally one way and round trips were considered, car-sharing operators find out difficult to control their vehicle distribution in one way trip cases. Their current service is based on in round trips only, so their typical clients are the ones that live nearby car-sharing stations, and often make the same round routes.
2. **Charging Station Management:** As Charging Station Managers are not involved into the smartCEM project in Gipuzkoa, CS management service is based in static CS location data.
3. **Can BUS access:** This interface usage was expected for both, the Hybrid BUS and the Car Sharing vehicles. In most of the cases, the vehicle manufacturers have not allowed the usage of CAN BUS interface for testing applications. As a consequence, in Car Sharing has not been possible to have CAN BUS access while in Hybrid BUS case, where the CAN data is mandatory, this issue has been solved. In fact, for efficient driving to properly work, CAN BUS access is essential.

3.3 Newcastle Pilot Site

3.3.1 Test site in brief

The Newcastle pilot site delivers a range of services targeted at private EV drivers. The main service is EV-Charging Station Management, facilitated through the participation of a key local partner, Charge Your Car (CYC), which provides the core infrastructure component for the operation of the site. CYC is a single national CS management system for the national UK network of charging stations. It enables station owners to connect to the network, making their posts visible to all EV drivers via the CYC live status map. Drivers can find and use charging stations using the CYC App. For a full explanation of CYC and the services it offers, see D2.4.3 (Platform integration for Newcastle pilot site).

A number of additional value-added services enhance the Newcastle site, namely:

- EV-Navigation: in Newcastle this is provided by CYC through the CYC APP, and in a limited number of vehicles by PTV, in collaboration with the Bluedash installation on the Hyperdrive vehicles (see below).
- EV-Efficient Driving: efficient driving feedback and advice will be given to drivers through an online service which takes into account driving style and

charging behaviour, including acceleration events (hard and light), speed, regenerative braking, and standard or fast charge.

- EV-City Policy Tool: a stand-alone analytical tool that will enable targeted network management to help EV drivers optimise routes, and more broadly will elicit understanding of the interaction between travel and energy planning as a cooperative electro-mobility challenge. This tool is still theoretical in scope, but will ultimately be targeted at city authorities and service providers, with the individual driver likely to be a key beneficiary.
- Connection to the Transport Direct (TD) Multi-Modal Transport Planner: a web-based national journey planner in the UK that aims to offer real-time pre-trip and on-trip information on door-to-door multi-modal travel. To enhance the energy-efficient, environmentally friendly credentials of smartCEM's Newcastle pilot, a link will be provided to this service to provide greater mode choice to enable drivers to make more informed travel decisions.
- Central to all the above services is the smartCEM Common App.

The pilot engages private motorists using their own vehicles, 8 Peugeot vehicles owned by UNEW driven by regular drivers, and 2 Cue V vehicles supplied by Hyperdrive. The Hyperdrive vehicles are equipped with BlueDash™ (www.dquid.com), which transmits on-board vehicle data via Bluetooth to a smart phone or tablet. The BlueDash™ unit is able to read vehicle data via the CANbus. The data can be used to visualise vehicle performance, electricity consumption and emissions. The Peugeots are equipped with RDM data loggers.

These components and interfaces enable services to cooperate and exchange information in a harmonized way to provide users with the best possible EV experience.

3.3.2 EV-Services

SERVICE: CS MANAGEMENT	
Developer	CYC
Partners involved	CYC
Technological Provider	CYC
Hardware components involved	User's Desktop PC or smartphone/ tablet User validation and payment method (e.g.

	RFID) CS Back Office (BO) Charging infrastructure
Software components involved	CYC software CYC APP
Communications	Charge point-BO-driver-BO-charge point
Comments	Maintaining communications between the system components is performed by CYC
User for verification	Graeme Hill, Simon Edwards (UNEW)
Verification	Drivers will use the APP to locate and navigate to charge points. The driver will use RFID, IVR or SMS to validate themselves and perform a charging action

Table 10:EV-CS Management NEW

SERVICE: EV-EFFICIENT DRIVING	
Developer	UNEW
Partners involved	UNEW
Technological Provider	UNEW
Hardware components involved	On board data loggers connected to CANbus Local/ Central servers Desktop PC or smartphone/ tablet
Software components involved	Communication software (client web, admin web) Django and PostgreSQL with additional data handling and analysis using bespoke Python scripts

Communications	GRPRS/GSM communication data logger to local server Transferred data in CSV format ftp local server to central serer
Comments	Connections between CANbus and on board logger, local server and central server will be checked according to data quality recommendations
User for verification	Graeme Hill (UNEW)
Verification	The system is a post-trip analyser where drivers can access their own driving data based on vehicle id and user id. The tool will provide driving behaviour feedback. Drivers will provide user acceptance information through questionnaire-based feedback

Table 11:EV-Efficient Driving NEW

SERVICE: EV-NAVIGATION	
Developers	CYC and PTV
Partners involved	GCOL (for CYC Navigation) UNIMORE, PTV, Hyperdrive, Teamnet (for PTV Navigation)
Technological Provider	PTV implementation with Bluedash on Hyperdrive Cue Vs CYC navigation service for drivers of UNEW Peugeots
Hardware components involved	For PTV: On Board Tablet, PTV Server, UNIMORE Server For CYC: On Board Smartphone/ Tablet, CYC server
Software components involved	EV-Navigation application

Communications	GPS signal by the tablet GPRS/3G between the tablet and servers
Comments	None
User for verification	Simon Edwards & Graeme Hill (UNEW)
Verification	Verification will focus on usability of the services and accuracy of the navigation system

Table 12:EV-Navigation NEW

3.3.3 Functional Changes

At the Newcastle PS navigation is supplied through both the CYC navigation service and the PTV navigation service. The PTV navigation service is specifically utilised in the vehicles manufactured and operated by Hyperdrive and will interface with the Bluedash units that are to be implemented on these vehicles. Navigation is delivered via Use Cases 07 and 14 (see Appendix D).

3.4 Reggio Emilia Pilot Site

3.4.1 Test site in brief

smartCEM services under evaluation at Reggio Emilia pilot site are: EV Efficient Driving App, EV Navigation system and Charging Station Management.

This will give insight on possible usage of smartCEM services on EV fleets owned or managed by public administration all over Europe.

The smartCEM services will be tested in Reggio Emilia on a local EV sharing fleet used by the employees of the Municipality of Reggio Emilia. From the fleet, composed by about 60 vehicles, 10 vehicles have been selected to be part of smartCEM project. The EVs composing the Reggio Emilia Municipal fleet are fully electric Piaggio Porters used for passengers and light goods transportation. They will be used in two configurations, i.e. baseline and experimental periods. 20 users will be involved in testing activities and they will drive vehicles normally in the first configuration and will be given access to smartCEM services in the latter.

Vehicles will be equipped with a BlueDash unit (i.e. BD) and an Android 7 inch tablet on which smartCEM services will be installed and accessible. BD will gather data (i.e. state of charge, current and tension) from the vehicle's electric network and will communicate them to a remote server located at UNIMORE facilities. Data will be sent to this "on-site" server via GPRS. There, they will be post-processed and then they will be available to be exchanged with partners in charge of

smartCEM services execution. Data will be also sent to project central database located at UNEW.

3.4.2 EV-Services

smartCEM electro-mobility services, integrated through the smartCEM platform, will be tested in REG PS and they are listed below.

- EV-Efficient driving: An on-board tablet connected to the EV will be used to collect data about performance (i.e. SoC, Speed…) and to provide tailored real-time advices to the driver about his driving style.
- EV-Navigation: it starts from eco-navigation and integrates charging stations. It shows real-time availability of charging stations and includes Battery Management System that shows drivers which charging stations are available on the basis of autonomy that is influenced by driving style and topography.
- EV-Charging Station Management: this service gathers and shares all the information needed by the other services concerning charging stations available at the pilot site.
- EV-Policy Tool: it is a simulation tool having the purpose to evaluate and establish a wider perspective of smartCEM impact (the involvement of this service at Pilot Site level is under discussion and its verification won't be addressed within this document).

SERVICE: EV-NAVIGATION	
Developer	PTV
Partners involved	UNIMORE, PTV, CRF
Technological Provider	PTV
Hardware components involved	On Board Tablet PTV Server UNIMORE Server
Software components involved	EV-Navigation application
Communications	GPS signal by the tablet GPRS/3G between the tablet and servers

Comments	None
User for verification	UNIMORE
Verification	Verification will focus on usability of the services and accuracy of the navigation system

Table 13:EV Navigation REG

SERVICE: CS MANAGEMENT	
Developer	TEAMNET
Partners involved	TEAMNET, UNIMORE
Technological Provider	TEAMNET
Hardware components involved	TEAMNET Server On Board Tablet (providing HMI)
Software components involved	SmartCEM web portal database. SmartCEM web portal CS Management android application
Communications	3G/GPRS connection between On Board Tablet and TEAMNET's Server
Comments	Any time CS data are updated in the smartCEM portal, the information is automatically updated for the CS Management android app. The list of CS and their location is automatically linked to the EV-Navigation service
User for verification	UNIMORE
Verification	Verification should take into account the proper refresh of the data, both in the portal database, as well as in the Android application. It is also important to check that the link between CS Management service and the EV-Navigation service works properly.

Table 14:EV-CS Management REG

SERVICE: EV-EFFICIENT DRIVING	
Developer	CRF
Partners involved	CRF, UNIMORE, PTV
Technological Provider	CRF
Hardware components involved	On Board Tablet BlueDash unit UNIMORE Server
Software components involved	Efficient Driving app
Communications	GPRS between BlueDash and UNIMORE server GPRS/3G between server and Tablet
Comments	None
User for verification	UNIMORE
Verification	Verification should ensure that the real-time data flow is fine and that advices concerning driver's style are provided by means of the Tablet

Table 15:EV-Efficient Driving REG

3.4.3 Functional Changes

According to first release of smartCEM project description of work, the Italian pilot site was meant to be located in the city of Turin. It was moved to city of Reggio Emilia due to the financial breakdown of a consortium partner. It was fixed in a project amendment.

An updated list of Use Cases, according to the specific situation at the Municipality of Reggio Emilia, can be found in Annex E. No further functional changes occurred with respect to the implementation of the platform as described in D2.4.4, "Platform integration for Reggio Emilia".

4 Operational Verification

In this chapter, the procedure and the results from the technical verification, performed in all Pilot Sites according to the methodology described in chapter 2, will be presented. The verification process is defined for all the different Use Cases, focused in the different smartCEM services that take part in each step of the Test Cases.

4.1 Barcelona Pilot Site

4.1.1 Test Cases Description/Scenarios

Barcelona Pilot Site implements the EV-Sharing service. The following scenario covers the core functionality of the smartCEM services to be tested (EV-Sharing, EV-Navigation):

1. When using the sharing service in Barcelona the end user needs to register to the service providing personal information by filling a form. If everything is correct the service administrator will accept the registration and enable the bookings for this user → BCN_UC_01: User registration

2. Afterwards, the user can start making booking of the shared vehicles using both the web application or the iOS/Android application → BCN_UC_04: Immediate Spot Trip Booking, BCN_UC_05: Planned Spot Trip Booking, BCN_UC_06: Time-based booking and BCN_UC_08: Incentives management (dynamic pricing) for efficient fleet management

3. Once the booking is completed, the user can modify booking parameters or also cancel the reservation using the web application or the smartphone application → BCN_UC_10: Cancellation / modification of spot trips

4. After the confirmation of the correct booking parameters, the user gets a notification on where to pick up the vehicle during the booking period. The user smartphone app is used in the picking up process, as it is used to lock and unlock the vehicle during the booking progress. → BCN_UC_07: e-scooter check-in

5. When driving the vehicle, the user has the possibility to use the on board tablet as an EV-Navigation system and have some driving aids during the trip (indications, battery level, etc.). → BCN_UC_11: e-scooter riding

6. After finishing the trip, the user needs to indicate through the smartphone application that the trip has been finished without problems → BCN_UC_12: e-scooter check-out

The testing of this scenario covers all the services implemented for Barcelona Pilot Site. The main use cases pre-defined in D2.1 and updated in Appendix C for this site, are also implicit within those scenarios. As commented in the testing methodology chapter, the main objective of these scenarios is to verify the correct behaviour of the system for the mentioned test cases.
The next paragraph describes the final results of the Barcelona PS test cases, during the verification period of the services.

4.1.2 Test Case Verification

Test Case	**An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, EV-Efficient Driving):**	
Tester	Marti Jofre (Creafutur) as verification tester	
Admin	Marti Jofre (Creafutur)	
Step 1		
Description	The tester accesses the corporative web site of the sharing service and continues to the user registration site. In this page, the tester completes the registration process filling the corresponding form with personal data: name, surname, address, email, national identification number, bank account number, driving license number, etc. The tester will also define the username and password that will use afterwards to log in the client web.	
Expected Result	If the sent information is correct and the administrator gives an approval, the tester will be registered as a service user in the administration database with a unique identifier matched to the personal data. The administrator will send an email to the tester confirming the registration and informing him to download the smartphone application that must be used to book trips and to lock and unlock the vehicle.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	BCN_UC_01: User registration	
EV-Service Implied	EV-Sharing	
To check	Client web application	✓

	Registration form	✓
	Client correct registration in system database	✓
Issues/Comments	Two different rate schemes are proposed: either a sign-up fee or a quarterly fee + cheaper price/km	
Step 2		
Description	When the tester is registered, he/she starts booking vehicles. This can be done through the client web application or the smartphone application. CLIENT WEB APPLICATION: The tester accesses the client web page. He/she needs to log in using the pre-defined username and password. He can book a vehicle indicating time of trip, origin and destination, per time or per distance. The "Reservations" option from the client web site shows past and future bookings for the user, in order to confirm that the new booking has been properly registered in the database. SMARTPHONE APPLICATION: First, it is required to download the android application and install it in the personal device. Once the application is installed, the booking process will be similar to the one completed using the web platform. The tester accesses the application and logs in using the correct username and password. He can book a vehicle indicating time of trip, origin and destination, per time or per distance. In this case, the pending bookings can be checked accessing the "Pending bookings" screen.	
Expected Result	If the booking process has been completed correctly, it should be registered in the system database. This can be checked accessing the reservations table from the administration web site.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	BCN_UC_04: Immediate Spot Trip Booking, BCN_UC_05: Planned Spot Trip Booking, BCN_UC_06: Time-based booking and BCN_UC_08: Incentives management (dynamic pricing) for efficient fleet management	
EV-Service Implied	EV-Sharing	
To check	Login in client web application	✓
	Correct client web visualization	✓

	Search vehicle booking solutions in web	Not active yet
	Correct booking (from web) storage in system database	Not active yet
	Check pending bookings list in "Reservation" option of the client web site	Not active yet
	iOS / Android application download and install	✓
	Login in iOS/Android application	✓
	Search vehicle booking solutions in application	✓
	Correct booking (from application) storage in system database	✓
	Check pending bookings list in "Pending bookings" screen of the application.	✓
Issues/Comments	Due to low availability of vehicles at this stage of the pilot, the tester booked a vehicle in a predefined area with a number of vehicles available. Time-based booking now requires to indicate Destination point. Booking cannot be done yet through the website.	
Step 3		
Description	The tester has the option to modify booking parameters before the reservation date and time. This is done accessing the Reservations option in the application. Modification and cancellation options are available.	
Expected Result	The correct modification of the booking is expected, not overlapping existing bookings. Both, cancellation or modification will be reflected in the reservation table of the application.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	BCN_UC_10: Cancellation / modification of spot trips	
EV-Service Implied	EV-Sharing	
To check	Correct modification of a booking via web	Not active yet
	Correct cancellation of a booking via web	Not active

		yet
	Correct modification of a booking via mobile app	✓
	Correct cancellation of a booking via application	✓
	Correct storage of modifications and cancellations in system database.	✓
Issues/Comments		
Step 4		
Description	After the booking process is completed, and all the modifications needed applied, the tester has to wait till the booking day to pick up the vehicle. Some minutes before the time selected for the trip, the user will receive a notification on his/her smartphone app with the booked scooter license plate and current location. Internally, the application has received a key code to unlock the scooter. Key code only matches the booked scooter within the allowed timeframe (some minutes before and after booked Start Time). The user goes to the location of the booked electric scooter, checks in and starts the trip. Check-in process is done through wireless communication between the user's smartphone MOTIT BCN app and the electric scooter OBU.	
Expected Result	The user should receive the notification with the scooter license plate and current location. The user app should unlock the vehicle during the booking period, not before. The screen should switch on properly and show the correct destination.	
Requirements	Smartphone	
UC Implied	BCN_UC_07: e-scooter check-in	
EV-Service Implied	EV-Sharing	
To check	User receives notification on the smartphone	✓
	User can unlock the vehicle.	✓
	OBU screen correct functioning.	✓
	User can take the helmet.	✓
Issues/Comments	The wireless communication between smartphone and vehicle is done through WiFi. In the case of iOS application, user needs to activate the WiFi connection manually and make a connection with the scooter.	

Step 5		
Description	In order to have indications and range estimation info the EV-Navigation application should be used in the on board tablet. The starting address and the arrival address are automatically introduced on the vehicle tablet. The application will provide the route and battery level of the vehicle, always above the required energy for the selected trip. The battery level is directly read from the Battery Management System of the vehicle.	
Expected Result	The EV-Navigation application should provide a route for the selected trip. Battery drain progress while driving should give a sensible result.	
Requirements	On Board tablet	
UC Implied	BCN_UC_11: e-scooter riding	
EV-Service Implied	EV-Sharing, EV-Navigation	
To check	Correct starting point	✓
	Indication of route to destination	✓
	Battery drain progress working	✓
Issues/Comments	CS-Management is not implemented since the vehicles won´t charge in public charging stations. The batteries will be swapped by the operator when the vehicle runs out of battery (the vehicle will be out of service during this process).	
Step 6		
Description	The tester finishes his/her trip. He/she finds a place to park the electric scooter within a short range of agreed destination He/she stops the scooter engine (“ON/OFF” button) and logs out from the scooter by pressing “End Booking” button on the app. The application connects to the Electric Scooter Sharing Server to complete the logout. Once logout is completed, the user receives a confirmation message on the app	
Expected Result	If the communications are OK, the system will correctly register that the trip corresponds the booking finishing time and location. The user will receive a confirmation message on his application.	
Requirements	User Smartphone, e-scooter Tablet	
UC Implied	BCN_UC_12: e-scooter check-out	
EV-Service Implied	EV-Sharing	

To check	Select finish booking option	✓
	Last RFID reading closes vehicle (screen switches off)	✓
	Check booking finished in system administrators web reservation table	✓
	Shows confirmation message to user	✓
Issues/Comments	In the case of the iOS version of the application, although the check-out is correctly registered in the system, some error messages are shown to user by the application. The issue is being investigated but it has no major impact on the service. The eco-driving report (EV-Efficient Driving service) isn't provided at the end of the trip. It will be available for users in a dedicated report that can be checked in a website, after the trip is completed.	

4.1.3 Visual facts

This chapter extends 4.1.2 by providing visual evidence, like images, screenshots and photos accompanied by comments, for functional verification tests.

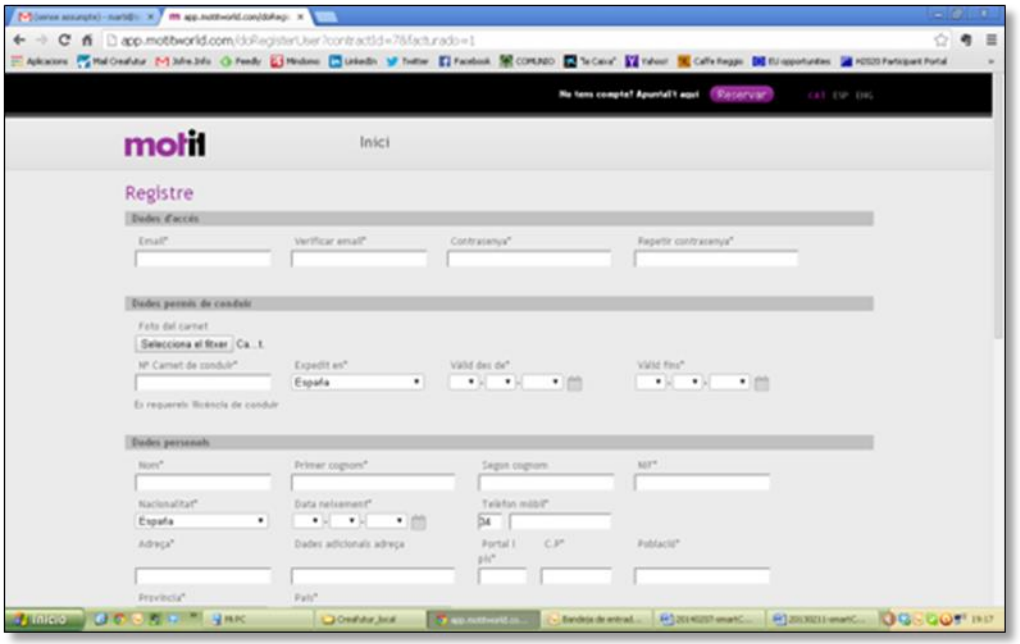


Figure 11: User registration form

Figure 12: Application – Home page (Book, Drive, My bookings, My User Account)

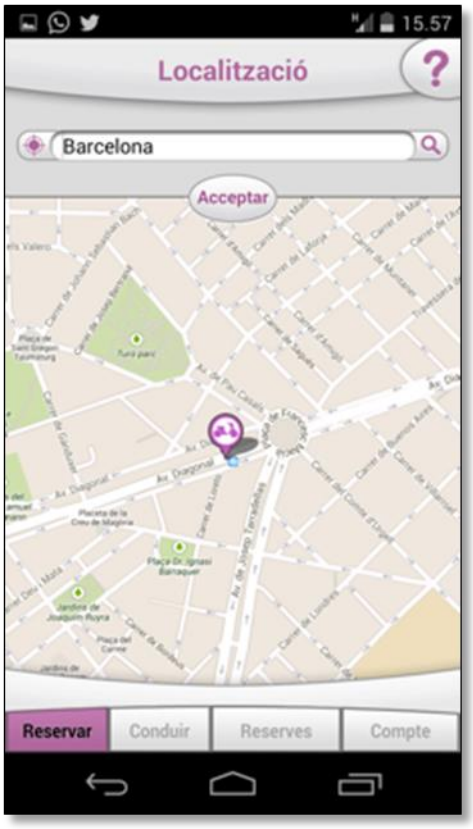


Figure 13: Selection of origin or destination on the map

Figure 14: Summary of booking (Date, Time, Origin, Destination)

Figure 15: Proposal of alternative trip with incentives (47m walk, 10% discount)

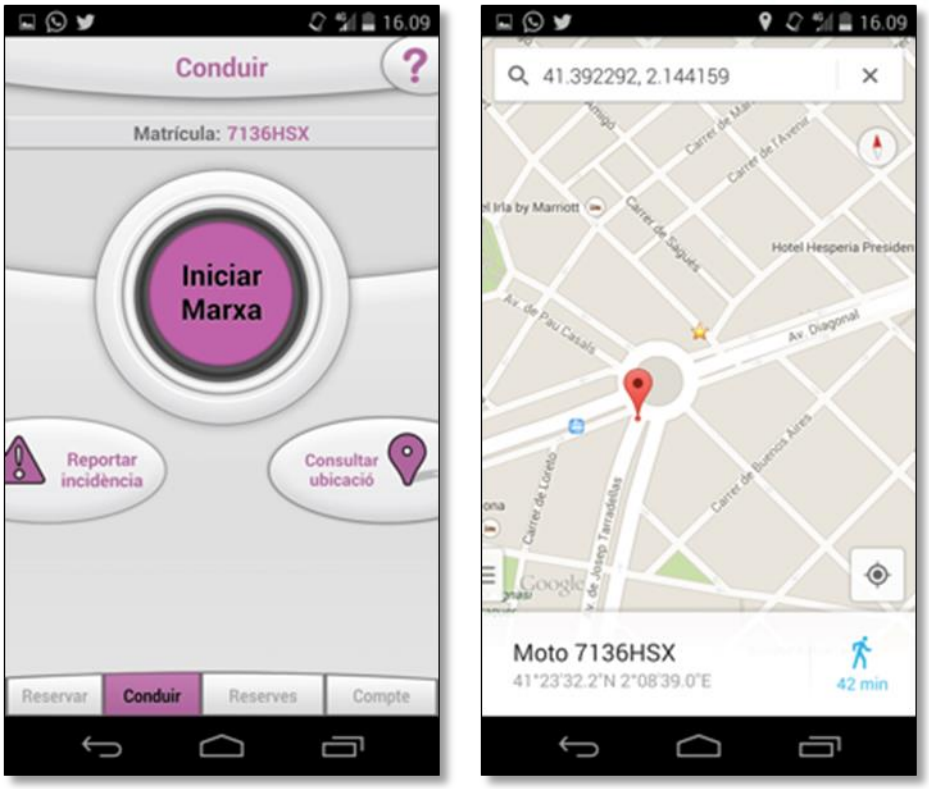


Figure 16: Check-in screen (right button shows the map with the position of the vehicle)

Figure 17: e-scooter pick-up

Figure 18: EV-Navigation

Figure 19: End of trip – Summary (including option to report incidence)

4.1.4 Lessons learnt

From the user perspective, the service is now functionally working and the tester feelings were positive when using the service. The first check-in on the motorbike is a bit confusing for users not familiar with scooter driving, since there are some actions to do both on the app and the motorbike. Nevertheless, the learning process is really fast and the check-out and the following check-ins were straight forward.

The only issue is about service availability. At this stage, the area covered is insufficiently served with the number of vehicles available. This fact will be progressively reduced when more vehicles are introduced.

4.2 Gipuzkoa Pilot Site

4.2.1 Test Cases Description/Scenario

Gipuzkoa Pilot Site is compound by EV-Sharing and Public Transport services. This has supposed the necessity to consider three different main scenarios when the smartCEM services are tested:

- An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, CS Management):

    1. When using a sharing service in Gipuzkoa the end user needs to register with the service providing personal information filling a form. If everything is correct the service administrator will provide a user card → GIP_UC_01: eCarsharing registration/EV-Sharing

    2. Afterwards, the user can make bookings over the service vehicles, using both: the web application or the android application provided for EV-sharing users → GIP_UC_02: eCarsharing booking/ EV-Sharing

    3. Once the booking is completed, the user can modify booking parameters or also cancel the reservation using the web application or the android application → GIP_UC_04: Web/android application booking modification/ EV-Sharing

    4. After the confirmation of the correct booking parameters, the user goes to the car-sharing station, to pick up the car during the booking period. The RFID user card is used in the picking up process, as it is used to lock and unlock the vehicle during the sharing process. → GIP_UC_06: start eCarSharing/EV-Sharing

    5. On trip the user can also modify the booking parameters using the OBU. → GIP_UC_08: On-Board booking modification/ EV Sharing

6. When driving the vehicle, the user has the possibility to use the on board tablet as an EV-Navigation system, in order to have driving aids during the trip (indications, efficiency, battery level, etc.). The CS Management service shows the list of CS. If a CS is selected, the EV-Navigation service is activated and gives directions to reach the place. → GIP_UC_07: eCarsharing driving / EV Navigation, CS-Management Service

7. After finishing the trip, the user needs to indicate via OBU that the vehicle is being returned. Last of all, he/she will close/lock the vehicle using the RFID user car. The system will store the booking summary data in the database. → GIP_UC_09: finish eCarSharing, GIP_UC_10: eCarSharing Data Analysis/ EV-Sharing

- A user driving the Hybrid Electric bus equipped with the EV – Efficient Driving system:

  1. The tester (driver) must validate the beginning of his driving shift, entering this information in the ticketing machine. The information is sent to the efficient driving application to activate the specific parameters ecodriving.

  2. Specific information to the bus is given to the driver during the trip, via efficient driving application.

  3. Once the shift is completed, the data recorded is sent to the Data Analysis Servers.

- A user combining EV-Sharing/Public Transport (Multimodal Trip Planner)

  1. If an already registered EV-Sharing user wants to find out whether Public Transport mode can help him/her reach the EV-sharing station or directly the final destination, the user has the option to plan the trip using the Multimodal Trip Planning service. →GIP_UC_03: Multimodal travel planning /Multimodal Trip Planner

  2. When a multimodal travelling service is selected, the end user has the possibility to combine two options:

     a. EV-Sharing driving (Refer to Test Case: An EV-Sharing user books a vehicle for a trip)

     b. Public Transport travelling →GIP_UC_05: Multimodal travelling/Multimodal Trip Planner

The testing of these three scenarios covers all the services implemented for

Gipuzkoa Pilot Site. The use cases pre-defined in D2.1 and updated in this document's Appendix C for this site, are also implicit within those scenarios. As commented in the testing methodology chapter, the main objective of these scenarios is to verify the correct behaviour of the system for the mentioned test cases.

The next chapter describes the final results of the Gipuzkoa PS test cases, during the verification period of the services.

4.2.2 Test case verification

Test Case	**An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, CS Management)**	
Tester	Arkaitz Urquiza (TECNALIA) as verification tester	
Admin	Oier Iribar (ENNERA) as Car-Sharing Operator	
Step 1		
Description	The tester accesses the corporative web site of the sharing service and continues to the user registration site. In this page, the tester completes the registration process filling the corresponding form with personal data: name, surname, address, email, national identification number, bank account number, driving license copy, etc. The tester will also define the username and password that will use afterwards to log in the client web.	
Expected Result	If the sent information is correct and the administrator gives an approval, the tester will be registered as a service user in the administration database with a unique identifier matched to the personal data. The administrator will send the tester a RFID card that must be used as the user card, to lock and unlock the vehicle in the booking process.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	GIP_UC_01: eCarsharing registration	
EV-Service Implied	EV-Sharing	
To check	Client web application	✓
	Registration form	✓
	Client correct registration in system database	✓
Issues/Comments	It is really important to have correct translations in the	

	registration form, as this will be the first contact of the user with the service.	
Step 2		
Description	When the tester is registered, he/she starts booking vehicles. This can be done through the client web application or the android application. CLIENT WEB APPLICATION: The tester accesses the client web page. He/she needs to log in using the pre-defined username and password. Then, in the home page, the search filtering column must be used in order to see vehicle availability for the requested specific date-time/km/station parameters. Once the tester selects the most suitable option, the booking is completed. The "Reservations" option from the client web site shows past and future bookings for the user, in order to confirm that the new booking has been properly registered in the database. ANDROID APPLICATION: First, it is required to download the android application and install it in the personal device. Once the application is installed, the booking process will be similar to the one completed using the web platform. The tester accesses the application and logs in using the correct username and password. Then, the "New booking" search screen must be used in order to see vehicle availability for the requested specific parameters. When the tester selects the most suitable option, the booking is completed. In this case, the pending bookings can be checked accessing the "Pending bookings" screen.	
Expected Result	If the booking process has been completed correctly, it should be registered in the system database. This can be checked accessing the reservations table from the administration web site.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	GIP_UC_02: eCarsharing booking	
EV-Service Implied	EV-Sharing	
To check	Login in client web application	✓
	Correct client web visualization.	✓
	Search vehicle booking solutions in web.	✓

	Correct booking (from web) storage in system database.	✓
	Check pending bookings list in "Reservation" option of the client web site.	✓
	Android application download and install.	✓
	Login in android application.	✓
	Search vehicle booking solutions in android application.	✓
	Correct booking (from application) storage in system database.	✓
	Check pending bookings list in "Pending bookings" screen of the application.	✓
Issues/Comments	Depending on the type of device used for the reservation process, a different platform should be used. The web application seems less convenient to use in nomadic devices, as it is not adapted to resize etc. In those cases, the android application feels better for its usage.	
Step 3		
Description	The tester has the option to modify booking parameters before the reservation date and time. This is done accessing the Reservations option in the client web site. Modification and cancellation options are available. In case of the android application, the only available alternative is booking cancellation.	
Expected Result	The correct modification of the booking is expected, not overlapping existing bookings. Both, cancellation or modification will be reflected in the reservation table of the administration web site.	
Requirements	Internet connection, PC or smartphone/tablet	
UC Implied	GIP_UC_04: Web/android application booking modification	
EV-Service Implied	EV-Sharing	
To check	Correct modification of a booking via web.	✓
	Correct cancellation of a booking via web.	✓
	Correct cancellation of a booking via android application.	✓

	Correct storage of modifications and cancellations in system database.	✓
Issues/Comments	At this stage the android application just permits the visualization of future bookings and its cancellation. If the project grows, it would be nice in the future, adding the modification option also, as well as the visualization of passed bookings.	
Step 4		
Description	After the booking process is completed, and all the modifications needed applied, the tester has to wait till the booking day to pick up the vehicle. Once the booking date and time arrives, the tester must put the user card (RFID card) over the RFID reader that is located on the driver's side of the wind screen, until the car is opened. The RFID reader is connected to the OBU that will programmatically check if the card that has been read corresponds to the pending reservation's user. If so, the OBU will show a green light with the LED and open the car. If not, the LED will show a yellow light (During the sharing process the user will use the RFID user card to lock and unlock the vehicle, as many times as is needed. The car keys that are inside the glovebox the vehicle are used just to start and stop the engine). When the vehicle is opened, the OBU screen switches on and asks if the car is in a correct status. If not, the user can specify the type of issues encountered from a selection presented in the screen. The message will be sent to the system administrator as a notification. If the vehicle status is correct, the user can start the trip, taking the car keys from the glove box. The screen of the OBU will show the booking time and km left for the user. If the screen is maintained pressed some other options will appear, such as base stations, adjustments, modify booking, etc.	
Expected Result	The user card should unlock the vehicle during the booking period, not before. The screen should switch on properly and ask about the vehicle status. Booked time and km quantity should be correctly shown in the reservation summary screen.	
Requirements	RFID user card	
UC Implied	GIP_UC_06: start eCarSharing	
EV-Service Implied	EV-Sharing	
To check	Correct response of the RFID card reader. Yellow for not allowed user. Green and open doors for the allowed user.	✓
	OBU screen correct functioning.	✓

	Booking parameters correctly loaded on OBU screen for the user.	✓
	Keys inside the vehicle	✓
Issues/Comments	The RFID readers coverage field is not too large/wide so the user card needs to be approached and maintained in the correct position until the vehicle gets unlocked. A sticker on the windshield in driver's side, advising how and where to put the card could help the end user.	
Step 5		
Description	As commented in the previous step, one of the options given via OBU is the Booking Modification. This is a specific screen in which the user can add more time to the current booking. Once the new period is defined, the OBU will send the request to the system central server; via GPRS/3G signal. The system will check in the database if that new time span is not covered by any other reservations. If the new time span is free, the system will respond with the confirmation. The new timings will be updated in the summary screen. On board, the booking can be just extended in time, not in km.	
Expected Result	The OBU should communicate with the system server via GPRS/3G in order to determine if the modification request is possible. In case there is bad coverage, the OBU will show a message notifying that has been impossible to establish the communication (bad coverage or communication failures can be also noticed as the OBU shows a red light in the LED when it loses communications). If the modification request is not possible to be executed (because of overlapping between reservations etc.) the system will notify it with a message. In any other case a confirmation will appear on-screen.	
Requirements	-	
UC Implied	GIP_UC_08: On-Board booking modification	
EV-Service Implied	EV-Sharing	
To check	Test On Board booking modification screen.	✓
	Try to overlap a booking. The system should respond that it isn't possible.	✓
	Booking extended. A confirmation and new timescale parameters should be shown in the summary screen.	✓
Issues/Comments	While driving, the led cannot be seen by the driver as it is	

	located on the backside of the OBU, facing outwards. So when communications are lost, the user is not aware until he tries to send new booking parameters through the OBU, like in the case of an On Board modification. At that moment a message will warn him about the communications lost status.
Step 6	
Description	In order to have indications and range estimation info the EV-Navigation application should be used in the on board tablet. Here the starting address and the arrival address must be introduced, as well as the vehicle model. After defining those parameters, the application will check the route, giving a description of the route and the vehicle before starting the navigation process. In this same screen, along with route and vehicle data, the estimation (based on car-manufacturers specifications) of the range that can be reached with the vehicle will be shown as a polygon over the map. When the navigation starts, having the tablet in landscape position, the user will see the efficiency bar on the right side of the screen. Here the battery drain progress, the users driving style (related to speed) and other consumer descriptions are shown. It has to be remembered, that all the provided information such as the range, the battery drain, etc. are estimations and not real values, as for these vehicles it has not been possible adding CAN BUS connection. There is another smartCEM service that works along with the EV-Navigation application. The CS Management service shows the list of the charging stations that have been registered by the administrator in the smartCEM web platform. The application can show all the CS when no filtering its applied, or in case geo-location option is used, it would show just the list of CS for the current PS. If the user selects a specific CS, the EV-Navigator will be executed, giving indications to reach the specified destination.
Expected Result	The EV-Navigation application should respond when searching a random route for the test. All the vehicle models should be included as choices in the application. Indications should feel clear. Range estimation and battery drain progress while driving (functionalities that add value when EV-driving) should give a sensible result. The addition of new CS in the Management Console of the smartCEM platform should be reflected in the application, once this is refreshed. If the user selects a specific filtering, the corresponding CS should appear. The selection of a CS should

	link the application with the EV-Navigation service properly.	
Requirements	On Board tablet	
UC Implied	GIP_UC_07: eCarsharing driving	
EV-Service Implied	EV-Sharing, EV-Navigation, CS-Management service	
To check	**EV -NAVIGATION**	
	All the vehicle models as choices.	✓
	Random routes working.	✓
	Valid range estimation.	✓
	Battery drain progress helpful and matching the vehicle monitor's battery level info.	✓
	CS-MANAGEMENT SERVICE	
	CS-Management application is correctly linked with EV-Navigation application, in order to provide driving indications. Tapping the "Navigate To.." button displayed on the right side for each CS in the list should launch the PTV Navigator with the destination correctly set.	✓
	SmartCEM Management Console working.	✓
	The newly added CS should be available in the list displayed by the CSManagement Android application (a manual refresh may be needed).	✓
	When CSManagement site is set to "Auto", the site should be automatically chosen by the application based on the current GPS coordinates.	✓
	Correct filtering of CS.	✓
Issues/Comments	The Navigator needs to have training data or better reference data in order to adjust the system to give a more accurate battery drain prediction in simulation mode (with no connection between navigator and vehicle). The current prediction felt optimistic during the test. Battery drain in the vehicle was faster than the prediction in the navigator. As there is no connection between the vehicle and the Navigator, the SoC and the vehicle model parameters are not automatically updated in the application. The user needs to specify manually the SoC and the vehicle model before starting the trip, in order to obtain a proper range estimation result in the navigator. Within the list of CS, the public and private CS should be	

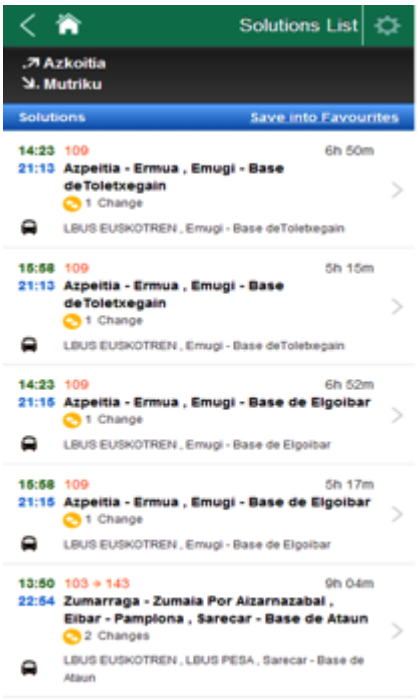
	differenced. Private CSs are just for private car-sharing company vehicle's usage, while public ones can be used by everyone.	
Step 7		
Description	At the end of the trip, the user must press on the OBU screen in order to see the options and select "Return vehicle". This is how the user indicates via OBU that the next locking of the vehicle will mean the finishing of the reservation. The OBU will know that the RFID card reading for this user, locking the vehicle, should be sent to the system as booking's real finish time. Apart from closing the vehicle, this real finishing time should be stored in the system database and the reservation must be closed in the system server. After selecting this option, the on board unit will show the "goodbye" message and the screen switches off. The user leaves the car, and puts the user card over the RFID reader. The vehicle closes and the booking gets finished. Booking final description parameters can be analysed in the reservation panel.	
Expected Result	If the communications are OK, the system will correctly register that the next RFID reading corresponds to the booking real finishing time. The "goodbye" message should appear on screen and then this should switch off.	
Requirements	RFID user card	
UC Implied	GIP_UC_09: finish_eCarSharing, GIP_UC_10: eCarSharing data analysis.	
EV-Service Implied	EV-Sharing	
To check	Select finish booking option	✓
	Shows goodbye message and screen switches off.	✓
	Last RFID reading closes vehicle.	✓
	Check booking finished in system administrators web reservation table.	✓
	Review that the reservation parameters are correct, once this has been closed.	✓
Issues/Comments	N/A	

Test Case	**A user driving the Hybrid Electric bus equipped with the EV – Efficient Driving system**
Tester	A bus driver
Admin	Eduardo González (DBUS) as Bus Operator
Step 1	
Description	When the tester (driver) is assigned to the bus, he must validate the beginning of his driving shift, introducing this information in the ticketing machine: Bus driver code Bus Lines and schedule Bus Number This information is sent to the tablet (EV Efficcient Driving Interface HMI) via WIFI. Then the ecodriving specific parameters for that bus line are activated and the system is ready to start giving instructions automatically.
Expected Result	The tester should see the Tablet (Interface) properly activated
Requirements	WIFI connection inside bus for iPanel access if wanted
UC Implied	GIP_UC_11 Pre-trip Bus route pre-learning GIP_UC_12 Pre-trip Bus driver working shift start
EV-Service Implied	Efficient Driving
To check	N/A
	N/A

Issues/Comments	N/A
Step 2	
Description	According to the planned route, the bus starts the Bus route with the EV-Efficient Driving system activated for this route. During the trip, the system recognises the events in the driving style that are showed to the driver as alerts and recommendations to accelerate or slow down.
Expected Result	The alerts showed should be realistic taking into account that the bus line must be completed in a tight schedule. If the instructions given are followed, the driver should gradually turn to an Ecodriving style behaviour.
UC Implied	GIP_UC_13 On-trip Hybrid bus driving
EV-Service Implied	Efficient Driving
To check	N/A
Issues/Comments	N/A
Step 3	
Description	Once the shift is completed, the data recorded is sent to the Data Analysis Servers. The information is accessible through the web analysis tool (iPanel)
Expected Result	With the web tool, the bus operator will be able to analyse the efficiency of the operation with real data. Operation Key Performance Indicators such as “consumption Alerts per bus driver”, “Consumption / Line”, “Accelerating Alerts / bus driver” and even the location of this alerts will be available in the web tool for the operator.

UC Implied	GIP_UC_14 Post-trip Bus working shift data analysis	
EV-Service Implied	Efficient Driving	
To check	N/A	
Issues/Comments	N/A	

Test Case	**A user combining EV-Sharing/Public Transport (Multimodal Trip Planner)**
Tester	Arkaitz Urquiza (TECNALIA) as verification tester
Admin	Oier Iribar (ENNERA) as Car-Sharing Operator
Step 1	
Description	When the tester wants to find out whether a combination of different transport modes offers a better option for him to get to his destination, the Multimodal Trip Planner service is used, either via web or via android application. In the application the initial and destination points are defined by the tester. A trip solution will be given for the specified route and time span. EV-Sharing option can be considered or disregarded. The solution will contain, the trip plan, where distances driven, walked, etc. will be determined in a summary.
Expected Result	The tester should have sensible travelling results. In case EV-Sharing is included, the solution should guide the tester to the EV-Sharing registration panel.
Requirements	Internet connection, PC or smartphone/tablet

UC Implied	GIP_UC_03: Multimodal Trip Planning	
EV-Service Implied	Multimodal Trip Planner	
To check	Multimodal Trip Planner web application	
	Multimodal Trip Planner android app	
Issues/Comments	The trip planner works as expected after several tests: e.g. entering Origin: Azkoitia, Destination: Mutriku - Range: 1/05/2014, 6.00pm to 8pm the system returns a list of solutions as expected. 	
Step 2		
Description	According to the planned route, the tester starts the trip either by BUS or using EV-Sharing vehicles. During the trip both services can be combined. (EV-Sharing case refers to Test Case: An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, CS Management)	

Expected Result	The planned options should be available in terms of Public Transport. (EV-Sharing case refers to Test Case: An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, CS Management)	
UC Implied	GIP_UC_05: Multimodal travelling	
EV-Service Implied	Multimodal Trip Planner	
To check	N/A	
Issues/Comments	N/A	

4.2.3 Visual Facts

Figure 20: Testing EV-Sharing car.

An EV-Sharing user books a vehicle for a trip (EV-Sharing, EV-Navigation, CS Management):

The car sharing user accesses the corporative web page of the car-sharing service provider. Apart from the information about the service, news, photos, etc. the tester finds a link to the booking/registration web page.

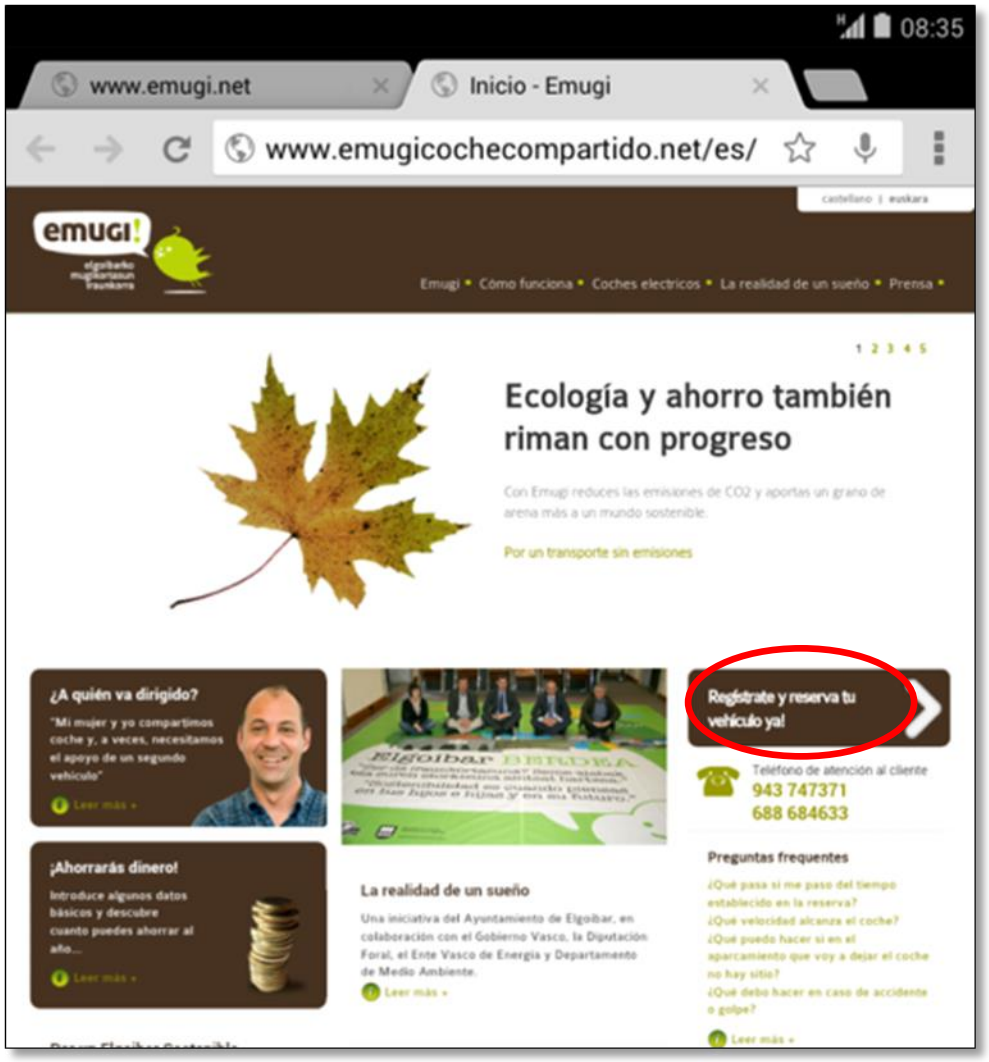


Figure 21: emugi EV-Sharing corporative web page.

As the user isn't registered yet, he accesses to the registration form pressing "Sign up".

Figure 22: emugi EV-Sharing user access menu.

The registration form asks about his personal information, such as name, surnames, address, driving license, bank account number, etc.

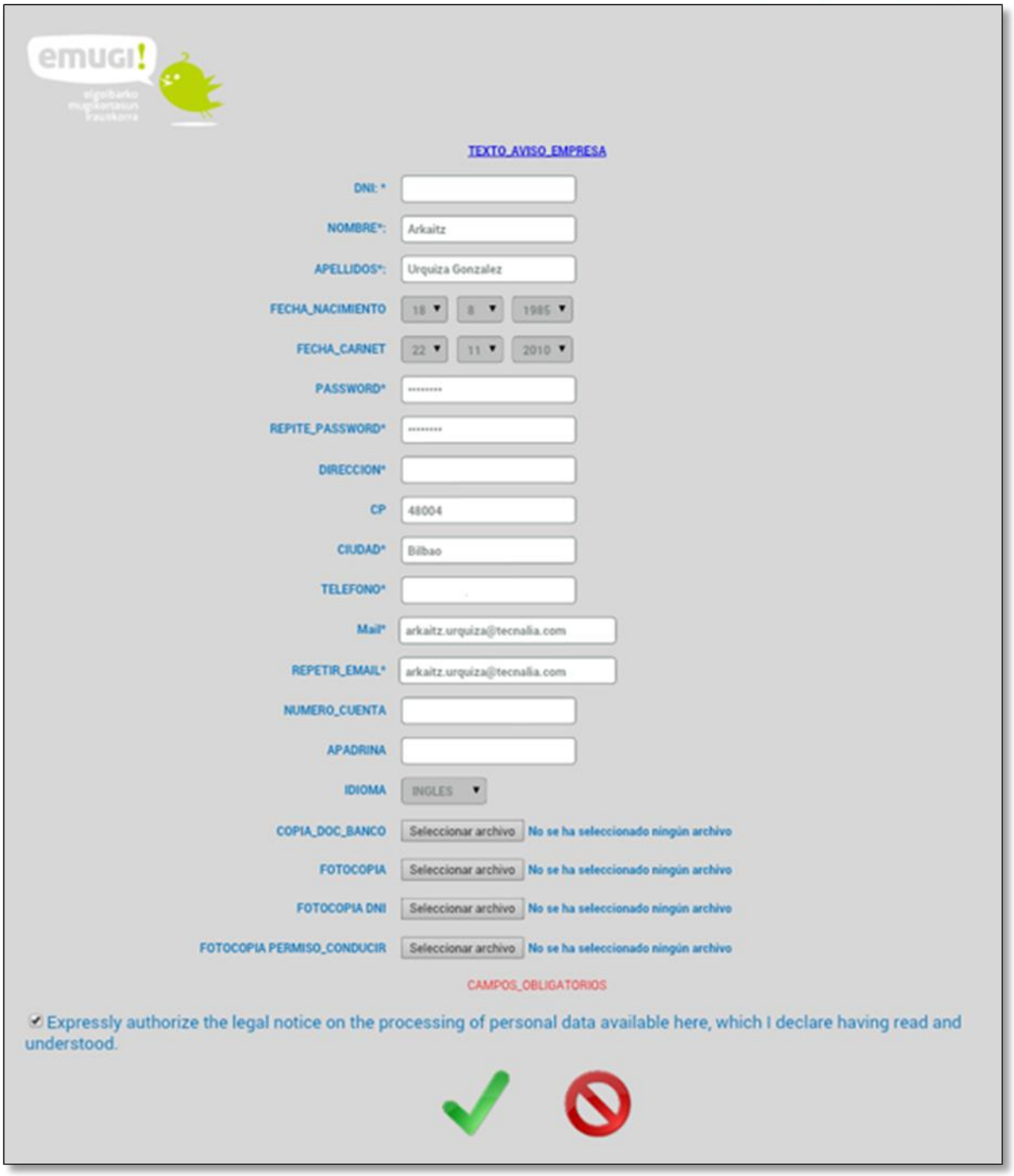


Figure 23: emugi EV-Sharing new user form.

Once the form is filled, the user finishes the registration process. Afterwards he can access to the booking web site using the username (national identity number) and password, pre-defined in the form.

There are two options to make bookings:

1. Web site

Images of a booking process in the web site

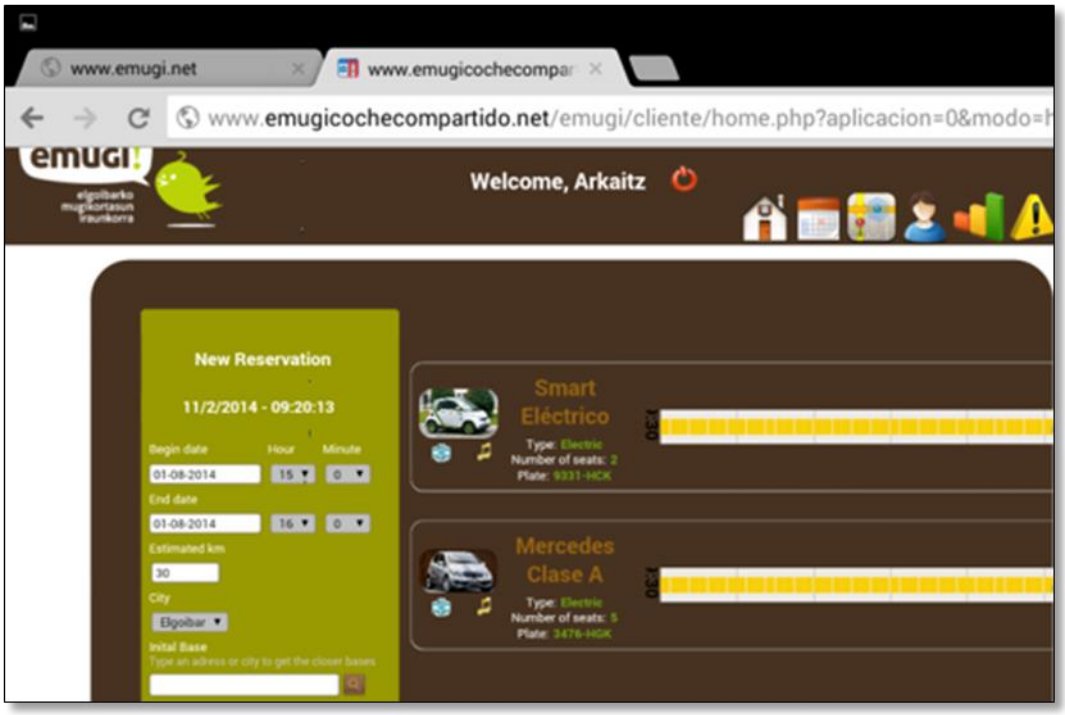


Figure 24: emugi EV-Sharing web page new booking form.

In the web site, past and future reservations can be seen, through the reservation panel. This panel also permits modifying and cancelling those bookings in advance.

Figure 25: emugi EV-Sharing web page user reservation panel.

The next image shows the booking modification screen. Another time span, distance or vehicle can be selected for the reservation when making the modification.

It is the same as the new booking screen. The only difference is that it just applies changes to an already stored reservation register in the database.

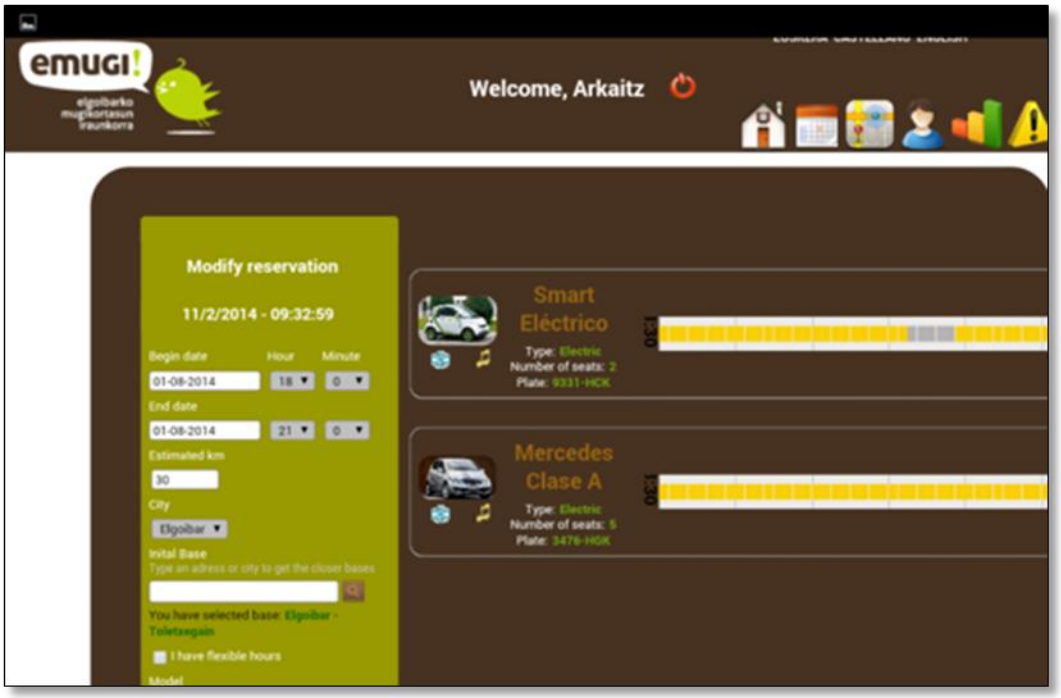


Figure 26: emugi EV-Sharing web page booking modification form.

If the booking cancellation option is selected, the next message will appear asking if the user confirms the reservation cancellation.

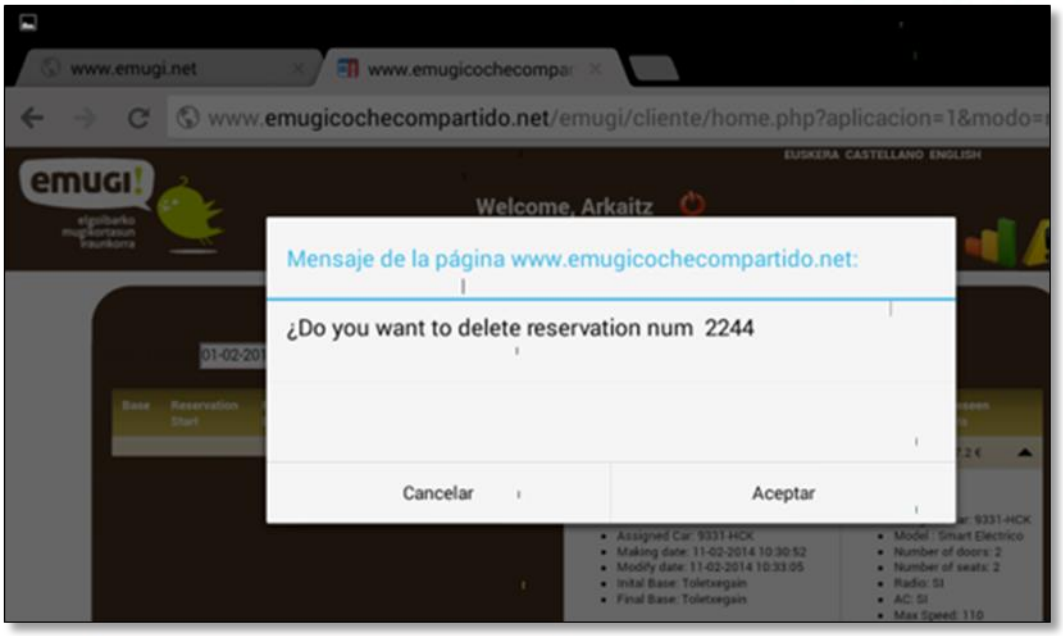


Figure 27: emugi EV-Sharing web page booking cancelation confirm.

2. Android application

The user needs to login to access the android application with his credential.

Figure 28: emugi EV-Sharing android application access menu.

Once logged in the new reservation screen will appear. Here the driver can use the specific filtering options (date, time, km, station, model, etc.) to search for available vehicles for an EV-Sharing booking.

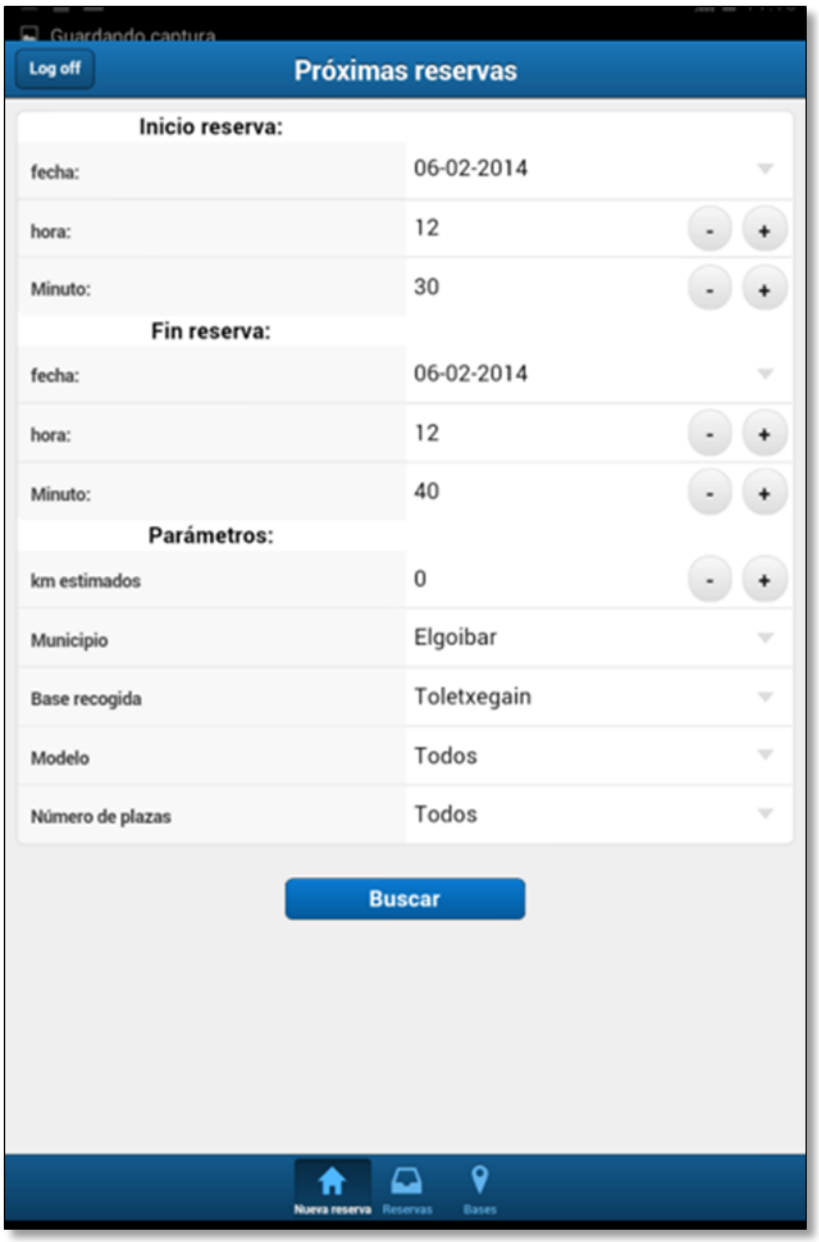


Figure 29: emugi EV-Sharing android application new booking form.

When the searching is made, the available vehicles are shown along with the reservation time span, km and the pricing information. Pressing the icon of the keys next to the specific available vehicle, the booking will be completed and a notification shown to the tester.

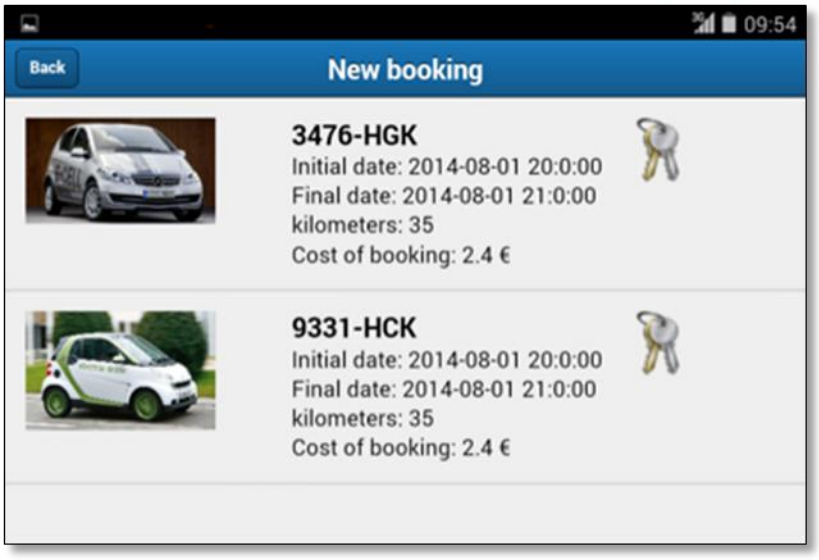


Figure 30: emugi EV-Sharing android application available vehicles for booking.

In the android application, future reservations can be seen, through the "Next bookings" reservations screen. This same panel permits to the tester, cancelling the bookings, pressing the recycle bin icon.

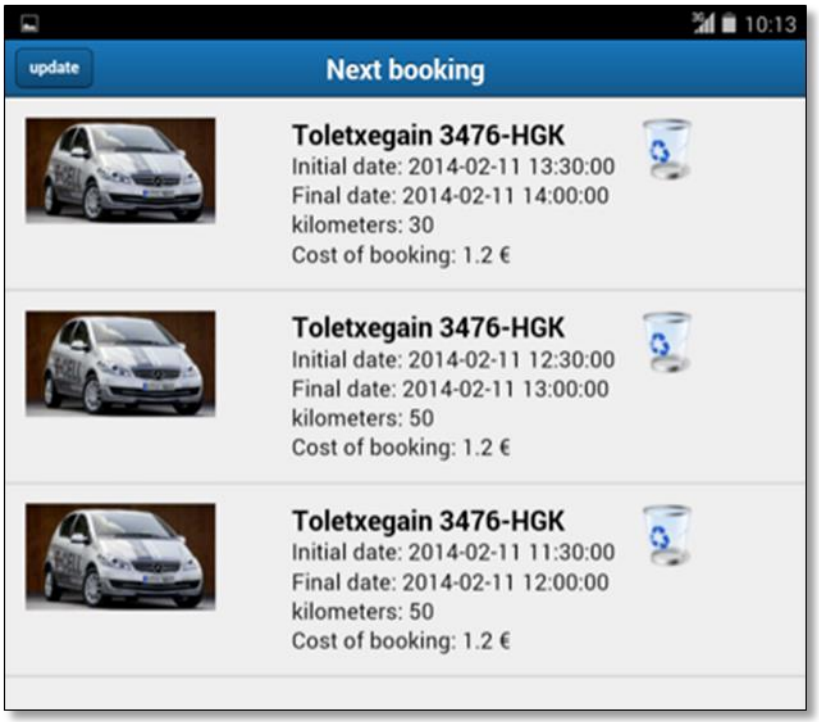


Figure 31: emugi EV-Sharing android application user reservations.

When the user confirms the correct bookings, he/she needs to wait till the reservation date and time to pick up the vehicle. This day, the user will go to the

corresponding CS, where the vehicle is expected to be picked up. He/she needs to put the user card over the RFID reader, located in the driver's side of the windshield. If the RFID card is passed before the booking starting time, the car won't open and the OBU led visible from outside will blink a yellow colour. This notifies that read card is not granted to take the vehicle at the moment.

Figure 32: Access not granted, yellow led in the OBU.

Figure 33: Access granted, green led in the OBU.

When the booking period starts, if the user card is read, the vehicle will open and the OBU screen will switch on, showing a welcome screen. Afterwards, the user will be asked about the status of the vehicle. If something is wrong, this panel will send a notification to the service administrators. If everything is correct, the user will continue to the booking summary screen. Here the distance to the CS, the booked distance and the booking time left are shown.

Figure 34: The user is asked about the status of the vehicle.

Figure 35: Booking summary in the OBU screen.

If the summary screen is maintained pressed, the user will visualize the different options given by the OBU. Among those, the user has the option to extend the booking period (not the booked km amount). If the new time span overlaps an existing reservation for the vehicle, the system will respond denying the booking extension. If the vehicle is free for the new period, the extension is confirmed and the summary screen will reflect the new booking time span parameters.

Figure 36: OBU options screen.

Figure 37: Booking time modification in the OBU screen.

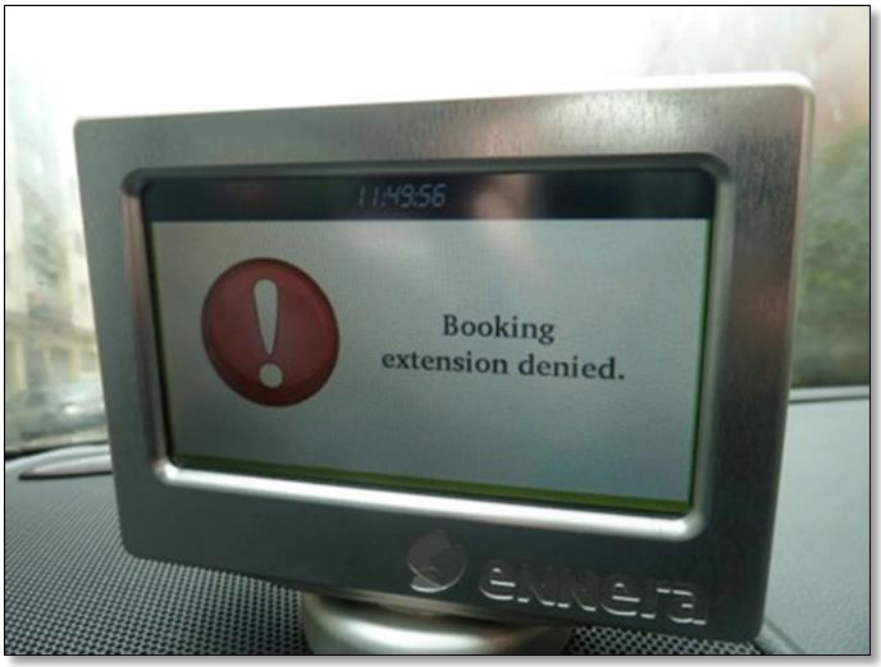


Figure 38: Booking extension denied screen in the OBU.

Figure 39: Booking extension confirmation screen in the OBU.

The driver has the option to use the EV-Navigation system to obtain driving aid information in terms of route indication and also for efficiency terms. When planning a route the navigation system also visualizes the range estimation for the specific vehicle model.

Figure 40: User selecting the destination in the EV-Navigation system.

Figure 41: The route summary for the selected destination in the EV-Navigation System.

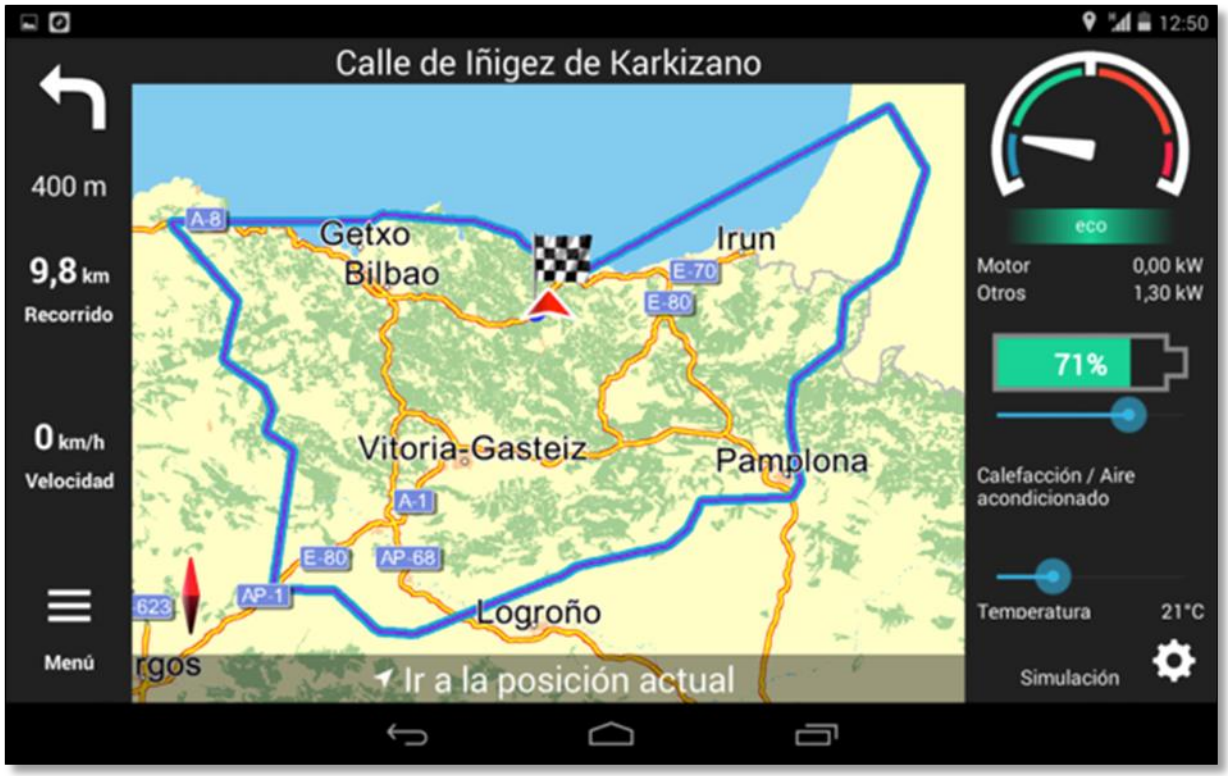


Figure 42: The allowed range according with the current battery charge in the EV-Navigation system.

Figure 43: The navigation screen in the EV-Navigation system.

Figure 44: The user driving following the EV-Navigation instructions.

The driver has also the option to use the CS Management system, in order to locate again the different CS of the car-sharing service. One of the CS shown in the application will be where the trip was started, the same point in which the vehicle should be returned.

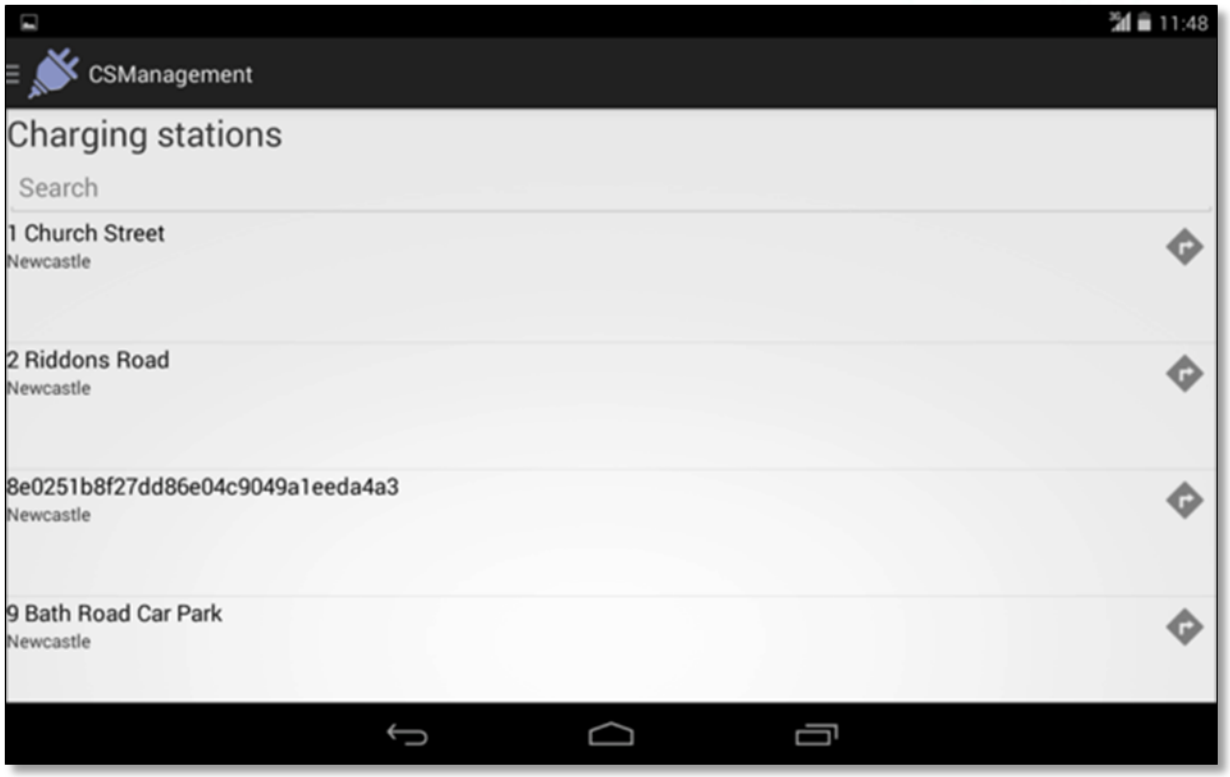


Figure 45: The complete list of the possible CS for SmartCEM.

The geo-location AUTO option in the application shows just the specific CS for the PS the user is in at the moment.

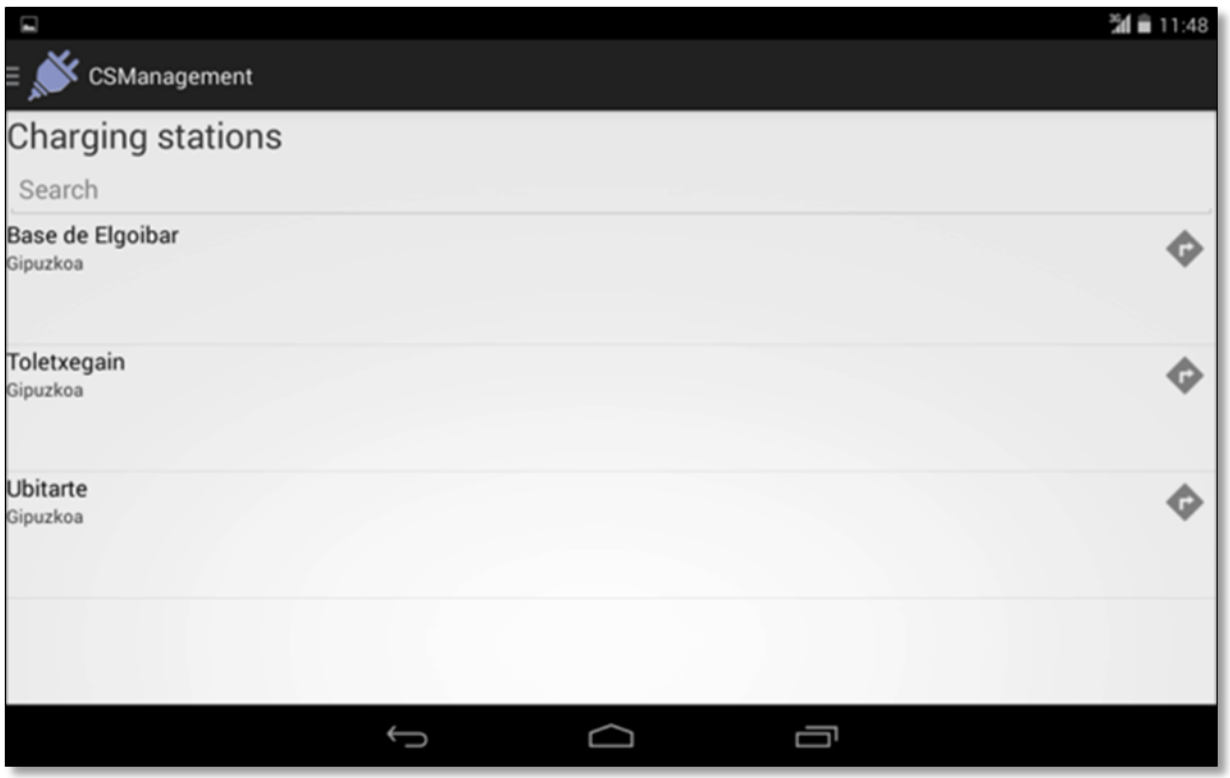


Figure 46: The CS list related to the current location of the vehicle (Gipuzkoa).

After finishing the trip and coming back to the departure CS, the user can proceed with the vehicle returning process. He presses the “Return vehicle” option in the OBU screen. A goodbye message is shown and the screen switches off. The next RFID card reading, made to close the vehicle, is also considered as the reservation closing notification. The system database will close the reservation’s register, adding the trip’s real finishing time.

Figure 47: Return vehicle selection on the OBU screen.

Figure 48: The OBU ask to the driver for the confirmation of the return.

Figure 49: The driver accepts the return of the vehicle.

Figure 50: The OBU shows the goodbye message to the driver.

Figure 51: The driver closes the vehicle using the user card in the RFID reader.

A user driving the Hybrid Electric bus equipped with the EV – Efficient Driving system

Figure 52: Driver ready to start.

Figure 53: Driving with HMI activated.

Figure 54: HMI giving instructions to the driver.

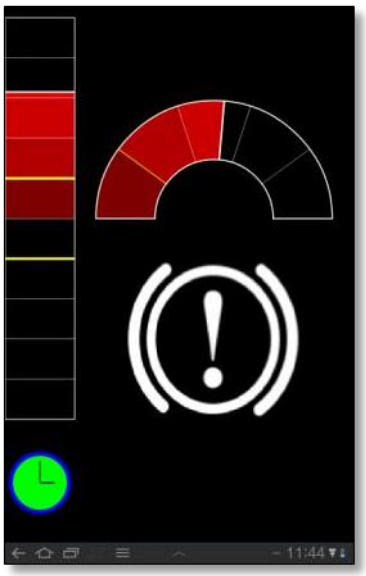


Figure 55: Snap shot of an excessive braking alert.

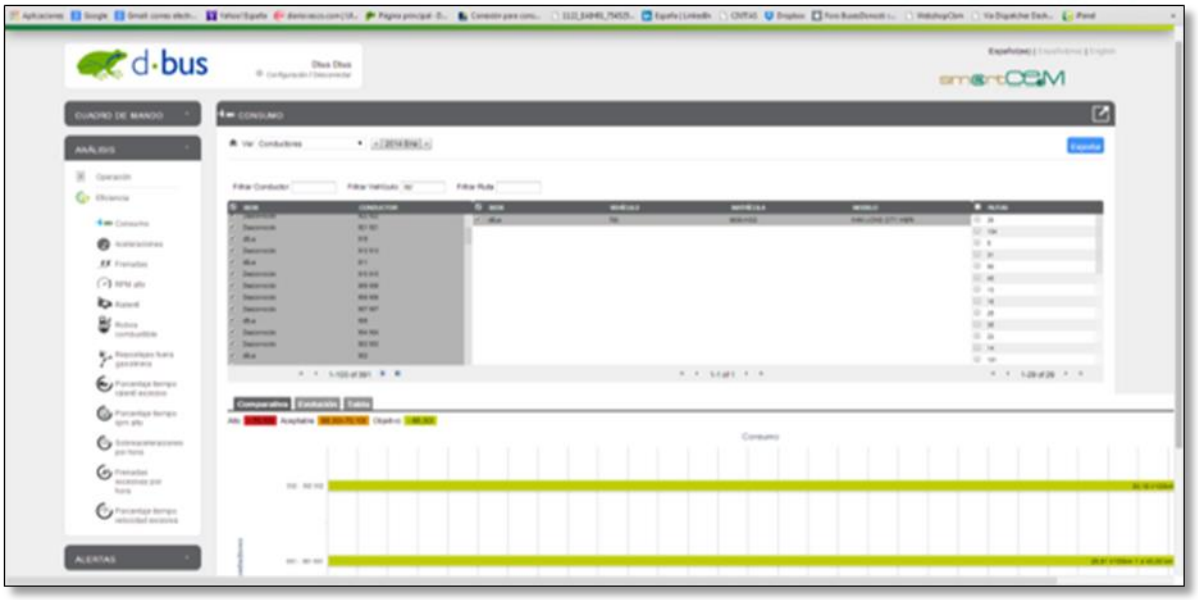


Figure 56: Screendump of iPanel, consumption per driver.

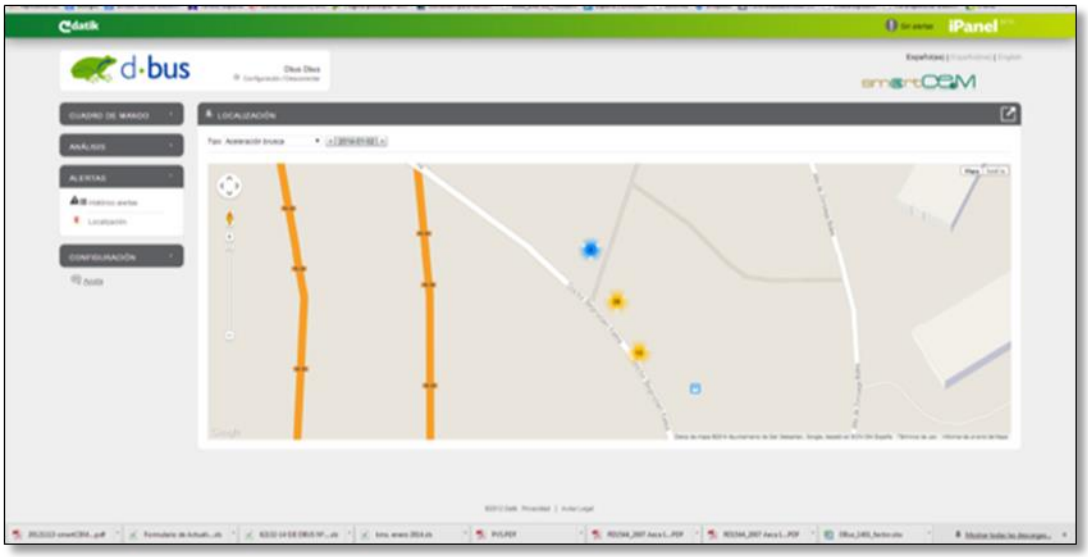


Figure 57: Snap of iPanel, alerts location.

A user combining EV-Sharing/Public Transport (Multimodal Trip Planner). A user can access to the trip planner service to plan the trip and get information on the public transport timetable and electric-vehicles availability in a desired slot of time.

Considering that the EV-sharing services are round trip (the vehicle must be returned to the initial base station at the end of the trip), if EVs are available, the Trip planner returns public transport solutions to reach the EV-base station in time. Furthermore, the trip planner makes calculations for the whole trip in order to help the traveller reach the final destination in time, taking into account the time range and the autonomy needed to bring back the EV. The following figures show the

snapshots of the web-based EV-trip management service.

Figure 58: Multimodal Travel planner Web site, main page

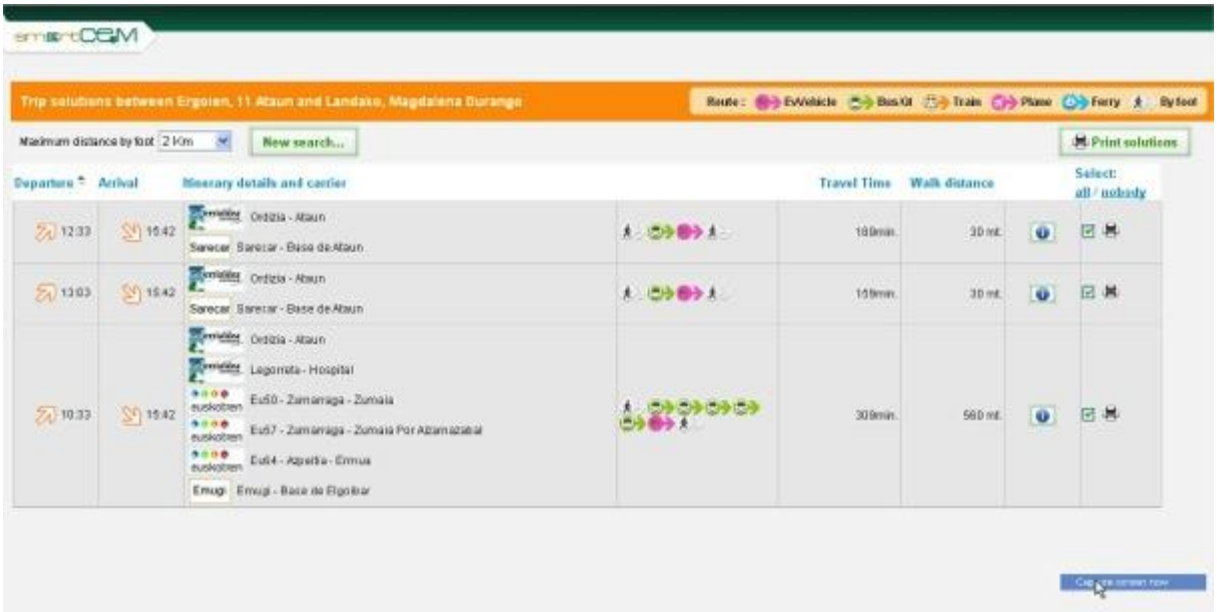


Figure 59: Multimodal Trip planner web portal: show solutions

Figure 60: Multimodal Trip planner web portal: show solution details

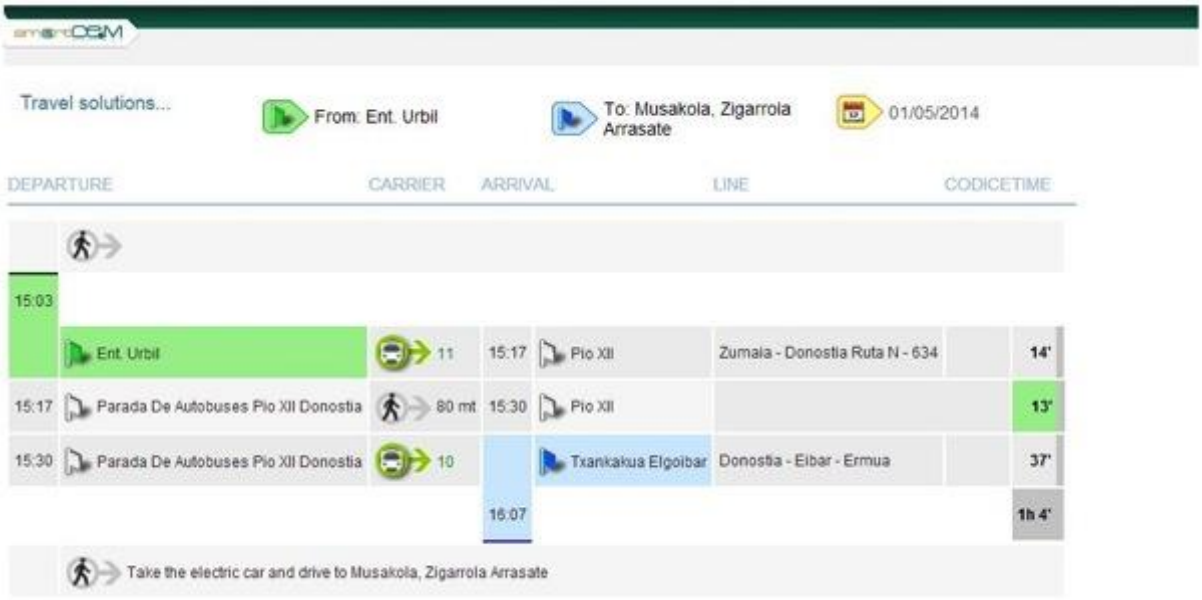


Figure 61: Multimodal Trip planner web portal: print solutions

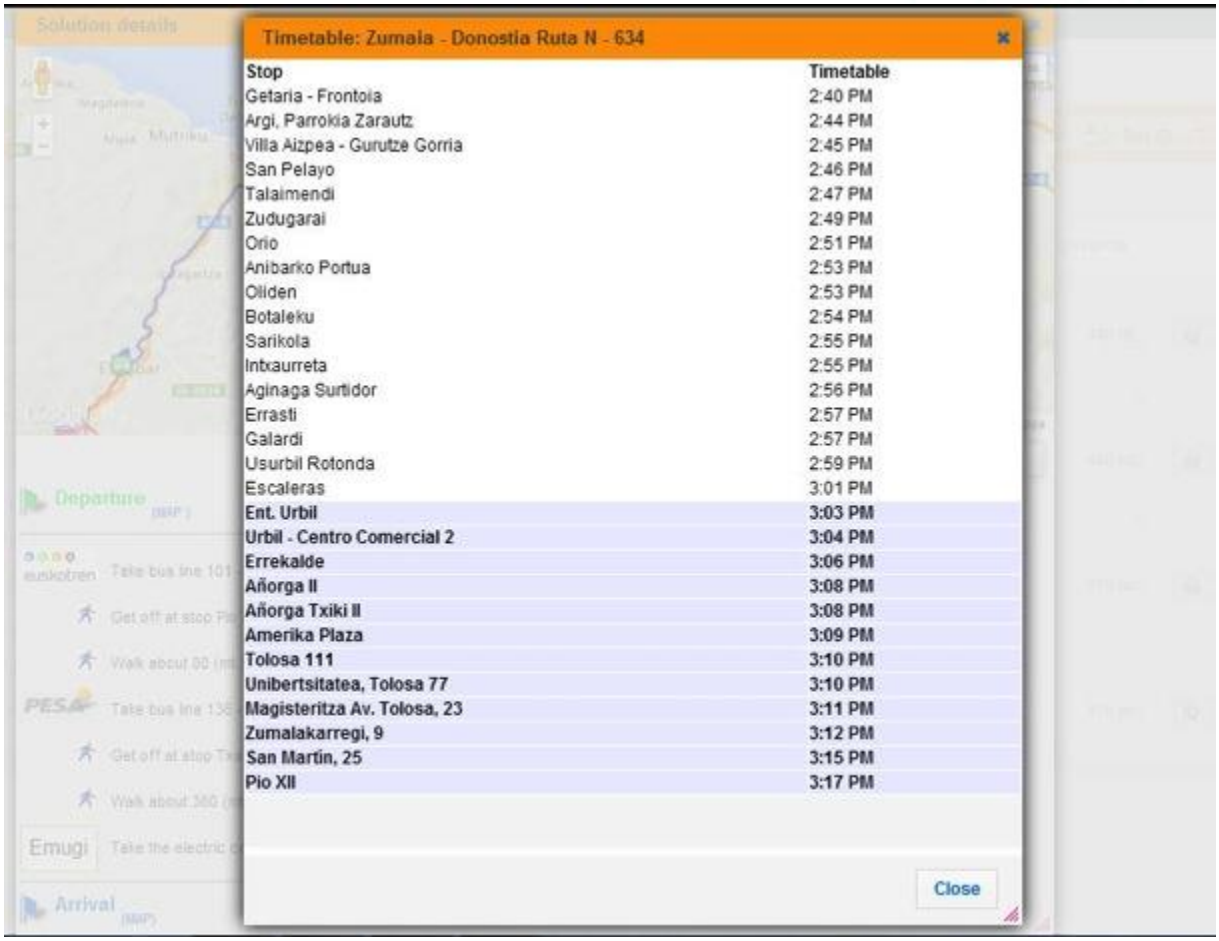


Figure 62: Multimodal Trip planner web portal: Bus timetable

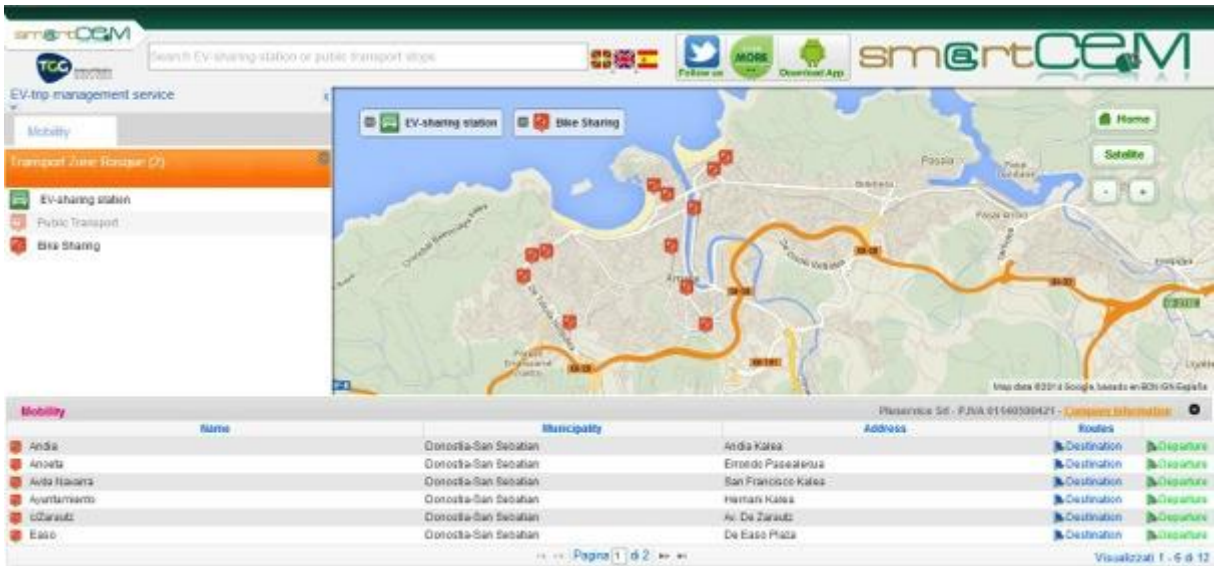


Figure 63: Multimodal Trip planner web portal: eBike-sharing points

The following figures show the snapshots of the mobile-based application of the EV-trip management service.

Figure 64: Multimodal trip planner Application

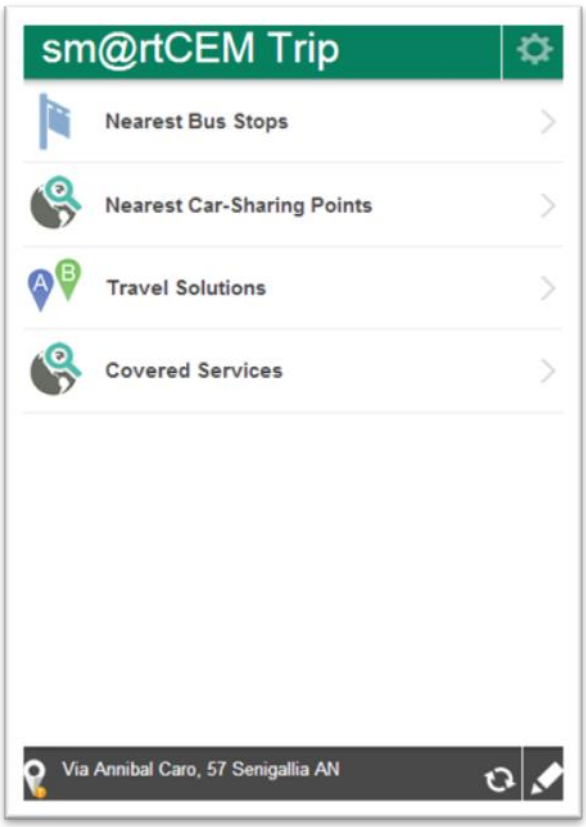


Figure 65: Trip planner App: main functions

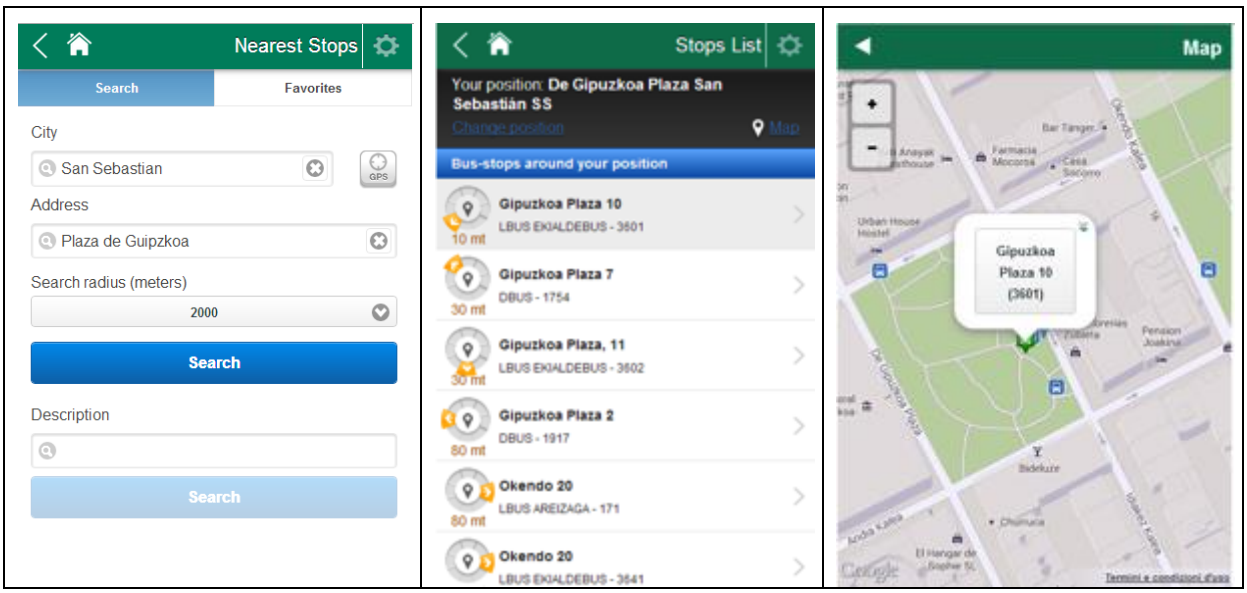


Figure 66: Trip planner App: Nearest stops

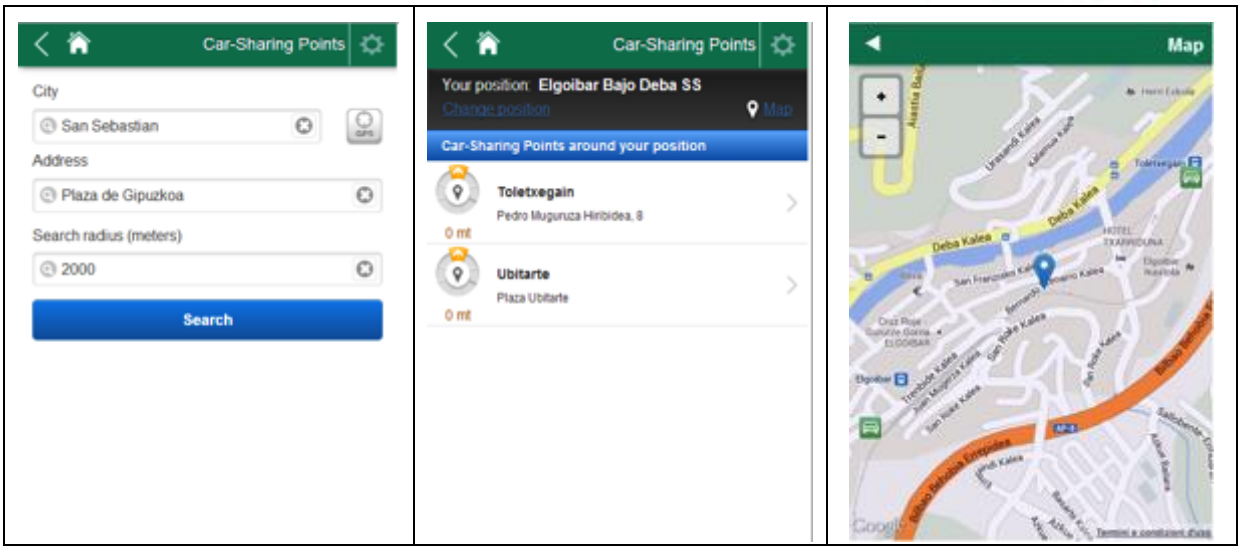


Figure 67: Trip planner App: Nearest Car-Sharing Points

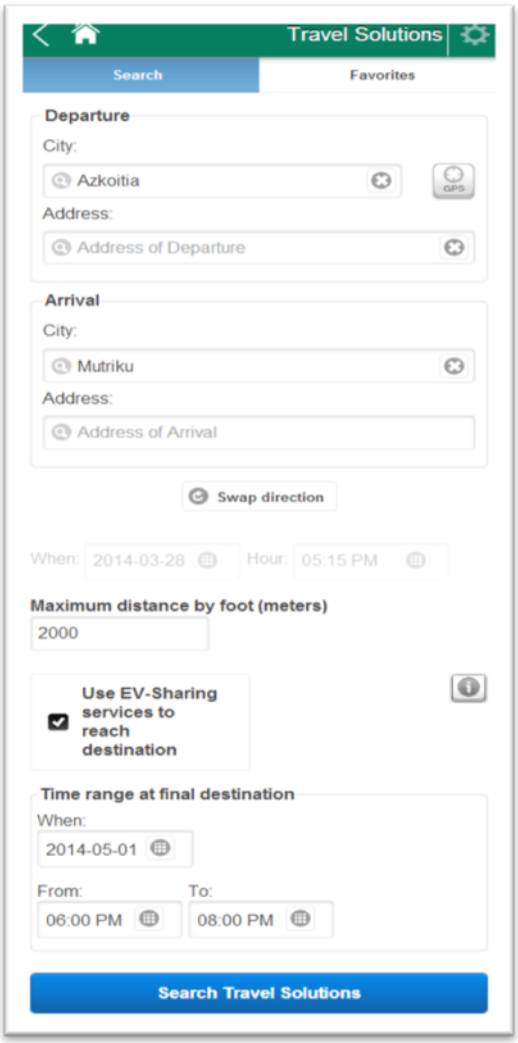


Figure 68: Trip planner App: Travel solutions

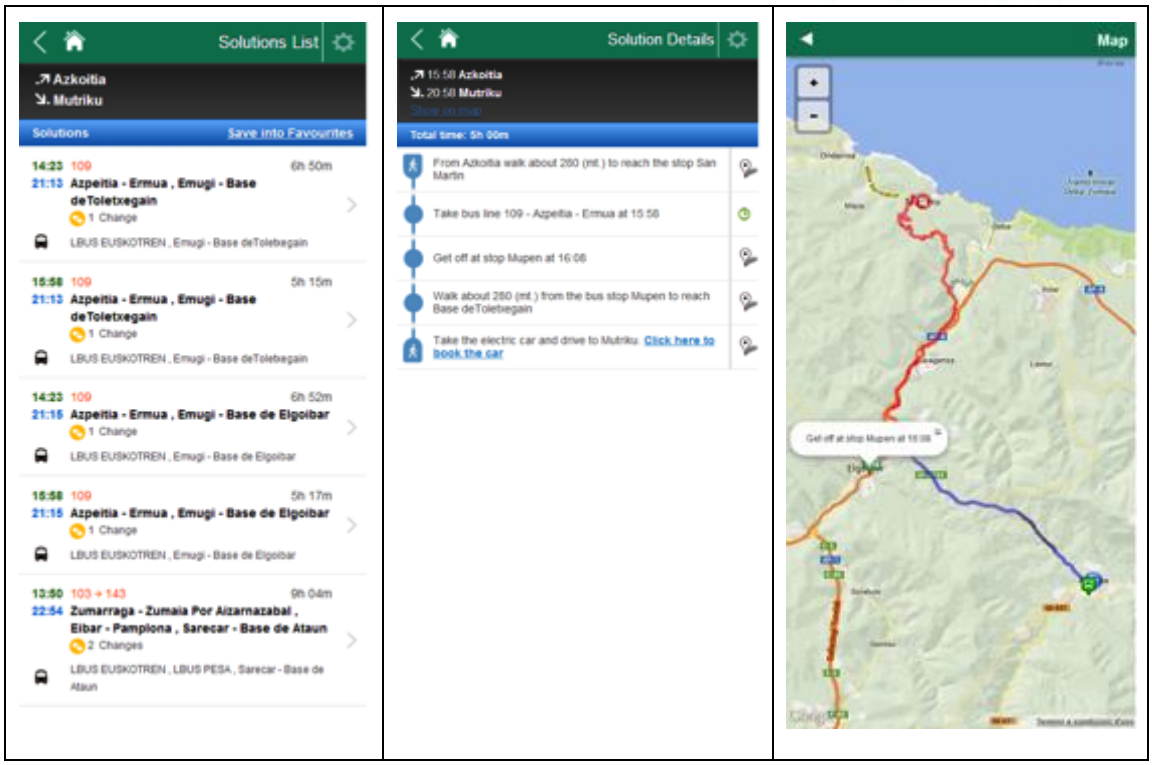


Figure 69: Trip planner App: Travel solutions details

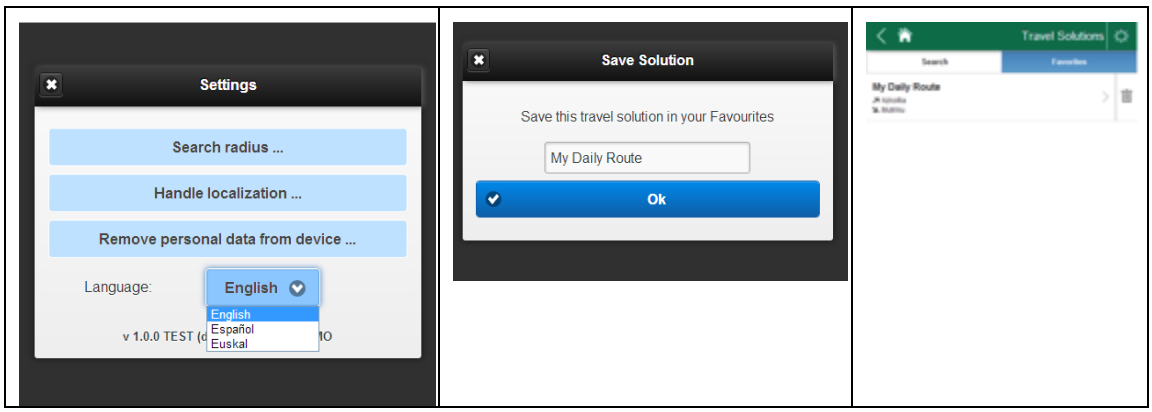


Figure 70: Trip planner App: Settings and preferences

4.3 Newcastle Pilot Site

4.3.1 Test Cases Description/Scenarios

The Newcastle pilot site will be based on existing implementations of EVs in the city and wider north east region of England. The operations phase will utilise compact urban electric cars, and will implement the EV-Charging Station Management service supplied by CYC, along with value-added services, namely the EV-Navigation (CYC and PTV), EV-Efficient Driving (UNEW), the EV-City Policy Tool (NEC), and a link to an existing Multi-Modal Transport Planner.

Two scenarios are defined, based on 14 use cases (see D2.1 *Reference architecture* for full details).

- SC-NEW-01 User manages services for charging:

  1. The basis for testing this scenario is access to the CYC APP (available free from the App Store and Google play). The user registers for the service and downloads the APP to his/her smartphone. Once this is done the tester launches the APP fulfilling NEW_UC_01: Charging station management APP access

  2. The user is then able to perform a variety of actions testing the functionality of the CYC APP. These include searching for a charging station, checking its availability, its cost, whether it is standard or fast charging, and seeing attributes in either list or map form. A route can be plotted to the charging station. These actions fulfil NEW_UC_07: CS search and NEW_UC_14: Integration with EV navigation. The tester then notifies the system of intention to charge (NEW_UC_12)

  3. Following this the testing process moves to the EV itself. The main features to test here are: efficiency of navigation function to charging station using on board unit; station access and user validation. Tests will involve use of RFID which will be swiped on the charge post to validate the user's ID and authorize payments. If this process is successful the charge post will display the appropriate user interface and the post is unlocked ready for use, along with notification of payment. This step tests NEW_UC_02: Charging station access with RFID and NEW_UC_13: User validation.

  4. The final steps involve the charging process and the conclusion of the charging process (NEW_UC_05: Charging initiation; NEW_UC_06: Charging conclusion). This requires effective attachment of the charging cable and on completion of charging, correct detachment of the cable and full efficient communication with back office (BO) in order to re-set the station.

- SC-NEW-02 Driving electric car efficiently:

1. This scenario is tested on desktop PC. The tester opens the web-based tool registration page. Upon registration a username is generated along with a password. The tester can then log into the system. The log-in process will ensure that each user can only access his/ her driving data. The relevant use case is NEW_UC_11: Efficient driving

2. Once in the system the tester can choose a vehicle id from a drop down menu (vehicle registration number) and can access data relating to his/ her trips in that vehicle as the registration number is referenced against his/ her unique user id. Efficient driving advice is provided relating to: acceleration profiles (hard and light), idling time, regenerative braking, and driving tips. Links to CYC and the Transport Direct multi-modal trip planner will also be tested.

In the next section test case verification plans are presented for the above scenarios.

4.3.2 Test case verification

Test Case	CS Management	
Tester	Graeme Hill (UNEW)	
Admin	Simon Edwards (UNEW)	
Step 1 Smartphone access to CYC APP		
Description	The tester has access to a Smartphone with Internet connection The tester visits the website for mobile services The tester downloads the Smartphone CYC application The tester starts the Smartphone CYC application	
Expected Result	The CYC application is installed and launched on a Smartphone	
Requirements	Smartphone with internet connection, CYC APP available	
UC Implied	NEW_UC_01: Charging station management APP access	
EV-Service Implied	Charging Station (CS) Management	
To check	Client web application	✓
	User registers	✓
	User logs in	✓

	User successfully downloads APP	✓
	User installs APP on mobile device	✓
	User opens installed APP on mobile device	✓
Issues/Comments		
Step 2 CS search using CYC APP		
Description	The tester wishes to locate an available, fully functioning charging station	
Expected Result	The tester is seeing the charging station information	
Requirements	Smartphone with internet connection, CYC APP, CS Back-Office, EV-charging station management	
UC Implied	NEW_UC_07: CS Search	
EV-Service Implied	CS Management	
To check	Quality of communication method between individual post / back-office	✓
	Post status refresh services of back-office	✓
Issues/Comments	None	
Step 3 Navigate to charge point		
Description	The tester wishes to get to an available, fully functioning charging station The tester accesses the charging station search function The APP searches and displays charging stations The tester selects the desired charging station The navigation application calculates the route The APP states the tester is intent to use the charging station and sends the data to the back-office application	
Expected Result	The tester is seeing a route mapped to the nearest available charging station	
Requirements	Smartphone with internet connection, CYC APP, CS Back-Office, EV-charging station management, CYC navigation application	
UC Implied	NEW_UC_14	

EV-Service Implied	CS Management	
To check	Battery depletion (range to charging station)	
	Back-office application and CS application are successfully communicating with the APP	✓
Issues/Comments	Battery depletion was not checked	
Step 4 Intention to charge		
Description	The tester wishes to charge his/her car to a charging station and notifies the system The tester selects the desired charging station and specifies the intention to use it. Information regarding the time and duration of use must be specified The back-office application informs the tester about the status of the charging station for the period he/she wishes to use it The back-office application inserts the tester into the CS notification list	
Expected Result	The back office is aware of the tester's intention to charge	
Requirements	Smartphone with internet connection, CYC APP, CS Back-Office, EV-charging station management	
UC Implied	NEW_UC_12: Intention of Charging	
EV-Service Implied	CS Management	
To check	Access to the charging station application	✓
	Back-office application inserts tester into the CS notification list	✓
Issues/Comments		
Step 5 Charging station access, user validation		
Description	The tester has made clear an intention to charge and wishes to charge his/her car The tester swipes the RFID on the selected charge post The charge post sends the RFID code to the back-office application The RFID is recognized by the back-office application The back-office application checks the status of the tester. The user status is "OK" The payment is authorized	

	The tester is validated The back-office application commands the charge post to continue The charge post displays the user interface The tester selects the appropriate socket The tester selects the authorization and payment method The back-office application unlocks the charge post The charging can start	
Expected Result	Charging is ready to be initiated	
Requirements	EV-charging station management, RFID, back-office application, user status	
UC Implied	NEW_UC_02: Charging station access (RFID) NEW_UC_13: User validation	
EV-Service Implied	CS Management	
To check	RFID is recognized by the back-office application	✓
	User is recognized by the back-office application	✓
	Quality of communication method between post / back-office	✓
	Post status refresh services of back-office	✓
Issues/Comments		
Step 6 Charging initiated		
Description	The tester plugs in the cable The tester sets in the “Start Charging” command The charging station locks the cable The charging starts	
Expected Result	The car has been charged	
Requirements	The tester, the EV, the charging station	
UC Implied	NEW_UC_05: Charging initiation	
EV-Service Implied	CS Management	

To check	Back-office can identify that a charge has taken place	✓
Issues/Comments		
Step 7 Charging concluded		
Description	The tester issues the command to interrupt the charging process The charging station unlocks the cable The charging station signals to the back-office application that the charging process is concluded The back-office application notifies the tester that the charging process is completed, including information regarding the time and the cost of the charge The back-office application updates the status of the charging station in the database	
Expected Result	The status of the charging station is updated	
Requirements	The driver, the back-office, the charging station, the EV	
UC Implied	NEW_UC_06: Charging conclusion	
EV-Service Implied	CS Management	
To check	The charging process is ended, the status of the charging station is updated	✓
	The EV is recharged and disconnected properly	✓
Issues/Comments		

Test Case	Driving EV efficiently
Tester	Graeme Hill (UNEW)
Admin	Simon Edwards (UNEW)
Step 1 User registration and log in	
Description	The tester opens the web-based tool registration page. Upon registration a username is generated along with a password. The tester can then log into the system. The log in process will ensure that each user can only access his/ her driving data
Expected Result	The user will have full access to the tool's functionality
Requirements	Internet connection, PC or smartphone/tablet
UC Implied	NEW_UC_11: Efficient driving

EV-Service Implied	EV Efficient Driving	
To check	Client web application	✓
	Registration form	✓
	Client correct registration in system database	✓
	Data provided by the system is the same as in the central database	✓
	The system handles errors and unexpected values in the processed data cleanly, both in reporting and visualisation	✓
Issues/Comments		
Step 2 Testing the functionality of the eco-driving tool		
Description	Once in the system the tester can use the different functionality available in the tool. The tester chooses a vehicle id from a drop down menu (vehicle registration number) and can access data relating to his/ her trips in that vehicle as the registration number is referenced against his/ her unique user id. Efficient driving advice is given to drivers taking account driving style and charging behaviour. The following indicators are available: • Acceleration • Idling time • Regenerative braking Driving good practice tips are also provided	
Expected Result	The user will be able to access his/ her dedicated data relating to undertaken trips in a selected EV, providing feedback to the user about his/ her driving behaviour	
UC Implied	NEW_UC_11: Efficient driving	
EV-Service Implied	EV Efficient Driving	
To check	User accesses correct eco-driving data (User id)	✓
Issues/Comments	None	

4.3.3 Visual facts

SmartCEM Website Tool and Central Database Connection Verification

To confirm that the website is displaying the appropriate data for a given user and that the connection between the website and the central databse is reliable, the steps needed to add a user (as an administrator) and then for the user to view their own data have been verified. The steps are as follows:

- Administration Step 1: Register user within the system
- Administration Step 2: Confirming user addition
- Administration Step 3: Data check between central database and website
- Administration Step 4: Dealing with unexpected values
- User Step 1: Log in
- User Step 2: User can access expected statistical information
- User Step 3: User can access driving tips

Administration Step 1: Register user within the system

Due to security issues, it is necessary for the administrator of the website to specifically add users into the system. However this is a straightforward procedure, taking less than five minutes per user and will only need to be conducted once.

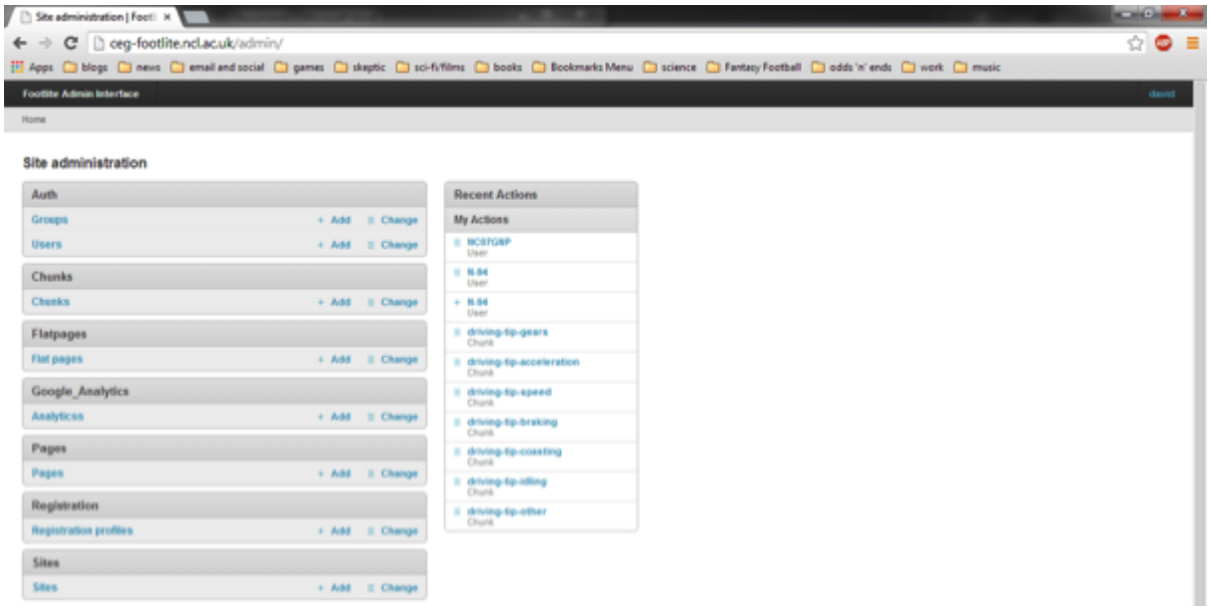


Figure 71: The base page for adding users using the admistrative rights

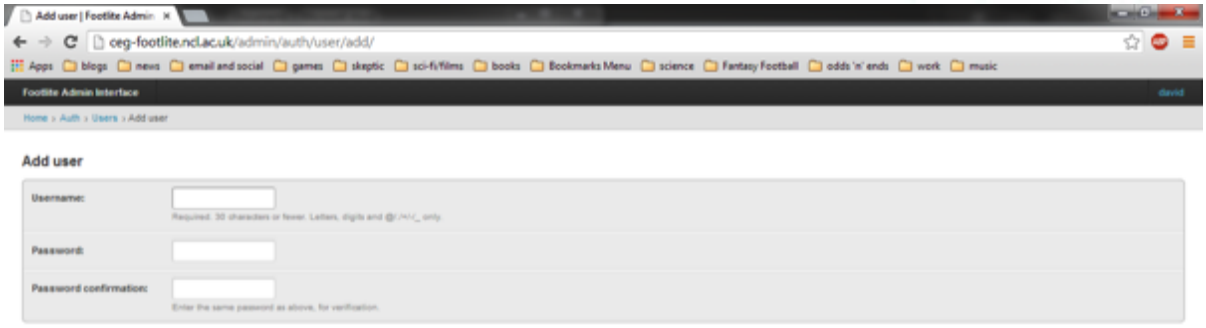
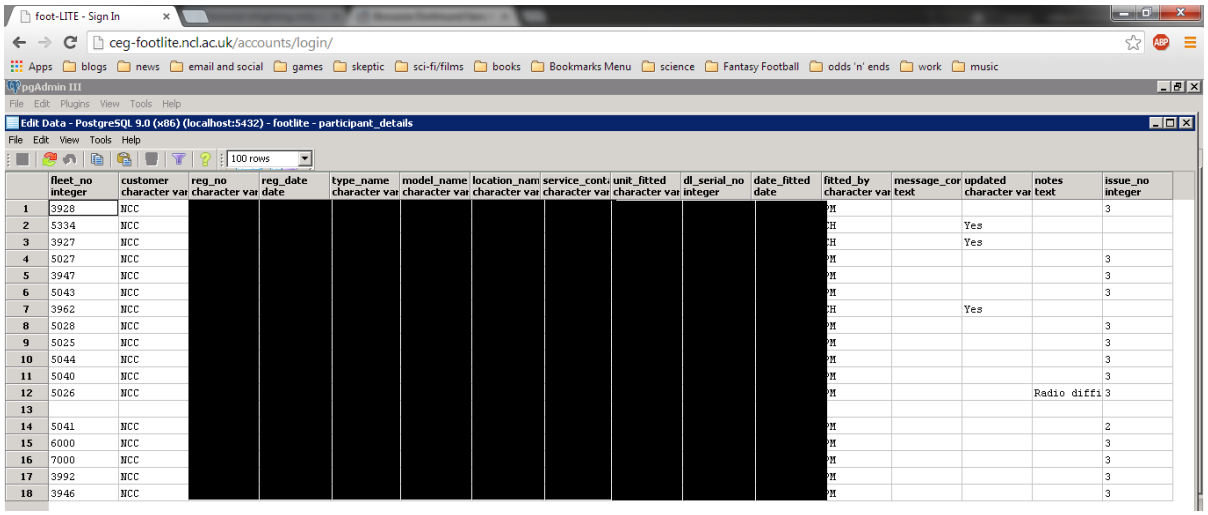


Figure 72: Setting the new user details and password

Administration Step 2: Confirming user addition

To confirm that a user has been added it is possible to check the back-end database for the system and check that the registered user has been added to the participant details list. Additional information can also be added at this stage. In the image below some information has been redacted for data protection issues.



	fleet_no integer	customer character var	reg_no character var	reg_date date	type_name character var	model_name character var	location_nam character var	service_cont character var	unit_fitted character var	dl_serial_no integer	date_fitted date	fitted_by character var	message_cor text	updated character var	notes text	issue_no integer
1	3928	NCC	[redacted]									PM				3
2	5334	NCC										CH		Yes		
3	3927	NCC										CH		Yes		
4	5027	NCC										PM				3
5	3947	NCC										PM				3
6	5043	NCC										PM				3
7	3962	NCC										CH		Yes		
8	5028	NCC										PM				3
9	5025	NCC										PM				3
10	5044	NCC										PM				3
11	5040	NCC										PM				3
12	5026	NCC										PM			Radio diffi	3
13																
14	5041	NCC										PM				2
15	6000	NCC										PM				3
16	7000	NCC										PM				3
17	3992	NCC										PM				3
18	3946	NCC										PM				3

Figure 73: Confirming that the user has been correctly added to the participant details database

Administration Step 3: Data check between central database and website

To check that the data being provided by the Central database is the same as that being displayed on the website it is necessary to directly examine the data both in the database and on the website. The two images below show two representations of the same data, one from the central database and one from the website tool.

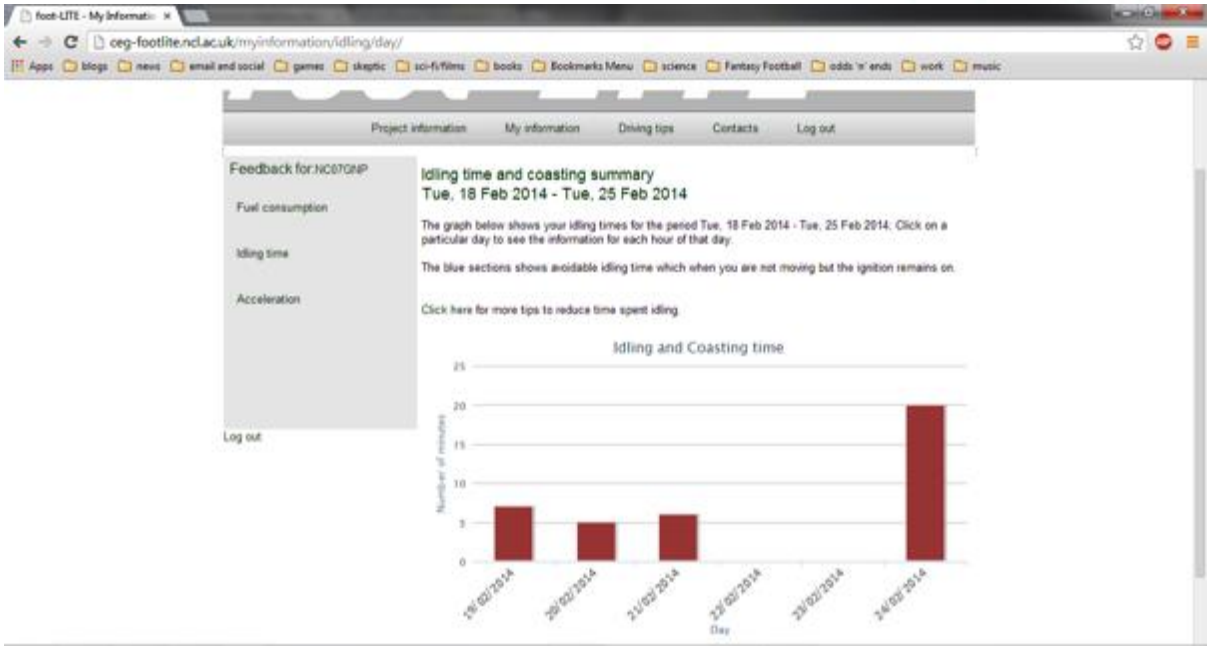
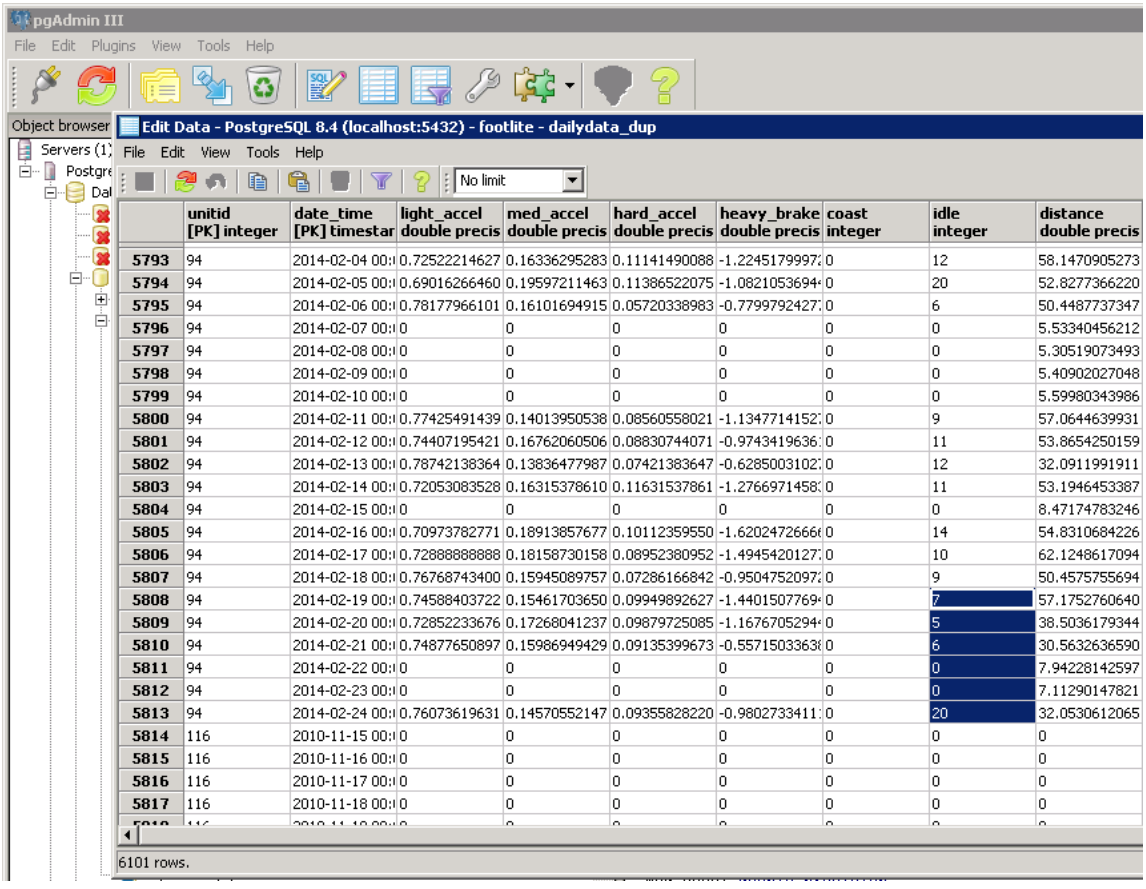


Figure 74: The idling time data accessed through the website



	unitid [PK] integer	date_time [PK] timestar	light_accel double precis	med_accel double precis	hard_accel double precis	heavy_brake double precis	coast integer	idle integer	distance double precis
5793	94	2014-02-04 00:0	0.72522214627	0.16336295283	0.11141490088	-1.2245179997	0	12	58.1470905273
5794	94	2014-02-05 00:0	0.69016266460	0.19597211463	0.11386522075	-1.0821053694	0	20	52.8277366220
5795	94	2014-02-06 00:0	0.78177966101	0.16101694915	0.05720338983	-0.7799792427	0	6	50.4487737347
5796	94	2014-02-07 00:0	0	0	0	0	0	0	5.53340456212
5797	94	2014-02-08 00:0	0	0	0	0	0	0	5.30519073493
5798	94	2014-02-09 00:0	0	0	0	0	0	0	5.40902027048
5799	94	2014-02-10 00:0	0	0	0	0	0	0	5.59980343986
5800	94	2014-02-11 00:0	0.77425491439	0.14013950538	0.08560558021	-1.1347714152	0	9	57.0644639931
5801	94	2014-02-12 00:0	0.74407195421	0.16762060506	0.08830744071	-0.9743419636	0	11	53.8654250159
5802	94	2014-02-13 00:0	0.78742138364	0.13836477987	0.07421383647	-0.6285003102	0	12	32.0911991911
5803	94	2014-02-14 00:0	0.72053083528	0.16315378610	0.11631537861	-1.2766971458	0	11	53.1946453387
5804	94	2014-02-15 00:0	0	0	0	0	0	0	8.47174783246
5805	94	2014-02-16 00:0	0.70973782771	0.18913857677	0.10112359550	-1.6202472666	0	14	54.8310684226
5806	94	2014-02-17 00:0	0.72888888888	0.18158730158	0.08952380952	-1.4945420127	0	10	62.1248617094
5807	94	2014-02-18 00:0	0.76768743400	0.15945089757	0.07286166842	-0.9504752097	0	9	50.4575755694
5808	94	2014-02-19 00:0	0.74588403722	0.15461703650	0.09949892627	-1.4401507769	0	7	57.1752760640
5809	94	2014-02-20 00:0	0.72852233676	0.17268041237	0.09879725085	-1.1676705294	0	5	38.5036179344
5810	94	2014-02-21 00:0	0.74877650897	0.15986949429	0.09135399673	-0.5571503363	0	6	30.5632636590
5811	94	2014-02-22 00:0	0	0	0	0	0	0	7.94228142597
5812	94	2014-02-23 00:0	0	0	0	0	0	0	7.11290147821
5813	94	2014-02-24 00:0	0.76073619631	0.14570552147	0.09355828220	-0.9802733411	0	20	32.0530612065
5814	116	2010-11-15 00:0	0	0	0	0	0	0	0
5815	116	2010-11-16 00:0	0	0	0	0	0	0	0
5816	116	2010-11-17 00:0	0	0	0	0	0	0	0
5817	116	2010-11-18 00:0	0	0	0	0	0	0	0

Figure 75: The highlighted section shows the same data for the user at the same time as the website

Administration Step 4: Dealing with unexpected values

Due to the nature of the PostgreSQL database, it is impossible to insert incorrect types of values (e.g. it is not possible to insert a string variable into an integer column) therefore all the data sanitisation is handled by an R script (an open source statistical language) which generates the data from the raw data files. Within the R script there are multiple checks to ensure that the data being produced is of the correct quality and type, with no unphysical data sets being sent forward to the central database. This data processing tool has been used in previous projects with great success in automating the process of data analysis and trip generation, which allow great quantities of data to be handled with relative ease. In general it is not possible to show the complete series of data handling and error recovery without an extensive section of code, however the following section gives an example of how unexpected infinites (due to divisions by zero, for example) are handled:

```
#check for divisions by zero
for(j in 3:17){
if( !is.finite(result[1,j])){result[1,j]=0}
}
```

User Step 1: Log in

After registration is completed by the administrator of the website, it is then possible for the user to log in under the user's chosen username and password. In the example shown below the user's username is the licence plate of the vehicle being examined.

Figure 76: The log in page is a simple username and password system with all the usual features

User Step 2: User can access expected statistical information

The following three webpages show the basic information that is available for each user

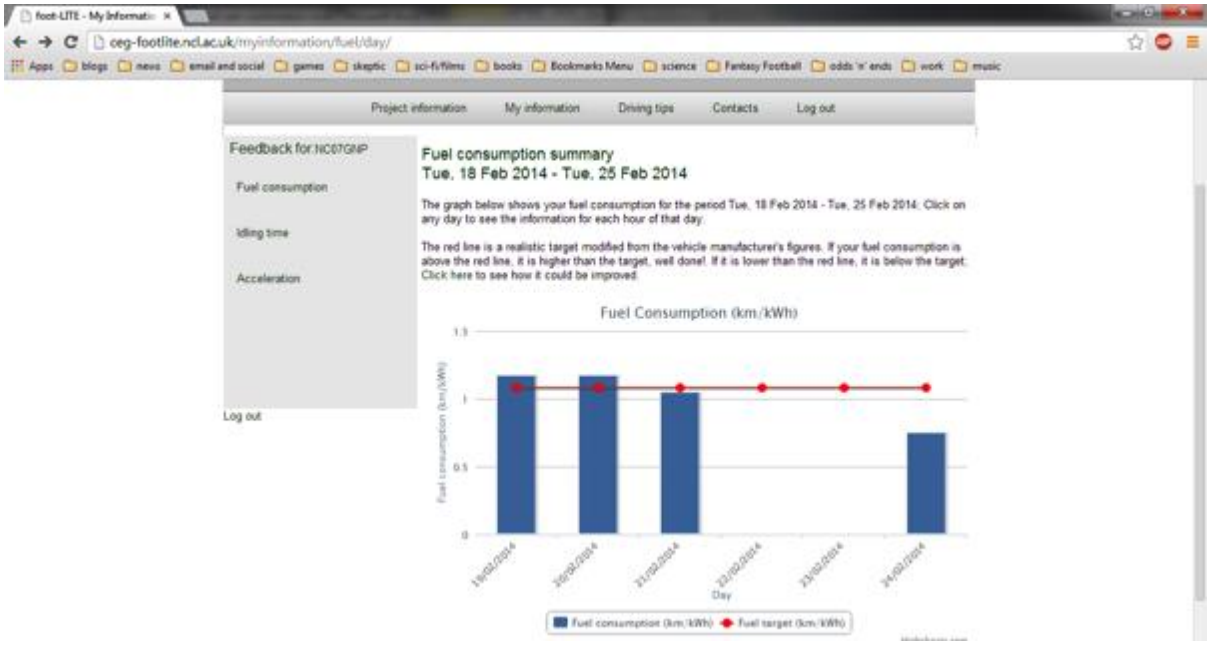


Figure 77: This shows fuel consumption in terms of km/kWh. Although this is an efficiency rating (rather than fuel consumption) it is felt that this is a more appropriate metric

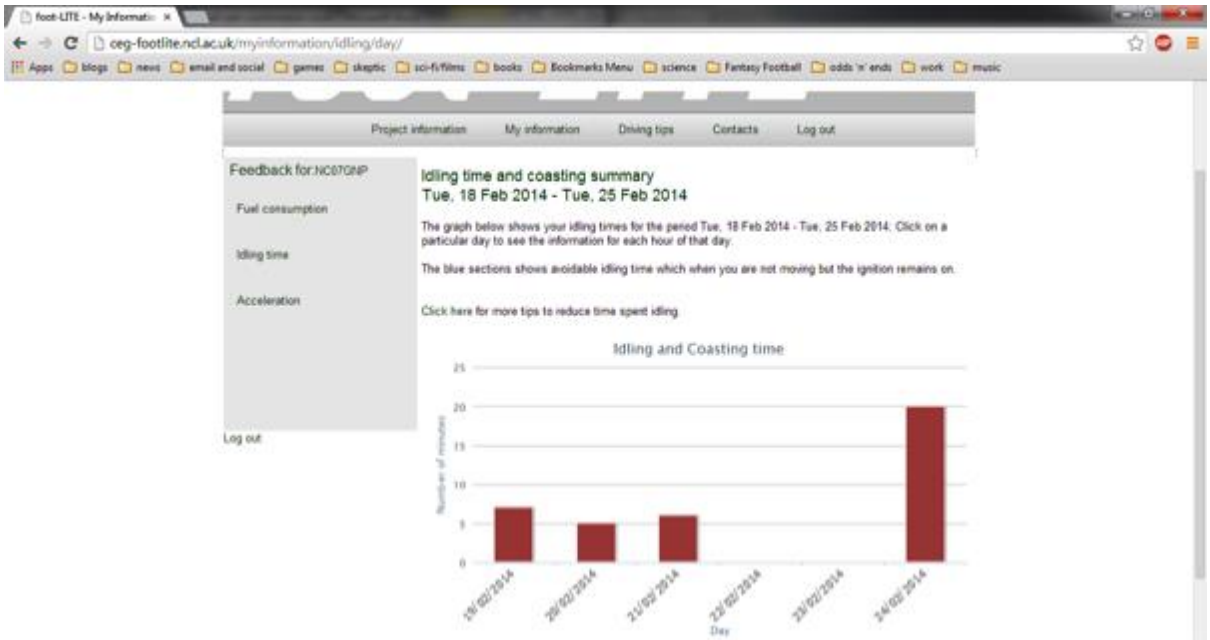


Figure 78: Idling/Coasting time. This image shows the idling time for an Electric Vehicle. It is also possible to display coasting but this would only be used for hybrid vehicles rather than pure electric.

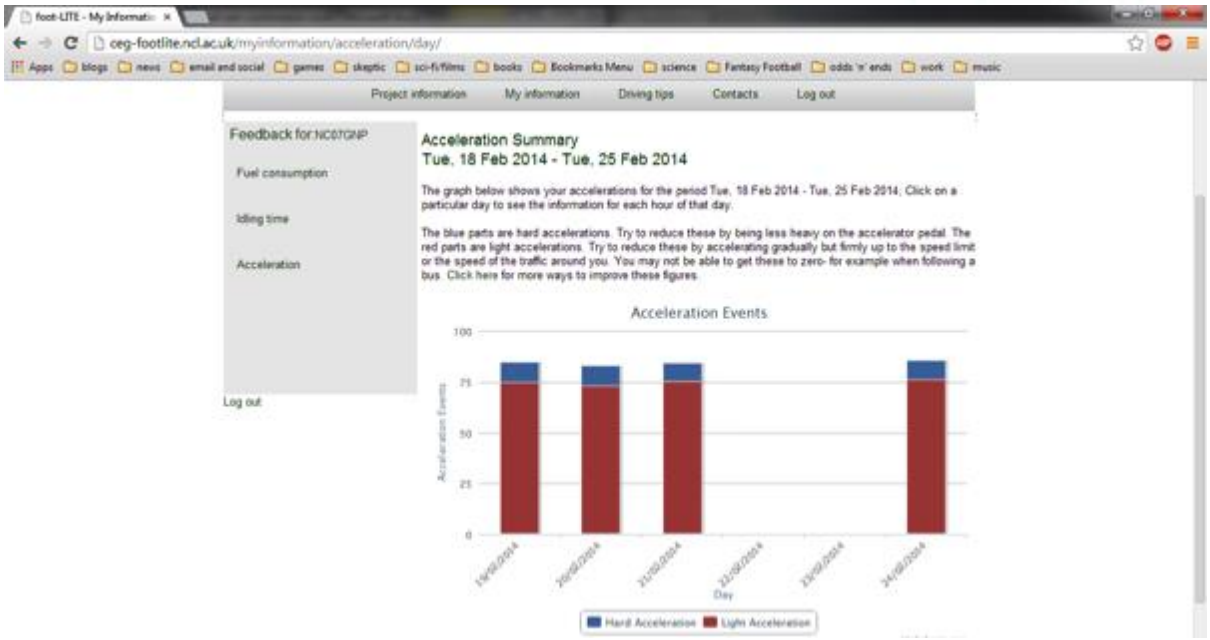


Figure 79: Acceleration summary. This figure provides a quick and convenient way to examine the acceleration profile. In general the bar should be as close to all red as possible, indicating the majority of acceleration was light, rather than the energy inefficient heavy acceleration.

User Step 3: User can access driving tips

This can be accessed through the appropriate link on the user homepage.

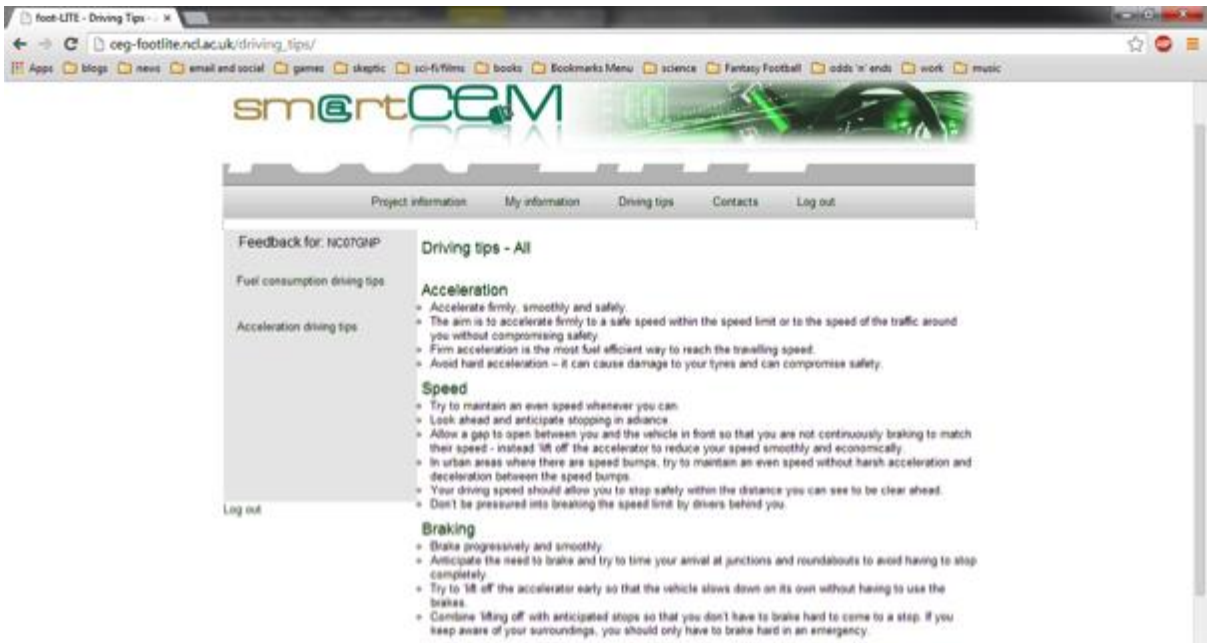


Figure 80: Driving tips. The driving tips provided are currently generic driving tips but if the user were sufficiently interested it would be possible to also include emailed personal driving tips

CS Management – Functional Verification

For steps 1-3 the smartphone used was a Samsung Galaxy (GT-S5570) with Android (v2.2.1). The test involved: downloading the CYC APP; navigating through the CP information page; viewing CP information in both map and list format; performing zoom in and zoom out functions on the map; selecting a CP by postcode and map; accessing the booking page via the CP list; plotting a route to the CP via the list. The CYC App worked quickly and effectively and delivered information in a clear, usable format.

Step 1: The tester logs in to the CYC App using password derived from the registration process. Once logged in, the App is launched.

Figure 81: Log in page

Figure 82: CYC upon log in

Step 2: The tester performs a search for a charge point. Here the tester input a postcode in order to deliver localised charge point options. CYC is a national network and can be used to access charge points across the country.

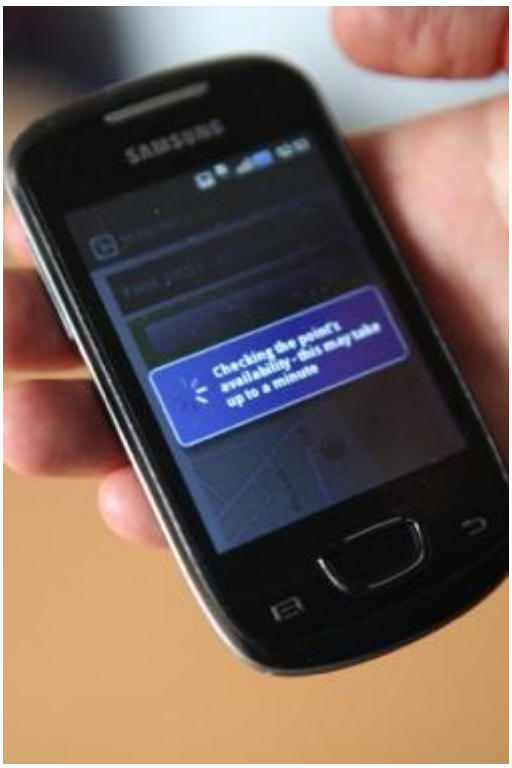


Figure 83: CP search

Available charge points are presented either in list form or as points on a map.

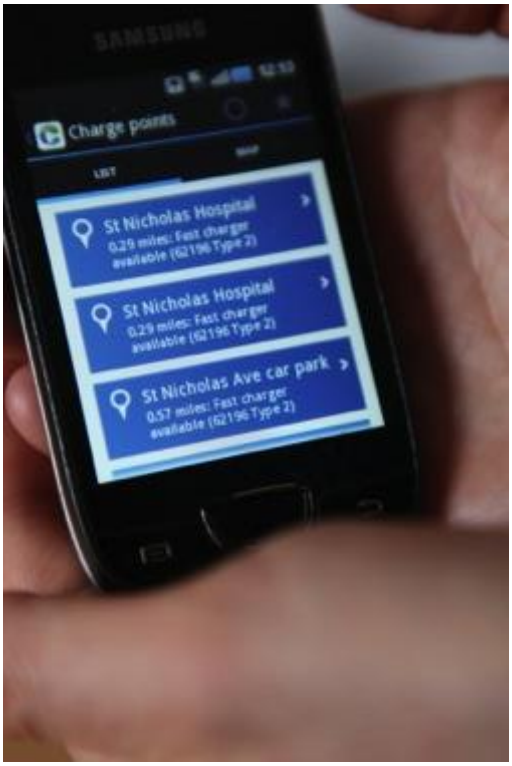


Figure 84: CP search (list)

Figure 85: CP search (map)

The map may be zoomed in.

Figure 86: CS search (map, zoomed in)

By clicking on a desired charge point, information relating to the charge point can be obtained, for example checking its availability status.

Figure 87: CP information

Step 3: The tester plots a route to the charge point using EV Navigation (CYC) by selecting the 'navigate' button (seen in Fig. above).

Figure 88: EV Navigation

Figure 89: EV Navigation

Step 4 & 5: The tester arrives at the charge point. In the functional verification performed on 26-02-14 the tester notifies the system of his/ her intention to charge by presenting an RFID card ('tag'). The RFID card validates the user and enables access to the post. The RFID card is like the one shown in Fig 10 below, although this image is from a different trip and shows a different type of charge post from the one performed in the functional verification.

Figure 90: RFID card (information only)

Figure 91: Available and functioning charge point

The charge post displays the user interface, with message: "please present tag to charge". Once the card has been presented and user ID validated a new message is displayed: "please insert plug to start recharging".

Figure 92: User interface

The appropriate socket is selected (3kw, 7kw, rapid charge) and the cable is plugged in and locked.

Figure 93: Socket selection

Step 6: Charging is initiated. Once charging is underway the default blue illumination on the post is replaced by green. The interface notifies the user that charging is in progress.

Figure 94: Charging in progress

Step 7: Charging is concluded by again presenting the RFID card. The display reads: "present tag to stop charging". Once this action is performed the illumination reverts to blue and the information display changes to: "please remove plug and close the door".

Figure 95: Information display indicating how to stop charging

Figure 96: Charging concluded

The cable can now be unlocked from both vehicle and charge post, and returned to the vehicle. Charging is concluded. The display on the charge post reverts to that shown in Figure 91: “please present tag to charge”.

4.3.4 Lesson learnt

There were no major issues arising from the functional verification. For the efficient driving testing process it was necessary to perform some steps as an administrator in order to add a user into the system.

4.4 Reggio Emilia Pilot Site

4.4.1 Test Cases Description/Scenarios

In the REG PS, the end users who will experience and take advantage of the smartCEM services are the employees of the Municipality of Reggio Emilia, which has a fleet of fully EV (Piaggio Porter) available for the work trips of the employees and for maintenance services. Scenarios can be described as follows.

1. An employee has the need to use an EV for his working activities. After having being registered to the list of users (i.e. users able and allowed to use an EV), the employee driver is able to book his trip with an EV → Use Case REG_UC_02: EV-sharing standard booking.
2. If the booking was successful (i.e. he is allowed to get the EV key), the municipality employee driver can pick the EV up from Charging Spot Area → REG_UC_04: EV-pick up.
3. He drives the EV to his destination taking advantage of the smartCEM on-board services, then brings it back to the Charging Spot Area → REG_UC_05 : EV-sharing driving.
4. Any interaction with EV and services is gathered and moved to DB where data available to be processed → REG_UC_07 : Car-sharing data report.
5. After the first trip of each user, tailored real-time advice on efficient driving will be provided to the driver according to his/her records → REG_UC_08 : Real-time advice on efficient driving.

4.4.2 Test case verification

Test case has been verified on using equipment and Data Acquisition System installed on a vehicle used for testing. It is not part of the final fleet owned by Municipality. It is a specific vehicle owned by University of Modena and Reggio Emilia.

Test Case	A Municipality employee books an EV equipped with smartCEM services and drives it back and forth for his work trip (EV-Sharing, EV-Navigation, Efficient Driving, CS Manager)
Tester	UNIMORE personnel involved in project on behalf of Municipality employees.

Admin	Leandro Guidotti (UNIMORE) as Service Provider	
Step 1		
Description	An employee of the Municipality wants to book an EV for his/her work trip: after completing the internal Municipality's procedure, he/she will be assigned the key of one of the EVs of the fleet, according to his/her ID.	
Expected Result	If the employee is one of the registered smartCEM users, then the key cabinet manager gives him the key of one of the EVs equipped with the smartCEM platform (unless they are all already booked). If he is not, then it will give out the key of one of the other vehicles.	
Requirements	- Employee involved in project want to use the EV. - Employee is allowed to use vehicle (booking procedure).	
UC Implied	REG_UC_01, REG_UC_02	
EV-Service Implied	EV-Sharing	
To check	Correct assignment of vehicles	✓
	Correct key is released	✓
Issues/Comments	Data about usage are also collected through key management infrastructure	
For the rest of this test case we will focus only on registered users who have access to the smartCEM services.		
Step 2		
Description	The employee enters the vehicle and switches on the on-board tablet. By clicking on the smartCEM portal app icon he can launch the application and access the smartCEM on-trip services related to the REG PS (EV-Navigation, Efficient Driving, CS	

	Manager).	
Expected Result	The smartCEM portal app is launched and the list of EV-services is displayed on the tablet.	
Requirements	Tablet available, accessible, connected via BT to BlueDash and in charge. Also GPRS/3G signal should be available.	
UC Implied	REG_UC_03	
EV-Service Implied	All services	
To check	The tablet is fully operative (e.g. connection, position, app available).	✓
	The portal app is properly launched	✓
	All the available services are showed on the tablet	✓
Issues/Comments	None	
Step 3		
Description	From the smartCEM portal app, the employee can launch the EV-Navigator and set his desired destination.	
Expected Result	The Navigator calculates the most suitable way for an EV to get to the desired destination and displays it on the tablet. The path should take into account the lack of Traffic Zone restrictions for EVs , the current State of Charge of the vehicle and Charging Spots.	
Requirements	GPS signal is available. App and Tablet running. Vehicle is available and suitable to start trip. Employee is suitable to start trip.	

UC Implied	REG_UC_04	
EV-Service Implied	EV-Navigation	
To check	EV-Navigator is correctly launched	✓
	The destination is properly set	✓
	The most suitable way towards the destination is showed on the map	✓
Issues/Comments	None	
Step 4		
Description	While on trip, vehicle data are collected by the BlueDash unit and sent in real time (at a frequency of 0.5 Hz): - to the on-board tablet via Bluetooth - to the local database for processing via GPRS (by unit) or 3G (by tablet)	
Expected Result	Data are properly received by the tablet and the local database and can be used in real time as an input for the smartCEM services	
Requirements	GPRS/3G and GPS signals are available Vehicle is running.	
UC Implied	REG_UC_04	
EV-Service Implied	EV-Sharing, Efficient Driving	
To check	The BD unit and all Data Acquisition System are properly connected to the Porter	✓
	The BD unit is collecting and sending the data via BT to	✓

	tablet and via GPRS/3G to local DB	
	The tablet properly receives data and they are available for smartCEM services (EV Efficient Driving, EV-Navigation)	✓
	The local database properly receives data	✓
	The local database is ready for processing data	✓
Issues/Comments		
Step 5		
Description	While on trip, data processed at the local database are sent back to the EV and feed the EV Efficient Driving and Navigation app: based on these, the EV Efficient Driving app recommends the driver to accelerate/slow down/change the path, in order to maximize driving efficiency and eco-driving style.	
Expected Result	Data regarding the employee's own driving style are correctly received by the tablet and read by the ED application, which shows its advices on the tablet in a brief and clear way.	
Requirements	GPRS/3G and GPS signals are available App is running Tablet is available and running Vehicle is running Employee can access to service	
UC Implied	REG_UC_04, REG_UC_07	
EV-Service Implied	EV-Navigation, Efficient Driving	
To check	The local database correctly sends data	✓
	Data on driving style are received by the tablet by means of the smartCEM apps	✓
	ED app shows the proper advices	✓
Issues/Comments		

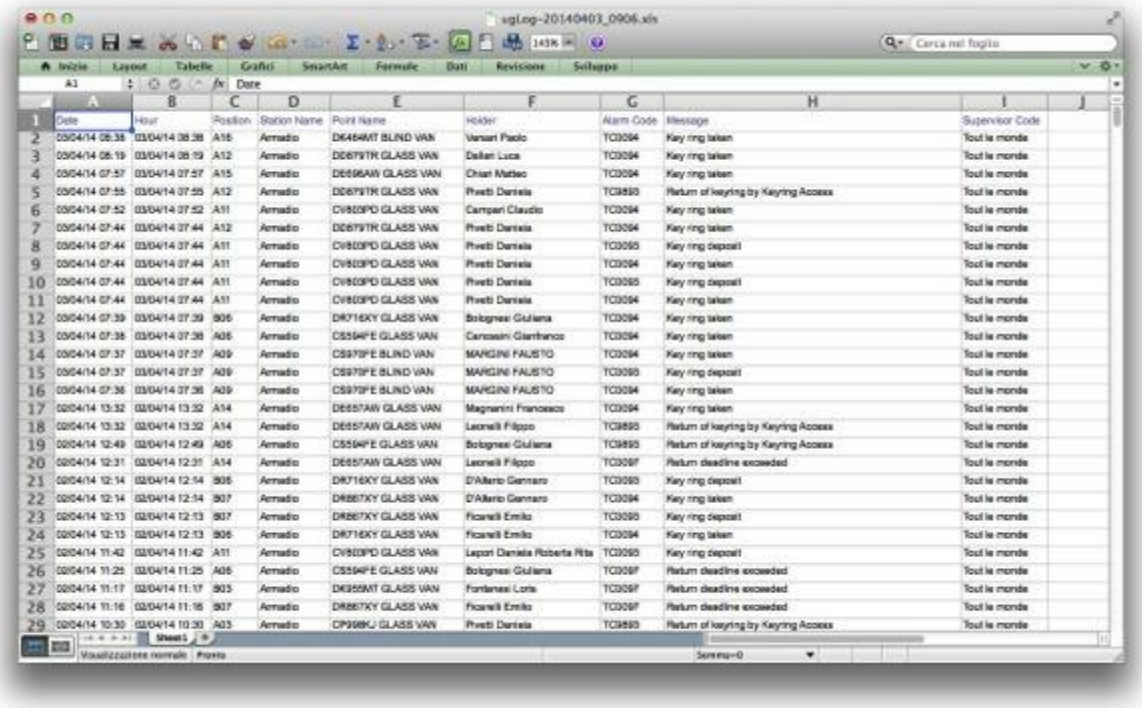
Step 6		
Description	The employee now has the possibility to drive the EV during his trip taking advantage of the smartCEM on-trip services (EV-Navigator, Efficient Driving).	
Expected Result	The proper path is continuously computed and displayed on the EV-Navigation together with the recommendations by the EV Efficient Driving, based on his driving style and the current state of the vehicle.	
Requirements	GPRS/3G and GPS signals are available	
UC Implied	REG_UC_04, REG_UC_07	
EV-Service Implied	EV-Navigation, Efficient Driving	
To check	The path to the destination is constantly displayed	
	Advices from the ED app are shown on the tablet	
Issues/Comments	None	

Step 7	
Description	Possibly, if the battery's State of Charge is running low, the driver can access the list of CS through the CS Manager application, which can be launched by the smartCEM portal app. The app shows the list of CS within range and their position on the map, so that the driver can choose the one that minimizes the deviation from the original path.
Expected Result	The CS are shown on the map and the EV-NAV will indicate the proper path to the selected CS.
Requirements	GPRS/3G and GPS signals are available
UC Implied	REG_UC_04
EV-Service	EV-Navigation, CS Manager

Implied		
To check	Available CS are listed	✓
	CS are ranked by their distance from the user	✓
	After selection, the NAV shows the path to the chosen CS	✓
Issues/Comments	None	
Step 8		
Description	The employee has come back to the Municipality parking: he switches off the tablet, plugs the EV and returns the key to the cabinet.	
Expected Result	Data about the trip are stored by the Key Cabinet Manager and the EV is marked as available again.	
Requirements	none	
UC Implied	REG_UC_05, REG_UC_06	
EV-Service Implied	EV-Sharing	
To check	The “end of the trip” event is correctly registered by the key cabinet manager	✓
	Data regarding the EV and the trip are properly logged and stored	✓
	Vehicle’s battery is now charging	✓
	The EV is marked as available again	✓
Issues/Comments	None	

4.4.3 Visual facts

Figure 97: Key management cabinet



	A	B	C	D	E	F	G	H	I	J
1	Date	Hour	Position	Station Name	Point Name	Holder	Alarm Code	Message	Supervisor Code	
2	03/04/14 08:38	03/04/14 08:38	A16	Armadio	DK464MT BLIND VAN	Versari Paolo	TC3094	Key ring taken	Tout le monde	
3	03/04/14 08:19	03/04/14 08:19	A12	Armadio	DD679TR GLASS VAN	Dallari Luca	TC3094	Key ring taken	Tout le monde	
4	03/04/14 07:57	03/04/14 07:57	A15	Armadio	DE696AW GLASS VAN	Chiari Matteo	TC3094	Key ring taken	Tout le monde	
5	03/04/14 07:55	03/04/14 07:55	A12	Armadio	DD679TR GLASS VAN	Preti Daniela	TC3093	Return of keyring by Keyring Access	Tout le monde	
6	03/04/14 07:52	03/04/14 07:52	A11	Armadio	CV803PD GLASS VAN	Campari Claudio	TC3094	Key ring taken	Tout le monde	
7	03/04/14 07:44	03/04/14 07:44	A12	Armadio	DD679TR GLASS VAN	Preti Daniela	TC3094	Key ring taken	Tout le monde	
8	03/04/14 07:44	03/04/14 07:44	A11	Armadio	CV803PD GLASS VAN	Preti Daniela	TC3093	Key ring deposit	Tout le monde	
9	03/04/14 07:44	03/04/14 07:44	A11	Armadio	CV803PD GLASS VAN	Preti Daniela	TC3094	Key ring taken	Tout le monde	
10	03/04/14 07:44	03/04/14 07:44	A11	Armadio	CV803PD GLASS VAN	Preti Daniela	TC3093	Key ring deposit	Tout le monde	
11	03/04/14 07:44	03/04/14 07:44	A11	Armadio	CV803PD GLASS VAN	Preti Daniela	TC3094	Key ring taken	Tout le monde	
12	03/04/14 07:39	03/04/14 07:39	B05	Armadio	DR716XY GLASS VAN	Bolognesi Giuliana	TC3094	Key ring taken	Tout le monde	
13	03/04/14 07:38	03/04/14 07:38	A05	Armadio	CS594PE GLASS VAN	Carcasoni Gianfranco	TC3094	Key ring taken	Tout le monde	
14	03/04/14 07:37	03/04/14 07:37	A09	Armadio	CS979PE BLIND VAN	MARGINI FAUSTO	TC3094	Key ring taken	Tout le monde	
15	03/04/14 07:37	03/04/14 07:37	A09	Armadio	CS979PE BLIND VAN	MARGINI FAUSTO	TC3093	Key ring deposit	Tout le monde	
16	03/04/14 07:36	03/04/14 07:36	A09	Armadio	CS979PE BLIND VAN	MARGINI FAUSTO	TC3094	Key ring taken	Tout le monde	
17	02/04/14 13:32	02/04/14 13:32	A14	Armadio	DE657AW GLASS VAN	Magnanini Francesco	TC3094	Key ring taken	Tout le monde	
18	02/04/14 13:32	02/04/14 13:32	A14	Armadio	DE657AW GLASS VAN	Leonelli Filippo	TC3093	Return of keyring by Keyring Access	Tout le monde	
19	02/04/14 12:49	02/04/14 12:49	A05	Armadio	CS594PE GLASS VAN	Bolognesi Giuliana	TC3093	Return of keyring by Keyring Access	Tout le monde	
20	02/04/14 12:31	02/04/14 12:31	A14	Armadio	DE657AW GLASS VAN	Leonelli Filippo	TC3097	Return deadline exceeded	Tout le monde	
21	02/04/14 12:14	02/04/14 12:14	B05	Armadio	DR716XY GLASS VAN	D'Alterio Gennaro	TC3093	Key ring deposit	Tout le monde	
22	02/04/14 12:14	02/04/14 12:14	B07	Armadio	DR867XY GLASS VAN	D'Alterio Gennaro	TC3094	Key ring taken	Tout le monde	
23	02/04/14 12:13	02/04/14 12:13	B07	Armadio	DR867XY GLASS VAN	Ficarelli Emilio	TC3093	Key ring deposit	Tout le monde	
24	02/04/14 12:13	02/04/14 12:13	B05	Armadio	DR716XY GLASS VAN	Ficarelli Emilio	TC3094	Key ring taken	Tout le monde	
25	02/04/14 11:42	02/04/14 11:42	A11	Armadio	CV803PD GLASS VAN	Lepori Daniela Roberta Rita	TC3093	Key ring deposit	Tout le monde	
26	02/04/14 11:25	02/04/14 11:25	A05	Armadio	CS594PE GLASS VAN	Bolognesi Giuliana	TC3097	Return deadline exceeded	Tout le monde	
27	02/04/14 11:17	02/04/14 11:17	B03	Armadio	DK356MT GLASS VAN	Fontanesi Loris	TC3097	Return deadline exceeded	Tout le monde	
28	02/04/14 11:16	02/04/14 11:16	B07	Armadio	DR867XY GLASS VAN	Ficarelli Emilio	TC3097	Return deadline exceeded	Tout le monde	
29	02/04/14 10:30	02/04/14 10:30	A03	Armadio	CP998KJ GLASS VAN	Preti Daniela	TC3093	Return of keyring by Keyring Access	Tout le monde	

Figure 98: Example of data logged by key management cabinet

Figure 99: Piaggio Porter EV under technical equipment

Figure 100: Data Acquisition System installation (1)

Figure 101: Data Acquisition System installation (2)

Figure 102: EV-Navigation displayed on tablet

Figure 103: smartCEM portal displayed on tablet

4.4.4 Lesson learnt

Services are functionally working and toolchain appears suitable for data acquisition. Most of pilot site effort in verification was spent for solving technical issues on the complex Data Acquisition System that was set up composed by cables, connectors and two specific units for data gathering, data conversion and data sending to server and tablet. From user point of view no issues seem to be present. Usability of tablet of course was not considered. In these sense main lessons learnt are about systems and technicalities.

5 Conclusions

5.1 General aspects

This document presented the technical verification of the functionalities of the smartCEM services and its components, performed at each of the Pilot Sites at the end of the implementation period.

This deliverable can be regarded as a bridge leading from WP2 (Implementation) to WP3 (Operation), as a complete verification of the technical chain was necessary in order to ensure a proper collection of data during the operational phase of the project.

5.2 Overall view

Services are working in all test sites. Only minor open issues could be related to usability for new users but learning process seems to be very fast. Some technical problems could arise and maybe they could require more test and review sessions in order to fix them all.

References

[1] smartCEM, D2.1 Reference Architecture, 2012

[2] smartCEM, D2.2 Platform Architecture, 2012

[3] smartCEM, D2.3 Guidelines and requirements for the integration of local systems into the smartCEM architecture, 2012

[4] smartCEM, D3.2 Common data exchange protocol for smartCEM, due October 2013

[5] smartCEM, D2.4.1 Platform integration for Barcelona, 2013

[6] smartCEM, D2.4.2 Platform integration for Gipuzkoa, 2013

[7] smartCEM, D2.4.3 Platform integration for Newcastle, 2013

[8] smartCEM, D2.4.4 Platform integration for Reggio Emilia, 2013

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Appendix A – Brief description of functionality of the Apps

Multimodal trip planner

The Multimodal trip planner component performs the following functions:

- Import Public Transport data.
- Interface EV-sharing systems for getting EV-sharing information on EV availability for booking in the desired slot of time.
- Processes multimodal travel solutions (Public Transport, EV-sharing, on foot) from the starting position to a desired destination.
- Search for parking points.
- Public Transport network generation for travel planning.
- Builder structured data controller: this component has the function of controlling and creating disk log files by reporting warnings about arcs and nodes with particular situations of missing connection in the PT network graph.
- Configuration graph generation from application interface: the application that produces the mathematic model (graph) of the network representing the public transport companies involved in the project, has an application interface that allows to set up the features of the produced graph (minimum time/max transhipment at the change bus stop, walking distance to reach the bus stop, working database, folder of produced files, other rules of zoning.
- TripPlanningMapServer: it is the calculation engine. The functions of such task materialize the travel solutions regarding the network generated by Builder. At every query from the external actors, the interface query capturing collects the information, queries the MapServer and produces the perfect set of travel solutions.
- The communication is possible through an XML file exchange following certain calls to an http (or https) address that depends on the web server on which the MapServer component is installed. MapServer is instantiated toward the closest car-sharing points to the destination.
- Web Interface for the presentation of the user-interface functions of the EV-trip management, where the user can interact with the portal through the following functions:
    - Display and cartographic functions (web trip planner)

- Entering research parameters: Origin, destination, slot of time
- Search POI: Bus stops and EV-sharing stations
- Find the solutions
- Search lines
- Search addresses
- Show Arrivals/Departures
- ShowMultimodalSolutions
- ShowMoltimodalSolutionOnTheMap
- Access to EV-sharing web site for vehicle booking
- PrintSolution
- Multiple languages: English, Spanish and Basque

- Android-Based smartphone/tablet Application: End user interface for the presentation of the functions of the EV-trip management, where the user can interact with the Android App through the following functions:
  - Nearest Bus stops
    - Search Bus stops
    - Search Bus stops around the current position
  - Nearest Car-Sharing Points
    - Search EV-sharing Points
    - Search EV-sharing Points around the current position
  - Travel solutions
    - Find solutions combining Public Transport with EV-sharing service
    - Find solutions with Public Transport only.
    - Entering research parameters: Origin, destination, slot of time
    - Show Arrivals/Departures
    - Show Multimodal Solutions
    - Show Moltimodal Solutions On TheMap, with itineraries and timetables

- Access to EV-sharing web site for vehicle booking
- Set favourites itineraries

- Settings:
  - Set the search radius
  - Handle localisation: GPS or manual
  - Preferences: e.g. preferred itineraries
  - Languages: English, Spanish and Basque
- Search lines

Both web and Android-based applications are accessible via the smartCEM common App.

EV Navigation

The EV Navigation App provides a full featured onboard navigation system for Android systems with available maps for many countries, available in 19 screen languages and 16 Text2Speech languages.

Functionalities under others are

- Entering Navigation targets (addresses, POIs, favourites, home, office, last destinations, point in map)
- Turn by turn navigation and simulation with tunnel extrapolation, realistic sign posts, junction views and auto zooming to the best view
- Support of extensive vehicle profiles (road preferences selection, vehicle speed predefinitions, tolls, Ecotaxe, …)
- Special strength lie in support of restrictions for logistic vehicles (height, width, length, axle weight, weight, legal restrictions, dangerous goods)
- And logistics routing (avoidance of u-turns, access on restricted areas, road preferences, logistic targets)
- Integration capabilities with a comprehensive API for an integration into business processes.

EV Navigation additionally offers functionalities to support electric vehicles:

- Support for feeding real time values from the vehicle into the navigation

- Simulation module, that uses trained simulation data based on vehicle models, for future based calculations if real time values are not available

- EV-Reachable Range Assistant for server based calculating of a polygon shaped reachable area based on current facts to show the driver if reaching his target is feasible

- EV-info Assistant for visualising the current consumption as a user feedback, also with integration of slopes and accelerations (personal driving style)

- EV-Range info: Displays a simple range information based on current consumption

- EV-Simulation Assistant gives the possibility to change current values like Battery level, AC/heating usage or outside temperature and see the consequences for the reachable range in an what if simulation

- EV Charging Station assistant allows to display the next charging points on the current planned route. Charging Stations can be added as intermediate stations or removed. There is also a range check, to see if the target is in the range

- EV-Vehicle Model : Physical vehicle model as a base for the calculation

- EV-Vehicle Profile Shaper: Training tool to shape vehicle profiles and vehicle models on base of a vehicle parameters like weight, range NEDC, max speed, battery type, battery aging specs, aerodynamics, component efficiencies, and other vehicle parameters

EV Sharing

The EV-Sharing component is compound by the next elements:

- EV-Sharing system server: It is the main server that stores the server side core application of the sharing service and the communications library that is used to communicate with the vehicle OBUs.

- EV-Sharing database: The database where all the information about the sharing service is stored: Users, vehicles, vehicle models, charging stations, reservations, tariffs, etc.

- OBU units : Embedded systems allocated within the vehicles equipped with touch screen, client's booking management user interface software, RFID reader, GPS and 3G/GPRS antennas and CAN BUS connection (just for those cases in which this connection is permitted by the manufacturer and the

service provider). These units will be used as HMI for user booking management and as data loggers.

- Administration web application: This web application permits the sharing service provider's management team to control the service. Allows vehicle and communications monitoring, data base data insertion, modification or deletion (users, groups, tariffs, vehicles, etc.).
- Communication library: Deals with communications between the vehicle OBUs and the server database.
- Client web application: This is the web based application used by the en-users for vehicle booking. It performs the next functions.
    - EV-Sharing service user registration
    - EV booking. Different vehicle availability searching parameters are used: date-time, km, location, car model and seat number.
    - Booking review, cancellation and modification options.
    - Pre-trip and on board booking modification options.
    - Base Station location visualization.
    - Issue notification.
    - User data modification.
    - Multiple languages: English, Spanish and Basque.
- Android application: This application permits the end user to perform the basic functionalities for the EV-Sharing.
    - Login as EV-Sharing user.
    - EV booking. Different vehicle availability searching parameters used : date-time, km, location, car model and seat number.
    - Pending bookings review and cancellation options.
    - Base station location visualization.
    - Multiple languages: English, Spanish and Basque.
- On board tablets: Included in vehicles for the end users in order to execute smartCEM EV-Navigation application as well as the CS-Management application.

EV CS Management Mobile Application

The Charging Station Management Mobile App is an Android application that performs the following:

- Connects to the CSManagement Service database and extracts the list of Charging Stations.
- Displays the list of Charging Stations to the mobile user
- Allows the user to search in the list, select one Charging Station and navigate to it (by pressing a dedicated button, the Navigator Android App is being launched and the destination is communicated to it.

EV CS Management Service

The Charging Station Management Service component is a REST web service that performs the following :

- Maintains the Charging Stations database
- Allows the administrators of SmartCEM sites to upload CS data to the database
- Exposes the Chargins Stations data to CS Management Mobile Application users.

SmartCEM Portal

Also known as «smartCEM Common App», this Android application which provides the users with the following:

- Information regarding the smartCEM electro-mobility services that the user can access with his/her Android device.
- The ability to install additional applications that provide the above mentioned services
- Information regarding the smartCEM implementation sites and the services available in each of them
- Links to background information regarding the project and partners

Appendix B – Barcelona use cases

Use Cases List

The following table summarises the use cases to be implemented at the Newcastle pilot site.

No. (UC Id)	Trip phase	Use Case name	Short Description
BCN_UC_01	Pre-trip	User registration	New user registration (frequent users + "spot" users); personal data (including bank account details) + type of contract (frequent user vs. "spot" user)
BCN_UC_02	Pre-trip	User account management	Update personal data / type of contract / frequent trips configuration
BCN_UC_03	Pre-trip	Frequent trip (automatic booking)	WDM generates bookings in advance for all frequent trips.
BCN_UC_04	Pre-trip	Immediate Spot Trip Booking	When "spot" Service Request cannot be satisfied smartphone app to provide alternatives by public transport (EV-trip management)
BCN_UC_05	Pre-trip	Planned Spot Trip Booking	
BCN_UC_06	Pre-trip	Time-based booking	
BCN_UC_07	Pre-trip	e-scooter check-in	
BCN_UC_08	Pre-trip	Incentives management (dynamic pricing) for efficient fleet management	
BCN_UC_09	Pre-trip	Cancellation / Modification of frequent trip(s)	
BCN_UC_10	Pre-trip	Cancellation / modification of spot trips	

BCN_UC_11	On-trip	e-scooter riding	
BCN_UC_12	Post-trip	e-scooter check-out	

Table B-1 List of Use Cases for Barcelona Pilot Site

Use Cases Description

The following tables provide a detailed description of each UC.

Use Case	**Code: BCN_UC_01**	**Title: User registration**
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Mikaël Baron & Marti Jofre - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	The user registers to the Electric scooter sharing service. There will be two types of users: citizens and tourists.	
Constraints	User must have a valid driving license. User must own an iOS or Android smartphone. Registration is done via Internet only (PC/Laptop, smartphone); user will be required to install a smartphone application. Registration not possible in person, nor by contacting the Call Centre.	
Pre-condition		
Actors	Scooter Driver, Electric scooter (open) sharing service operator, smartphone	
Services involved	EV-Sharing	
Trigger	The user wants to register to the Electric Scooter sharing service.	
Basic path/Main Flow	*1.* The user clicks “Create new account” button in the Electric scooter sharing service website / smartphone app. If the user	

	enters the website URL in his/her smartphone browser, he/she will automatically be prompted to download and install the app and register from there. 2. He/She is informed on the main clauses of the contract (that he/she must acknowledge and accept): a. He/She will be charged a flat rate fee per month or a sign up fee, and then for actual usage (valid both for frequent and spontaneous users; not valid for tourists) b. He/She will be required a valid driving license: licence number + expiration date (SS will not verify validity, user will be requested to confirm validity under his own responsibility) c. Citizens will be required to provide a valid bank account, while tourists will be required to provide a credit card number + expiration date. d. Use of iOS or Android smartphone is required for the main actions related to the service (book a trip; check-in / check-out) e. Other commercial agreements between the operator of the service and the customer (e.g. policy on type of contract changes). 3. He/She is requested a personal login and password 4. He/She is requested to complete a form with the following input fields: a. Personal Data (including address, e-mail, phone number...); set of required data will be different for frequent/spot users that are citizens and for tourists (e.g. address will not be requested to tourists) b. Bank account details (if citizen) / Credit Card number + expiration date (if tourist) c. Driving license: number + expiration date 5. He/She is informed that his/her account is under validation and he/she will receive confirmation within 24h. 6. Once the Electric scooter (open) sharing operator validates that the sharing system has capacity to allow for a new user (with some predefined mobility patterns, in the case of frequent users), the user receives an e-mail with the confirmation and instructions to start using the service (including the need to download the app to be able to use the electric scooters).
Post-condition	The user has successfully registered and can start booking

	electric scooters.
Exception path/Alternate Flow	[The user does not comply with any of the requirements] Registration not accepted. Electric scooter (open) sharing operator will contact user personally in order to try to solve the issue.

Indicators		
Category	**Indicator name**	**Brief Description**
System	Nr of users	Number of registered users.

Table B-2: Use Case BCN_UC_01: User registration

Use Case	**Code: BCN_UC_02**	**Title: User account management**
Version	02	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Mikaël Baron & Marti Jofre - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	The user updates his/her personal data and/or contract(s).	
Constraints	-	
Pre-condition	User must be registered to the Electric scooter sharing service.	
Actors	Scooter Driver, Electric scooter (open) sharing service operator	
Services involved	EV-Sharing	
Trigger	User wants to optimize costs (different types of contract have different pricing schemes; e.g. frequent users have cheaper rates) or modify personal data.	
Basic path/Main Flow	1. The user logs in the Electric scooter sharing service website / app 2. In his/her personal account, he/she clicks on the "Modify personal data" button 3. He/she can modify any field of the personal data form 4. He/she can choose between the available types of contract.	

	Policy on which changes are permitted has been previously clearly stated (when registering to the service BCN_UC_01) 5. He/she receives an e-mail with the confirmation of the contract modifications.
Post-condition	Personal data is updated and/or the user is charged according to the new rates (in case there has been some contract modification which implies a different pricing scheme).
Exception path/Alternate Flow	

Indicators		
Category	**Indicator name**	**Brief Description**

Table B-3: Use Case BCN_UC_02: User account management

Use Case	**Code: BCN_UC_03**	**Title: Frequent trip (automatically generated booking)**
Version	03	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Mikaël Baron & Marti Jofre - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	The Electric Scooter Sharing Service user can request a frequent trip contract. It consists on a monthly flat rate for the use of the Electric Scooter Sharing Service at a predefined daily scheduled return trip (e.g. Monday to Friday, from A to B, starting at 9h and back at 18h).	
Constraints	Weekends excluded. Fixed trip, the user will not be able to modify the route or schedule. Admission subject to availability of the service.	
Pre-condition	User must be registered to the Electric Scooter Sharing Service.	

Actors	Scooter Driver, Electric (open) sharing service operator
Services involved	EV-Sharing
Trigger	User wants to use the Electric Scooter Sharing Service in a fix and daily basis.
Basic path/Main Flow	1. The user logs in the Electric Scooter Sharing Service website (web access, in principle from a PC) or smartphone application 2. In his/her personal account, he/she clicks "Request Frequent Trip" button 3. He/she specifies the parameters of the frequent trip he/she wants to request: start time, time back, origin, destination. Send. 4. The system checks if there is some capacity for this request. If there is some, go to step 6. If not, User will be asked if he/she wants to be on the waiting list. 5. When user accepts, the system will check availability for this request on a regular basis. When availability is found, user will be contacted by e-mail to confirm the request. 6. If the user confirms, the request is validated. The service is contracted: from this day on, a vehicle will be made available to perform the daily trips. Trip price is calculated based on the estimated mileage for the desired frequent trip. Pricing schemes will be different for frequent users and spontaneous users.
Post-condition	The system books an electric scooter for the contracted daily use.
Exception path/Alternate Flow	1. If at any validation step user cancels the request, the process ends. No new contract is set. The same happens if user notifies he/she does NOT want to be on the waiting list. 2. If, after a given time, the system is not able to find availability, the request will be cancelled automatically (and the user will be informed).

Indicators		
Category	**Indicator name**	**Brief Description**
System	Contracts	Number of contracts
User Satisfaction - SLA	Immediate Availability	Was the system able to propose contract immediately?

User Satisfaction - SLA	Waiting Time	How long did the user wait before the contract was made available
User Satisfaction - SLA	System Rejection	Was the request rejected by the system?
User Satisfaction - SLA	User Rejection	Was the request rejected by the user?

Table B-4: Use Case BCN_UC_03: Frequent trip (automatically generated booking)

Use Case	Code: BCN_UC_04	Title: Immediate Spot Trip Booking
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organisation)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	User books an electric scooter to go to a specified place (now).	
Constraints	Origin and destination of the trip must be within Service Area. The Service Area is the space within which a user can start or end a trip (by contract). It is the same for all users, and basically describes where the Electric scooter sharing service is operative. It is planned that the service area will grow, along with the user base and the available fleet of e-scooters. However, during a trip, user could temporarily leave this area as long as he/she returns the vehicle at the agreed time and location (e.g. best trip plan from A to B, both within service area, has some sections beyond the service area)	
Pre-condition	User must be registered to the Electric Scooter Sharing Service.	
Actors	Scooter Driver, Electric Scooter (open) sharing service operator	
Services involved	EV-Sharing, EV-Trip Planner	
Trigger	User wants to go somewhere.	
Basic path/Main Flow	1. User starts the Electric Scooter Sharing Service smartphone application. 2. He/she selects the Trip Management --> Booking tab 3. He/she specifies the parameters of the trip he/she wants to request: start time (now), origin (here), destination. Destination can be selected from “my places”/favourites list (home, work, gym, train station, etc.) or specified on an interactive map. 4. The system checks availability of e-scooters for this request. It proposes an electric scooter within a range of YYY m around the current user location and specifies a price for the trip (price is based on the type of user contract and estimated mileage of the trip). He might be offered an	

	incentive to modify his trip (refer to BCN_UC_08). 5. User accepts proposal, and is invited to go and pick up the booked electric scooter and check-in. He has XX minutes (*) to get to the scooter and use it. If user has previously made another booking and never used the scooter, he/she is informed about the penalization as agreed in the Terms of Service. * This parameter will be calibrated and adapted during the pilot operational phase (some preliminary figures have already been calculated / estimated out of simulations, but actual values of parameters will be a result of real testing).
Post-condition	The system books a vehicle for the user.
Exception path/Alternate Flow	1. No availability is found → SS provides a suitable alternative by public transport (EV-Trip planner) 2. User rejects proposal

Indicators		
Category	**Indicator name**	**Brief Description**
User Satisfaction – SLA	Availability on Request	Measures if the system has been able to come out with a proposal on user's service request.
User Satisfaction - KPI	User Acceptance	Measures if user accepted proposal
User Satisfaction - KPI	Vehicle Distance	How far from the origin (user location) was vehicle proposed to the user ?
System	Request Parameters : Locations, time	What trip was requested? Origin, Destination, time of the day.

Table B-5: Use Case BCN_UC_04: Immediate Spot Trip Booking

Use Case	Code: BCN_UC_05	Title: Planned Spot Trip Booking
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	User books a vehicle to make a planned trip (in the near future; for example, now it is 9AM and I want to book an electric scooter today starting at 1PM)	
Constraints	Origin and destination of the trip must be within Service Area.	
Pre-condition	User must be registered to the Electric Scooter Sharing Service.	
Actors	Scooter Driver, Electric Scooter (open) sharing service operator	
Services involved	EV-Sharing, EV-Trip Planner	
Trigger	User wants to plan a trip.	
Basic path/Main Flow	1. User starts the Electric Scooter Sharing Service application, or accesses his/her account on the web. 2. He selects the Trip Management --> Booking tab 3. He/she specifies the parameters of the trip he/she wants to request: start time, origin, destination. Origin and Destination can be selected from list of "my places", or specified on an interactive map. 4. The system checks availability for this request. It availability is found, it specifies a price for the trip (price is based on the type of user contract and estimated mileage of the trip). 5. User accepts proposal, he/she will be noticed of the place he/she has to go to pick the vehicle in a notification X minutes (*) before the beginning of the trip. Booked electric scooter will be within a range of YYY meters from specified origin. * These parameters will be calibrated and adapted during the pilot operational phase (some preliminary figures have	

	already been calculated / estimated out of simulations, but actual values of parameters will be a result of real testing).
Post-condition	The system books an electric scooter for the user.
Exception path/Alternate Flow	1. No availability is found at request time → SS provides a suitable alternative by public transport (EV-Trip planner) 2. User rejects proposal

Indicators		
Category	**Indicator name**	**Brief Description**
User Satisfaction – SLA	Availability on Request	Measures if the system was able to come out with a proposal on user's request.
User Service - SLA	Availability on Trip Start	Measures if vehicle could be assigned to the trip
User Satisfaction - KPI	User Acceptance	Measures if user accepted proposal
User Satisfaction - KPI	Vehicle Distance	How far from the origin (initial user location) was scooter proposed to the user?
System	Request Parameters : Locations, time	What trip was requested? Origin, Destination, time of the day.

Table B-6: Use Case BCN_UC_05: Planned Spot Trip Booking

Use Case	Code: BCN_UC_06	Title: Time-based booking
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA-RACC	
Description	User books a vehicle to go around in the city (now), no pre-determined destination	
Constraints	Origin of the trip must be within Service Area. Electric scooter must stay within Service Area (to be defined). Max range will be driven by scooter battery level.	
Pre-condition	User must be registered to the Electric Scooter Sharing Service.	
Actors	Scooter Driver, Electric Scooter (open) sharing service operator	
Services involved	EV-Sharing, EV-Trip Planner	
Trigger	User wants to ride an electric scooter	
Basic path/Main Flow	1. User starts the Electric Scooter Sharing Service application, or accesses his/her account on the web. 2. He/she selects the Trip Management --> Booking tab 3. He/she specifies the parameters of the trip he/she wants to request: start time (now), usage time, origin (here), destination. 4. The system checks availability for this request. If availability is found, it specifies a price for the trip (price is based on a flat rate / min). 5. User accepts proposal, he/she will be informed of the location he/she has to go to pick the booked scooter in a notification X minutes (*) before the beginning of the trip. Booked scooter will be within a range of YYY meters from specified origin. * These parameters will be calibrated and adapted during the pilot operational phase (some preliminary figures have already been calculated / estimated out of simulations, but	

	actual values of parameters will be a result of real testing).
Post-condition	The system books an electric scooter for the user.
Exception path/Alternate Flow	1. No availability is found at request time→ SS provides a suitable alternative by public transport (EV-Trip planner) 2. User rejects proposal

Indicators		
Category	**Indicator name**	**Brief Description**
User Satisfaction – SLA	Availability on Request	Measures if the system was able to come out with a proposal on user's request.
User Service - SLA	Availability on Trip Start	Measures if vehicle could be assigned to the trip
User Satisfaction - KPI	User Acceptance	Measures if user accepted proposal
User Satisfaction - KPI	Vehicle Distance	How far from the origin (user location) was vehicle proposed to the user?
System	Request Parameters : Locations, time	What trip was requested? Origin, time of the day.

Table B-7: Use Case BCN_UC_06: Time-based booking

Use Case	Code: BCN_UC_07	Title: e-scooter check-in
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Josep Laborda / ACASA - RACC Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners		
Description	The user gets to the location of the booked electric scooter, checks in and starts the trip. Check-in process is done through WiFi communication between the user's smartphone MOTIT BCN app and the electric scooter OBU.	
Constraints	The user can only check-in (unlock) the booked electric scooter. The user needs his/her smartphone working (with WiFi communication enabled) to do the check-in; (Reminder: smartCEM DoW stated that a RFID card would be used, and this is no longer valid)	
Pre-condition	The system assigns a scooter to the user: User has received a notification on his/her smartphone app with the booked scooter license plate and current location. Internally, the application has received a key code to unlock the scooter. Key code only matches the booked scooter within the allowed timeframe (X minutes before and after booked Start Time; tolerance will be set during the Operation phase, and will be a very flexible parameter). The message will be received Y minutes ("courtesy time") before the beginning of the trip.	
Actors	Scooter driver, Electric Scooter OBU,	
Services involved	EV-sharing,	
Trigger	With previous information, user has reached (location) and clearly identified the booked electric scooter	
Basic path/Main Flow	On the street 1. Start e-scooter system: User press "ON/OFF" button on the scooter handlebar (only one button available). e-scooter and	

app synchronize.

2. Check-In: User presses “Drive” button on the app. “READY” indicator is displayed.
3. Start Engine: User presses “ON/OFF” button on the scooter handlebar. “ON” indicator is displayed.
4. Pre-trip information is displayed on the e-scooter HMI (Android-based tablet):
   - Welcome message (in the user’s preselected language; available languages: Catalan, Spanish, English, French, Italian, German)
   - Suggested routes for the booked trip displayed on a map (for tourists willing to do a free destination booking - i.e. use the electric scooter for some time to get around the city – some predefined tourist routes will be displayed); for each route, estimated travel time and riding distance is indicated; user does not necessarily need to take any of the suggested routes provided that he/she does take the booked trip (from A to B) in a “reasonable” time frame without exceeding a predefined mileage; SS will calculate the expected arrival time at destination (B) and mileage adding a security margin (extra riding time/mileage) to it: if the user exceeds this “reasonable” riding time/mileage (which is a misUse Case as clearly stated in the Terms of Service previously agreed with the customer) he/she will be penalized (charged fare will be higher). OBU retrieves booked trip information (origin – destination) from the SS and queries EV-Navigation software (provided by PTV) to obtain routes, distances and time. If the user has made a free-destination booking (refer to BCN_UC_06) routing information is not provided.
   - Current driving range (in Km). Driving range will be estimated based on current Level of Charge obtained from the Battery Management System – BMS
   - Ambient temperature (in ºC) obtained from the Battery Management System – BMS
   - Current Date-Time
   - Ridden kilometres = “0” before starting the booked trip. The SP will calculate the maximum number of kilometres the user can ride for the booked trip (plus estimated riding time, as stated above). The user will be clearly informed, before starting the trip, about the allowed mileage and riding time for the booked trip (on-trip, there will be no “countdown” timer shown on the OBU screen, as this would be too distracting, but the user will still know, before starting riding the electric scooter, that he/she must not exceed an agreed usage time/mileage; on the other hand, actual ridden kilometres against agreed maximum riding distance will

	indeed be shown on-trip on the screen) - Breakdown warning (if any). Blinking (on-trip) / Informative pop-up while scooter is stopped - Helmet lock indicator: “open” / “closed”; if “open” user cannot start riding the scooter. Note: the electric scooter will have a mechanism to fix the (shared) helmet to the e-scooter. The user can decide whether to use the shared helmet or his/her own. In any case, helmet lock mechanism must be safely fixed (closed) to start riding the e-scooter. - ON / OFF / READY indicator. “READY” meaning user has successfully checked-in the booked electric scooter; “OFF” meaning something is wrong and the scooter is not available (e.g. wrong reservation, some problem with the reservation); “ON” meaning user can start riding the electric scooter. Important to notice: the user does not interact with the OBU, i.e. the provision of information is from the OBU to the user only (not the other way around), and the user cannot request any other information or provide additional information to the system through the OBU (only way the user can interact with the sharing system is by means of his/her smartphone, web portal or call centre). The electric scooter is on and ready for riding.
Post-condition	The user starts riding the electric scooter. The parking slot is again available.
Exception path/Alternate Flow	- User gets too late at the location of the booked scooter → if the scooter is still present at the agreed location, the user will get a message at check-in asking to call the Electric scooter sharing service Call Centre. If the SP determines that using the electric scooter at that given moment is acceptable (e.g. this scooter has not been booked for another trip) user will be remotely enabled to do the check-in. If the scooter is no longer at the agreed location or SP does not allow riding it, user will be invited to make another “immediate spot trip booking” (refer to BCN_UC_04, user will be penalized for violating previously agreed Terms of Service). - Scooter issue: (booked electric scooter is not in the agreed location – time, Engine does not Start, Breakdown warning, problem at check-in, …): user communicates with the Electric scooter sharing service Call Centre, where an operator handles the incident. The operator will be able to deal with a number of scooter issues, e.g. find an

	alternative scooter and book it for the user. - WiFi communication is not enabled on the user smartphone → after user press the "ON/OFF" button on the scooter handlebar and the OBU attempts to synchronize with the user app (and the process fails after some unsuccessful attempts), the app will warn the user about this error and indicate WiFi must be activated. Whenever possible, application will automatically activate Bluetooth on the smartphone. - Helmet lock indicator: "open". User must try to lock the helmet mechanism. If this is not possible for whatever reason, the user will communicate with the Call Centre for instructions. - "OFF" indicator meaning something is wrong and the e-scooter is not available (e.g. wrong reservation, some problem with the reservation). User must communicate with the Call Centre and alternative e-scooter is booked (or taxi is sent to the user location).

Indicators		
Category	**Indicator name**	Brief Description
System	**Global Lateness**	Percentage of times the users came in late, with detail of alternative subsequent scenarios (user did not turn up, user could pick up the vehicle late, etc…)
System	**Arrival Time**	Time at which the user arrived for check-in, against reservation window.
User satisfaction - SLA	**System issues**	List and number of incidents where the user could not access the service as expected. Resolutions.

Table B-8: Use Case BCN_UC_07: e-scooter check-in

Use Case	**Code: BCN_UC_08**	**Title: Incentives management (dynamic pricing) for efficient fleet management**
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA – RACC	

Description	User receives alternative offer (cheaper than standard rate). He/she accepts to go with the proposed option.
Constraints	
Pre-condition	
Actors	Electric Scooter Sharing (SS) server, Scooter Driver
Services involved	EV-Sharing
Trigger	User is booking a trip / User receives information about vehicle location and id.
Basic path/Main Flow	Trigger 1: During booking 1. User logs into the Electric Scooter Sharing Service application 2. User searches for a trip: start point, end point, start date and time. 3. User gets proposal for this trip, and an alternative proposal comes along. This alternative proposal has a clearly cut down price, and clearly specifies in which way it is different from the original proposal (start point, end point, more…) 4. User chooses alternative proposal. Trigger 2: After booking has been completed 1. User receives information about the trip he/she has booked. An alternative offer comes along, for a competitive price. This offer specifies clearly in which way it differs from the original offer. 2. User chooses alternative offer. 3. He receives full details of vehicle id and location. The other booking is automatically cancelled (without fee).
Post-condition	User has booked the trip proposed by the SS.
Exception path/Alternate Flow	User is not interested in the offer. He/she can do the normal booking.

Indicators		
Category	**Indicator name**	**Brief Description**
System	Acceptance	Percentage of accepted incentivized proposals. Split up by type of proposal and by timing of the proposal (booking or vehicle assignment).

Table B-9: Use Case BCN_UC_08: Incentives management (dynamic pricing) for efficient fleet management

Use Case	Code: BCN_UC_09	Title: Cancellation / Modification of frequent trip(s)
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA – RACC	
Description	User interrupts frequent trips scheme for a limited period of time	
Constraints	There will be a maximum duration of the cancellation period (TBD). Charging policy for cancellation period to be defined.	
Pre-condition	User has at least one frequent trip Service contracted	
Actors	Scooter driver, SS server	
Services involved	EV-Sharing	
Trigger	User wants to cancel the service for a limited period of time (illness, vacation, etc.)	
Basic path/Main Flow	1. User connects and logs in the Electric Scooter Sharing Service website. 2. He/she selects a frequent trip that has been contracted. 3. He/she selects the permanent cancellation button OR He/she selects the temporary cancellation button and inserts the cancellation period (initial date + duration): cancellation conditions will be shown to the user 4. User confirms cancellation.	
Post-condition	WDM re-defines the planning for the scooter fleet taking this modification into account.	
Exception path/Alternate Flow		

Indicators		
Category	**Indicator name**	**Brief Description**

System	Nr. of cancellation of frequent trips	Number of events and mean duration.
System	Nr. of unexpected cancellations	Number of events when user does not alert on the cancellation in advance (he/she forgets).

Table B-10: Use Case BCN_UC_09: Cancellation / Modification of frequent trip(s)

Use Case	**Code: BCN_UC_10**	**Title: Cancellation / modification of spot trips**
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Marti Jofre & Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA - RACC	
Description	User cancels a previously booked trip. User needs to make some modification to a booking.	
Constraints	Cancellations free of charge must be done 24 hours before the trip starts. For modifications, the same concept applies.	
Pre-condition	User has booked a trip.	
Actors	Electric Scooter Sharing (SS) server, Scooter Driver	
Services involved	EV-Sharing	
Trigger	User will not be able to make the trip that was booked / User needs to make a change to the planned trip.	
Basic path/Main Flow	1. User connects to the Electric Scooter Sharing Service website/smartphone application. 2. He/she selects a spot trip that has been booked. 3. He/she selects the cancellation button: cancellation conditions will be shown to the user (if performed more than 24 hours previous to the trip, there will be no charge. In case there is less than 24 hours, and the assignment message has not been sent yet, the trip will be charged to the user, but no penalty will be applied. If vehicle has already been	

	assigned, some penalties may be considered) 4. User confirms cancellation. For changes in the spot trip bookings (user click "Modify trip"), the cancellation process of the current booking (after user has accepted the Modification conditions and these are feasible according to the Terms of Service) is coupled with the new reservation – the cancellation is confirmed only at the time the new booking is confirmed (as a transaction).
Post-condition	Trip is cancelled / modified
Exception path/Alternate Flow	After revising cancellation conditions, user decides not to cancel.

Indicators		
Category	**Indicator name**	**Brief Description**
System	Number of Cancellations	Number of cancellations compared to number of trips, with time range of cancellation (before 24 hours, after 24 hours, last minute).
System	Number of Cancellations by Service Centre	Number of cancellations that have been done following a user call.

Table B-11: Use Case BCN_UC_10: Cancellation / modification of spot trips

Use Case	Code: BCN_UC_11	Title: e-scooter riding
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Josep Laborda - ACASA – RACC	
Contributing Partners	Marti Jofre & Mikaël Baron - CREAFUTUR	
Description	The user rides the booked electric scooter (intermediate stops are possible without checking out); built-in datalogger (part of the Electric Scooter OBU) logs data every 1 second and transmits data packets every 2 minutes) to the SS database (WP4 indicators will be obtained out of this database).	
Constraints	The user can only use the electric scooter for the booked trip (fixed origin – destination) / riding time. If the user changes his/her mind during the trip, the scooter might run out of battery. In any case, violating the conditions of use, as clearly stated in the Terms of Service agreed upon registration (i.e. exceeding the allowed riding mileage for the booked trip) will result to an economic penalization. Of course, if the scooter runs out of battery for reasons beyond the user's responsibility he/she will not be penalized but compensated (e.g. with an extra discount on his/her next trip). The user smartphone is the key for using the booked scooter (check-in, intermediate stops - if any, check-out); smartphone should be available at all times.	
Pre-condition	User has successfully checked-in (booked electric scooter has been unlocked and engine has been started)	
Actors	Electric scooter; Scooter Driver; smartphone; Electric scooter OBU; Electric Scooter Sharing (SS) server	
Services involved	EV-Sharing	
Trigger	The user wants to ride the booked electric scooter	
Basic path/Main Flow	User rides the electric scooter normally. Intermediate stops procedure: - User stops the electric scooter and press the "ON/OFF" button on the handlebar (this is NOT a check-out process,	

	session is still active). - To re-start: • User press "ON/OFF" button on the scooter handlebar. • User press "Drive" button on the MOTITBCN app. • User again presses "ON/OFF" button on the scooter handlebar.
Post-condition	
Exception path/Alternate Flow	- Electric scooter runs out of battery; this situation might be the user's fault (user rides more kilometres than agreed) or could be an unexpected run-out of battery (due to technical problems), in this second case, the Electric scooter (open) sharing service operator will withdraw the scooter from the service and start maintenance tasks (battery replacement, in most cases). - Accident, User fined by police, etc contingency plan is activated as established by the Electric scooter (open) sharing service operator. - Smartphone runs out of battery: user communicates with the Call Centre (he/she will need to find another telephone, but only to talk with the service operator); operator will be able to remotely activate the scooter in case of intermediate stops / check-out process. There will be a process on the Call Centre side to verify that the caller is indeed the actual user and so he/she is allowed to use the scooter. - Datalogger fails. User is still allowed to ride the e-scooter. Some parameters will not be monitored / calculated (e.g. eco-driving report), but still most of the relevant parameters of the service will be assessed upon checking-out (like usage time, actual final destination, etc.) as this process is done by means of the smartphone app.

Indicators		
Category	**Indicator name**	**Brief Description**
	Speed – TimeStamp	Driving speed as logged (every 1 second) by the datalogger→ this data is stored at the SS database and eco-driving report (EV-efficient driving) is produced as feedback to the user
	Location –	GPS location coordinates (latitude –

	TimeStamp	longitude) as logged (every 1 second) by the datalogger, together with TimeStamp of each position message
	Riding time	Will be compared against maximum allowed riding time, if booking was trip-based (refer to BCN_UC_12: e-scooter check-out)
	Riding distance	Will be compared against maximum allowed riding distance, if booking was trip-based (refer to BCN_UC_12: e-scooter check-out)
	Level-of-Charge – TimeStamp	
	Cost difference between free destination trip and fixed destination trip	

Table B-12: Use Case BCN_UC_11: e-scooter riding

Use Case	**Code: BCN_UC_12**	**Title: e-scooter check-out**
Version	01	
CIP Project Id	smartCEM	
Pilot	BCN	
Author (Name/Organization)	Mikaël Baron - CREAFUTUR	
Contributing Partners	Josep Laborda - ACASA - RACC Marti Jofre - CREAFUTUR	
Description	On the street The user finishes his/her trip. He/she finds a place to park the electric scooter within a short range of agreed destination (allowed parking area around the agreed final destination will be clearly stated in the Terms of Service, and there will be a very flexible policy in this respect), and communicates this exact location during check-out.	
Constraints	The user can only check out at the location that has been agreed when booking the trip.	

Pre-condition	Trip has been done without problem. User has arrived at the destination of the trip.
Actors	Scooter driver, Electric Scooter OBU, Electric Scooter Sharing server.
Services involved	EV-sharing
Trigger	User wants to return the electric scooter (finish the trip).
Basic path/Main Flow	On the street 1. User arrives at destination 2. He/she finds a parking place to return the scooter 3. He/she stops the scooter engine ("ON/OFF" button) 4. He/she logs out from the scooter (by pressing "End Booking" button on the app). User will be prompted to confirm the exact location of the vehicle in case there is poor GPS coverage (app will allow the user to easily put a "pin" on a map indicating where exactly he/she is). The application connects to the Electric Scooter Sharing Server to complete the logout. **5.** Once logout is completed, the user receives a confirmation message on the app and the eco-driving report. Post-trip feedback can be received via the service web portal / smartphone app / Electric scooter OBU screen.
Post-condition	User has performed trip, and returned vehicle to the Sharing Service.
Exception path/Alternate Flow	- Electric Scooter is not able to connect to the Electric Scooter Sharing server (Note: this may only happen in open trips; all charging stations have good network coverage). User is still able to logout from the Scooter. He will have to connect to the phone network to finish the Check-Out process. - User has parked the vehicle incorrectly: any fine sent to the Electric scooter sharing service operator will be redirected to the user that is responsible for it. - User does not respect conditions (time, distance, end trip location). Penalties will be applied to the user not respecting the service conditions. User will be informed of infringement during the check-out process. In case of wrong location, he/she will be given the opportunity to resume his trip, and move to the correct place. - User does not perform check-out correctly. After some

	established time, any scooter that has been turned off and has not been used will be made available back to the Sharing Service.

Indicators		
Category	**Indicator name**	**Brief Description**
System	Incidents	Parking issues (fines, incorrect locations). Connection issues.
	Riding time	Time between check-in and check-out and processes. Figure will be compared against maximum allowed riding time, if booking was time-based or trip-based (refer to BCN_UC_12: e-scooter check-out)
	Riding distance	Mileage. Figure will be compared against maximum allowed riding distance, if booking was trip-based (refer to BCN_UC_12: e-scooter check-out)
	Level of Charge	Current LOC (on the Electric scooter OBU screen only)
	Extra charged fare	If Riding time or Riding distance exceeds the agreed Terms of Service, the user is informed about the extra cost of his/her trip.
	Eco-driving report (EV-efficient driving)	Including CO_2 savings and other information about user performance (relates to the Real-Time data recorded by the datalogger about acceleration / deceleration, energy consumption – LOC, etc.). This report is displayed on the smartphone app and web portal only.

Table B-13: Use Case BCN_UC_12: e-scooter check-out

Appendix C – Gipuzkoa use cases

Use Cases List

The following table summarises the use cases to be implemented at the Newcastle pilot site.

No. (UC Id)	Trip phase	Use Case name	Short Description
GIP_UC_01	Pre_Trip	eCarSharing registration	The user registers to an eCarsharing service
GIP_UC_02	Pre-Trip	eCarSharing booking	A user registered in an eCarsharing service books his Trip before driving an electric car.
GIP_UC_03	Pre-Trip	Multimodal transport planning	A user that plans a trip combining public transport and car sharing services.
GIP_UC_04	Pre-Trip	Web/android application booking modification	The user makes reservation modification/cancellation via web or cancellation vía android application.
GIP_UC_05	On-Trip	Multimodal Travelling	A user that makes a trip combining public transport and car sharing services. Uses the same user card.
GIP_UC_06	On-Trip	Start eCarSharing	Car driver is starting his eCarsharing session
GIP_UC_07	On-Trip	eCarsharing driving	Car driver is driving using the eCarsharing service
GIP_UC_08	On-Trip	On-Board booking modification	Car driver modifies via OBU the booking parameters while on-trip
GIP_UC_09	On-Trip	Finish eCarsharing	Car driver is finishing the car-sharing session

GIP_UC_10	Post-trip	eCarSharing data analysis	After eCarSharing trip is finished all the booking/ monitoring data stored during the trip is analyzed.
GIP_UC_11	Pre-trip	Bus route pre-learning	Bus driver driving in a certain route in order to teach the efficient driving service.
GIP_UC_12	Pre-trip	Bus driver working shift start	Bus driver carries out the necessary tasks in order to start his working shift.
GIP_UC_13	On-Trip	Hybrid-bus driving	Bus driver is covering his working shift driving in the bus line assigned with the EV-Efficient Driving Service activated.
GIP_UC_14	Post-trip	Bus working shift data analysis	Downloaddata gathered during the bus working shift, process it and analyse It with the webtool (iPanel)

Table C-1: Use cases list for Gip PS

Use Cases Description

The following tables provide a detailed description of each UC.

Use Case	**Code: GIP_UC_01**	**Title: eCarSharing registration**
Version	02	
CIP Project ID	smartCEM	
Pilot	GIP	
Autor [Name/Organization]	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	Process to become a registered eCarsharing user, carried out on the car-sharing service operator front office web site.	
Constraints	The potential user needs to have a bank account, driving license, and at least, one year of driving experience in order to become an eCarsharing user. If any of the potential user's personal data is not correct, he or she cannot become an	

	eCarsharing user.
Pre-condition	It is required internet connection to access to the registration web
Actors	Car driver, eCarsharing Operator, eCarsharing server, Web application, PC/laptop, RFID smart card.
Service Involved	EV-Sharing Management
Trigger	-
Basic path/Main Flow	***1***. The potential user accesses to the car-sharing service operator web site, where the user is able to start the registration process. ***2***. User goes to "registration". ***3***. Next, he/she introduces his/her personal data, such as name, surname, birth date, e-mail, address, number of years with driving license. 4. Once the information is input, it is stored in the eCarsharing server Data Base and a warning is sent to the eCarsharing operator. During this process, the ID of the RFID smart card is assigned to the user information. The eCarsharing operator checks the information provided by the potential user via "registration". ***5***. If everything is correct, the potential user becomes an eCarsharing user: ***a***. A unique ID is given to each eCarsharing user. This ID is an indispensable requirement to book an eCarsharing vehicle. ***b***. and the identification card or RFID smart card is sent to the given address by post
Post Condition	The user has his ID number and receives the RFID smart card at his/her home address.
Exception path/ Alternate Flow	If the user does not receive the assigned card at home in two weeks maximum, i.e. if RFID smart card is lost during this process a new one is sent. In order to start this process,

	the eCarsharing user must ask for a new card. Currently, the sharing service that takes part in smartCEM asks the users to be present in the service office to complete the registration, as they ask to sign some paperwork and also to receive a specific amount of money from the end user, as a deposit.

Table C-2: Use_Case_GIP_UC_01: eCarsharing registration

Use Case	**Code: GIP_UC_02**	**Title: eCarSharing booking**
Version	02	
CIP Project ID	smartCEM	
Pilot	GIP	
Autor [Name/Organization]	6 Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	Process to book an eCarsharing vehicle to drive (round way trip).	
Constraints	The user needs to be already registered to the eCarSharing service.	
Pre-condition	An already eCarsharing service registered user, wants to book a trip using an electric car. This user must have an ID and the corresponding RFID smart card.	
Actors	Car driver, eCarsharing server, EV Car (OBU), android smartphone/tablet application, web application, PC/laptop, RFID smart card.	
Service Involved	EV-Sharing Management	
Trigger	-	

Basic path/Main Flow	1. The user accesses to the booking site login as a service client either using the web application or the android smartphone/tablet application. 2. The registered driver introduces desired parameters for booking in the system. This will include at least the following parameters: User ID, trip date and time, km amount to travel and place for the start and end (same base station, as just round trips are accepted). 3. The system offers to the end user a set of available vehicles for the defined booking parameters. Information contained in eCarsharing options will include at least the following parameters: *a*. Trip start time, end time, km amount, location (CS location), vehicle (electric car). 4. The user selects one of the options given by the system. 5. Once the option is selected, the system: *a*. Sends the EV Car (OBU) the user ID (given by RFID smart card) and period of time when he or she is authorized to access the electric car, i.e. time start and end of booking. *b*. Confirms the user his booking.	
Post Condition	The user for the eCarsharing trip has the confirmation of his booking, being informed where his electric car is parked, in order to cover his booking request.	
Exception path/ Alternate Flow	If no vehicles were available for the searching parameters, the user can change those searching parameters or skip the booking process.	
Indicators		
Category	Indicator Name	Brief Description

Table C-3: Use_Case_GIP_UC_02: eCarSharing booking

Use Case	Code: GIP_UC_03	Title: Multimodal transport planning
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar(ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	Process to plan a trip combining EV-Sharing service and public transport	
Constraints	Data availability from global transport server, at current time of writing, is not available but in counterpart road public transport, such as bus, data is available in order to cover a multimodal trip, i.e. public transport server.	
Pre-condition	An already registered in a car-sharing service user, wants to plan a trip using a combination of travelling in public transport (f.e. Hybrid/combustion buses) and driving an electric car.	
Actors	Car driver, Traveller, trip planner server, eCarsharing server, Public Transport server, Global Transport server, CS server, web application, android application, smartphone/tablet or PC/laptop	
Services involved	EV-Sharing Management, EV-Trip Management	
Trigger	PLUSERVICE	
Basic path/Main Flow	1. The trip planner server is continuously updated with information coming from the Public Transport server (e.g.: bus time schedules, delays …), schedule (timing availability) and, Global Transport server information. 2. The traveller has two different multimodal transport planning platforms to plan his trip, via web application or using the android smartphone/tablet application 3. Using any of the platforms, the traveller sets a bunch of parameters to filter his search like departure and destination points, the maximum distance walking, the time in which he/she will start the trip and if EV-Sharing usage needs to be included or not in the solutions. 4. The system generates a set of multimodal trip options including combinations of electric car and hybrid/conventional bus. Information contained in	

	multimodal trip options will include at least the following parameters: – Multimodal trip start time, end time, locations (CS location/bus line-stop), vehicle (electric car/hybrid or conventional bus) 5. The user selects one of the options given by the system 6. Once the trip is selected, the system: – Shows the summary of the proposed trip, and the route printed over a map, highlighting the main spots. – In case an EV-Sharing solution is raised, gives links to access the corresponding car-sharing booking platforms.
Post-condition	After the trip planning, the user for the multimodal trip has to access to the car-sharing booking platforms in order to make a reservation.
Exception path/Alternate Flow	Given the continuous data monitored from the different servers and the desired parameters from the user, two scenarios can occur when generating the multimodal trip: – The trip perfectly matches the user preferences (in time, vehicle and location) – Some of the preferences of the trip are changed (wider time ranges etc.).

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-4: Use Case GIP_UC_03: Multimodal transport booking

Use Case	**Code: GIP_UC_04**	**Title: Web/android application booking modification**
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	

(Name/Organization)	
Contributing Partners	
Description	In this Use Case the user can modify his booking. He/she can select a new vehicle, a different date and time range, etc. as the new booking parameters. It is also possible to cancel the booking. The EV-Sharing web application permits both booking modification and cancellation, while the android application just permits booking cancellation.
Constraints	This process will only be allowed by the system in case the modification does not affect a following user or reservation.
Pre-condition	The EV-car is already booked
Actors	Car driver, Traveller, eCarsharing server, EV- Sharing web or android application and smartphone/tablet or PC/laptop.
Services involved	EV-Sharing
Trigger	
Basic path/Main Flow	VÍA WEB APPLICATION 1. The user accesses using the credentials to his/her client web site in the EV-Sharing service and goes to the "Reservations" page, where future reservations are shown. 2. Each of them can be cancelled or modified. 3. If modification is selected the vehicle availability searching screen is opened. Here new searches will be done by the user in order to change booking parameters (vehicle, date-time, km amount, etc.) VÍA ANDROID SMARTPHONE/TABLET APPLICATION 4. The user needs to login with his/her credentials. 5. Accesses to the "Next bookings" screen. 6. Each of the future bookings has the cancellation option attached.
Post-condition	The booking will be modified or cancelled. If a modification is executed a new prize will be assigned to the booking. All the changes will be processed in the eCarsharing server.
Exception path/Alternate Flow	none

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-5: Use Case GIP_UC_04: Web/android application booking modification

Use Case	**Code: GIP_UC_05**	**Title: Multimodal Travelling**
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	PLUSERVICE	
Description	The multimodal traveller reaches the BUS stop defined in the Trip Planner to catch the pre-specified line. He/She will leave the BUS in the stop suggested by the Planner in order to have a short walking distance to the CS where the booked vehicle will be picked up by the user.	
Constraints	Normally the multimodal trip will be planned in a the specific order in which, first of all, the traveller needs to pick up public transport to reach afterwards the booked EV (An EV permits the end-user travelling to almost any place, more flexible than public transport to reach destination).	
Pre-condition	The driver has planned the trip and booked the EV. He/she needs to have the EV-Sharing and the driving license on. Having the bus ticket or the public transport card (RFID card used for public transport usage and payment) on could also make faster the transport changes, because if not, the payments for the BUS need to be done on-board.	
Actors	Traveller, eCarsharing server, trip planner server, Public Transport server, Global Transport server, CS server, EV Car (OBU), CS, trip planner web/android application and smartphone/tablet.	
Services involved	EV-Sharing, EV-Navigation, EV-Trip planning and EV-charging station management	
Trigger		

Basic path/Main Flow	1. The user uses the smartphone to check the arrival times of the bus line and waits for the next bus. 2. Drops in the bus. The user could also check for the stop to drop off, which is specified for the next step of the trip. 3. He drops off the bus in the stop and walks to the CS where he has an already booked EV. 4. He reaches the EV, opens it with the RFID card, and drives safe. (For the current EV-Sharing services taking part in smartCEM, vehicle is not plugged and unplugged by the user. This task is completed by the service operator every day. Charging is completed during the night, when no service is available) 5. After completing the trip with the EV, he/she returns the vehicle to the same (starting) CS. The CS Management application linked to the EV-Navigation system can be used to have the proper indications to come back to the starting CS. CS Management application also permits user to obtain indication to any of the public CS, linking with the EV-Navigation application. 6. If needed, the user can check again available buses to plan the way back to the departure point or any other spot, using the Trip Planner.
Post-condition	The EV needs to be parked in the starting CS, as just round trip services are provided.
Exception path/Alternate Flow	Having just round trip services available for EV-Sharing, it might happen that the EV usage is not the best choice for the trip plan. That is why the system permits enabling or disabling EV-Solutions when planning a combined trip with the Trip Planner applications.

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-6: Use Case GIP_UC_05: Multimodal travelling

Use Case	**Code: GIP_UC_06**	**Title: Start eCarsharing**
Version	02	
CIP Project Id	smartCEM	

Pilot	GIP
Author (Name/Organizsation)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)
Contributing Partners	
Description	The car driver, who has booked the EV previously, has to head the parking where it is located. To open the assigned car, the user will have to place the RFID card through the reader placed in the front card windshield. The information contained on the RFID card, allows the vehicle to identify the driver and opens its doors. Finally, driver starts his trip.
Constraints	The user will only be allowed to get the assigned car, not any other. The car will only be accessible by use of the RFID card; if lost, the user will need to ask for a new one.
Pre-condition	The EV car is booked
Actors	Car driver, eCarsharing server, EV Car (OBU)
Services involved	EV-sharing
Trigger	
Basic path/Main Flow	1. The user will have to place the RFID card through the reader located in the windshield I order to unlock the car doors. (For the current EV-Sharing services taking part in smartCEM, vehicle is not plugged and unplugged by the user. This task is completed by the service operator every day. Charging is completed during the night, when no service is available) 2. Grab the car keys placed in the globe compartment 3. Turn on the car and drive safe.
Post-condition	The driver starts his trip.
Exception path/Alternate Flow	In case the assigned car is not parked in its location - when the booking is due to start because the previous driver is late - the user will have to call the call centre so a substitution EV is provided to him.

Indicators		
Category	**Indicator name**	**Brief Description**

Table 7: Use Case GIP_UC_06: Start eCarsharing

Use Case	Code: GIP_UC_07	Title: eCarsharing driving
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	PTV, TEAMNET	
Description	In this Use Case, car driver drives the EV sharing, following the information provided by the EV-Navigation service. Also the CS Management application is available in order to link CS spots to the navigation system as destinations.	
Constraints	It will not be possible to drive far away from the electric range unless the car is hybrid or an intermediate fast charge is available.	
Pre-condition	The driver booked the EV, and checks in.	
Actors	Car driver, eCarsharing server, CS Server, EV-Navigation Server, on board smartphone/tablet	
Services involved	EV-sharing, EV-charging station management and EV-Navigation	
Trigger		
Basic path/Main Flow	1. First of all the EV Car (OBU) will ask the driver whether the car status is ok. If this is not the case, the driver should point out the defect so he is not charged for it. 2. Next, the EV Car (OBU) will remind the driver the conditions of the booking (time and kilometres) 3. While driving, the driver will be able to search for an intermediate CS. For this purpose, a map will be shown at the display with the nearest CS. 4. The CS Management application allows the end user to select the destination CS. Once this is selected, the CS Manager application allows the user to tap a button, which will launch the EV Navigation application, with the destination set to the chosen CS	
Post-condition	The driver should leave the EV at the appropriate parking place or at the starting CS if the trip is finished and the vehicle needs to be returned.	
Exception path/Alternate Flow	The driver could just drive straight without using any service described above, just like a normal car taking into account the electric range in case the car is fully electric.	

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-8: Use Case GIP_UC_07: eCarsharing driving

Use Case	**Code: GIP_UC_08**	**Title: On Board booking modification**
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners		
Description	In this Use Case the user can modify his booking to extend it in time.	
Constraints	This will only be allowed by the system in case the modification does not affect a following user.	
Pre-condition	The EV-car is already booked and the user has already picked up the vehicle during the booking period.	
Actors	Car driver, Traveller, eCarsharing server, EV Car (OBU)	
Services involved	EV-Sharing	
Trigger		
Basic path/Main Flow	1. User selects “booking modification” in the EV Car (OBU) menu. 2. For time extension: a. Set a new end time b. Request modification c. If allowed a confirmation message will be displayed	
Post-condition	The booking will be modified and a new price could be assigned.	
Exception path/Alternate Flow	none	

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-9: Use Case GIP_UC_08: On Board Booking modification

Use Case	**Code: GIP_UC_09**	**Title: Finish eCarsharing**
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners		
Description	In this phase the user will end the use of the eCarsharing vehicle	
Constraints	As the booking is defined as “round trip” the user should drop the EV off in the very same car park it has been taken.	
Pre-condition	The driver has finished his trip	
Actors	Car driver, eCarsharing server, EV Car (OBU), CS	
Services involved	EV-Sharing	
Trigger		
Basic path/Main Flow	1. Park the car in the assigned car park equipped with a CS. 2. Select “check out” in the EV Car (OBU) 3. Place the car keys in the glove compartment 4. Close the car doors and place the card through the RFID reader in the windshield so as to lock the EV down.	
Post-condition	The EV is safely parked at the assigned CS and it is available for the next user. At the end of the day, the sharing service operator will plug the vehicles to the CS, for night time charging.	
Exception path/Alternate Flow	none	

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-10: Use Case GIP_UC_09: Finish eCarsharing

Use Case	**Code: GIP_UC_10**	**Title: eCarsharing Data analysis**
Version	02	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Oier Iribar (ENNERA), M. Larburu and A.Urquiza (TECN)	
Contributing Partners		
Description	Any interaction with the fleet is reported to the server where it is stored and processed. This describes this data analysis.	
Constraints	Only the reported information could be analysed.	
Pre-condition	The logged data is available	
Actors	Car-sharing operator and eCarsharing server	
Services involved	EV-sharing	
Trigger		
Basic path/Main Flow	1. Any interaction with an OBU (card reading, plugging, unplugging, etc) is logged and transmitted to the server via 3G. 2. This data arrives to its Car-Sharing server and is appropriately stored 3. At the time the Car-Sharing operator decides to perform any kind of analysis of the Car-Sharing/fleet, he/she will open an online back-office developed for this purpose and it will gather the necessary and requested information from the different Car-Sharing servers “via web services”. 4. Once the analysis is done, the operator could print or download the results.	

Post-condition	The historic data will not be modified.	
Exception path/Alternate Flow	none	
Indicators		
Category	**Indicator name**	**Brief Description**

Table C-11: Use Case GIP_UC_10: eCarsharing data analysis

Use Case	**Code: GIP_UC_11**	**Title: Bus route pre-learning**
Version	01	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Eduardo González (DBUS), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	Process to learn the route in order to calibrate the efficient driving service. This is possible as the bus line is a fixed route. During the driving the Bus (OBU) will be collecting bus in-vehicle data such as axle accelerations or steering wheel positions in order to learn the bus line profile.	
Constraints	This Use Case should be done for each of the routes the hybrid bus is travelling along. There is four of them (lines 17, 21, 26 and 40).	
Pre-condition	The Bus (OBU) is configured to acquire and log all necessary data in order to calibrate the efficient driving service with the route profile.	
Actors	Bus driver, Bus (OBU)	
Services involved	EV-Efficient Driving	
Trigger		
Basic path/Main Flow	1. The bus driver starts the bus and drives along the route specified. 2. While driving along the route, bus (OBU) is acquiring and	

	logging specific in-vehicle data, at least acceleration, deceleration, steering wheel position and derived axle acceleration, in order to define the route profile. This is done until the bus reaches the end of the route. 3. Later in the project it will be defined how many times this run should be done in order to obtain a reliable route profile model. It is assumed that depending on the bus line this number may change. 4. Once the number of runs is finished, the bus reaches the depot and all logged data is downloaded manually in the PT in order to make the necessary calculations so as to calibrate the efficient driving service for that certain line.
Post-condition	The specific lines where the hybrid bus is going to drive have been learnt and ready to be used by the efficient driving service.
Exception path/Alternate Flow	The driver model is not correct or corrupted, then the pre-learning runs should be done over again.

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-12: Use Case GIP_UC_11: Bus route pre-learning

Use Case	**Code: GIP_UC_12**	**Title: Bus driver working shift start**
Version	01	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Eduardo González (DBUS), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	Process to be carried out by the bus driver in order to start his working shift, i.e. .list of tasks he needs to do before leaving depot.	
Constraints	The bus and plan for a certain driver should be ready 3 hours ahead of schedule.	

Pre-condition	There is a schedule planned by the PT server for the bus driver at the depot.
Actors	Bus driver, Bus (OBU), Bus central (OBU), Ticketing machine, PT server.
Services involved	EV-Efficient Driving
Trigger	
Basic path/Main Flow	1. Prior to getting on the bus, the bus driver is given (by the inspector) his plan for his working shift, including bus line, schedule, bus number, pick and drop times. 2. Once inside the bus, the driver types in his ID in the ticketing machine. As soon as this is done PT server couples ID driver with bus and schedule (meaning bus line and timing). 3. Driver starts the engine and leaves depot
Post-condition	PT server knows that a certain bus has left depot in order to cover a certain by an ID bus driver. Bus central has a WiFi that allows this information flow.
Exception path/Alternate Flow	There is a problem with WiFi connections and all communications with the bus are lost. The driver is immediately contacted by PT operator and asked to come back to depot.

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-13: Use Case GIP_UC_12: Bus driver working shift start

Use Case	**Code: GIP_UC_13**	**Title: Hybrid bus driving**
Version	01	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Eduardo González (DBUS), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	

Description	The bus driver drives along the bus line he has been assigned, stopping at the bus stops demanded by the travellers, making sure he is driving safe and efficiently and everything is going well in his bus and trip.
Constraints	Cannot think of any
Pre-condition	The bus driver has already left depot and is driving in this assigned lane
Actors	Bus driver, Bus (OBU), Bus central (OBU), PT operator, PT server.
Services involved	EV-Efficient Driving
Trigger	
Basic path/Main Flow	1. The bus driver is normally driving his bus following his schedule, making the necessary laps within the assigned bus line: a. For the efficient driving service, the bus (OBU) is continuously acquiring and logging in-vehicle data, at least the following: speed, fuel consumption, acceleration, deceleration, comparing them to the model (learnt in UC11). In case of deviation, the Bus (OBU) will assist the driver so he/she can react and try to change his driving behaviour into a more efficient one. The different axle accelerations will also be monitored by the Bus (OBU) so the driver can enhance the traveller comfort by again changing his driver behaviour. b. The bus (OBU) is also acquiring and logging in-vehicle data continuously at least the following: engine temperature and Ucaps state, comparing them to normal functioning. If there is an anomaly the bus driver is automatically informed and can report to the PT Operator using the voice device. 2. Once his working shift has come to an end, the bus driver enters depot and drives bus either to his parking lot or cleaning and refuelling station. Depending on the number of buses queued at the refuelling station. 3. At the parking lot, maintenance people at depot will download Bus and Bus central (OBU) data for post-trip analysis (refer to GIP_UC_14)
Post-condition	Bus driver has finished his working shift, bus is properly parked in his place and all registered data during trip by Bus (OBU) and Bus Central (OBU) is properly downloaded in PT server

Exception path/Alternate Flow	1. The bus driver takes wrong turn and missed line (human error). Bus central (OBU) is continuously transmitting its position and bus ID at each bus stop in order to track the bus at all times. If PT operator detects that the bus is out of its line immediately contacts the bus driver (voice device) and tells him/her its way back to the line. There is also the possibility to have inside video in order to detect any incidence/ vandalism. All data logged in this case will be disregarded for post-trip analysis. 2. Bus central (OBU) is not transmitting properly the bus' position and ID at each bus stop in order to track the bus at all times. PT operator immediately contacts the bus driver (voice device) in order to find out anomaly. All data logged in this case will be disregarded for post-trip analysis. 3. Bus central (OBU) is transmitting properly the bus' position and ID at each bus stop in order to track the bus at all times. PT operator detects delays according to schedule and contacts the city traffic light management centre so as to allow green wave for that bus in that particular line. This process is transparent to the driver.

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-14: Use Case GIP_UC_13: Hybrid bus driving

Use Case	**Code: GIP_UC_14**	**Title: Bus working shift data analysis**
Version	01	
CIP Project Id	smartCEM	
Pilot	GIP	
Author (Name/Organization)	Eduardo González (DBUS), M. Larburu and A.Urquiza (TECN)	
Contributing Partners	None	
Description	The bus working shift data analysis is properly arranged for post-trip analysis. PT Operator is interested on having on a monthly basis: fuel consumption and km. driven comparison between combustion and hybrid buses.	

Constraints	Data logged is corrupted
Pre-condition	The Bus and Bus Central (OBU) logged data is properly downloaded at the PT server.
Actors	PT operator, PT server.
Services involved	EV-Efficient Driving
Trigger	
Basic path/Main Flow	On daily basis, PT Operator carries out the following post-trip data analysis **1.** the Bus (OBU) downloaded data is introduced in the program comparing the hybrid and combustion performance (fuel consumption and km. driven).This analysis also includes maintenance (UCAPs) **2.** the Bus central (OBU) downloaded data is introduced in the program comparing the hybrid and combustion performance (delays and communication failures)
Post-condition	Comparison on a monthly basis on fuel consumption and km driven for combustion and hybrid buses.
Exception path/Alternate Flow	Not applicable

Indicators		
Category	**Indicator name**	**Brief Description**

Table C-15: Use Case GIP_UC_14: Bus working shift data analysis

Appendix D – Newcastle use cases

Use Cases List

The following table summarises the use cases to be implemented at the Newcastle pilot site.

No.(UC Id)	Trip phase	Use Case name	Short Description
NEW_UC_01	Any	Charging Station Management APP Access	All the steps needed for a user to obtain access to the CS Management Application (APP)
NEW_UC_02	On-trip	CS Access by RFID	A registered user (which is paying a periodic subscription fee) uses an RFID to access the CS and charge his EV
NEW_UC_03	On-trip	CS Access by IVR	An anonymous user calls by phone and navigates an audio menu in order to access the CS and charge his EV
NEW_UC_04	On-trip	CS Access by SMS	An anonymous user sends an SMS in order to access the CS and charge his EV
NEW_UC_05	On-trip	Charging Initiation	All steps performed when the charging starts
NEW_UC_06	On-trip	Charging Conclusion	All steps performed when the charging concludes
NEW_UC_07	Any	CS Search	All steps performed when the user has to find a suitable CS
NEW_UC_08	Any	CS State-Change Notification	The APP can notify users when the CS that they intend to use (or already using) is changing state
NEW_UC_09	n/a	CS Status Polling	The BO is polling the current status of all CSs

NEW_UC_10	Any	CS Status Visualization	All steps performed when the user wants to see status details of a specific CS
NEW_UC_11	On-trip	Efficient Driving	Real-time recommendation for improving EV driving efficiency, and offline data analysis for later review of driving style efficiency.
NEW_UC_12	Pre-trip/ On-trip	Intention of Charging	Users may express interest in using a certain CS. This is used by the BO to estimate occupancy and notify users on the status of their CS of interest.
NEW_UC_13	Pre-trip/ On-trip	User Validation	BO must validate the user before granting him access to the CS
NEW_UC_14	Pre-trip/ On-trip	Integration with EV-Navigation	In order to make the APP available on-trip, CS management functions are tightly integrated with Navigation functions, all running on the OBU, during the trip.

Table D-1: List of Use Cases for Newcastle Pilot Site

Use Cases Description

The following tables provide a detailed description of each UC.

Use Case	**Code NEW_UC_01**	**CS Management APP Access**
Version	01	
CIP Project Id	smartCEM	
Pilot	NEW	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	

Contributing Partners	Gabriela Trandafir – TeamNet International
Description	Accessing the smart phone application for EV-Charging Station
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office
Pre-condition	
Actors	The driver, the CYC smartphone application, helpdesk operator
Services involved	EV-charging station management
Trigger	The driver wants to check the availability of the charging station
Basic path/Main Flow	1. The driver visits Charge Your Car website using a computer. [1.a], [1.b] 2. The user clicks on the link to the charge post application
Post-condition	The charge station application is launched.
Exception path/Alternate Flow	[1.a] The driver is unable to use a computer, but has access to a Smartphone with Internet connection. 1.a.1. The driver visits the website for mobile services. 1.a.2. The driver downloads the Smartphone application. 1.a.3. The driver starts the Smartphone application. [1.b] The driver is unable to use a computer or a Smartphone with Internet connection, but he is using a regular telephone. 1.b.1. The driver calls the helpdesk. 1.b.2. If it is within the working hours, the operator will open the charge post application and use it for the driver. If the call is made outside working hours, the driver will receive an out-of-the-office message, indicating a 24/7 help desk for technical problems.

Table D-2: Use Case NEW_UC_01 CS management app access

Use Case	**Code NEW_UC_02**	**CS Access by RFID**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author	Dorin Palanciuc – TeamNet International and Alexandra Prescott	

(Name/Organization)	- CYC Gateshead College
Contributing Partners	Gabriela Trandafir – TeamNet International
Description	The EV driver wishes to charge his/her car using an RFID
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office
Pre-condition	The EV driver must have an RFID
Actors	The driver, the charging station, RFID, back-office application
Services involved	EV-charging station management
Trigger	The driver wishes to charge his/her car
Basic path/Main Flow	1. The driver swipes the RFID on the charge post 2. The charge post sends the RFID code to the back-office application 3. The RFID is recognized by the back-office application [3.a] 4. The back-office application commands the charge post to continue 5. The charge post displays the user interface 6. The driver selects the appropriate socket 7. The driver selects the authorization and payment method 8. The user is validated (Use case NEW_UC_13) [8.a] 9. The back-office application unlocks the charge station 10. The charging can start (Use Case NEW_UC_05: Charging initiation)
Post-condition	The charging is initialized
Exception path/Alternate Flow	[3.a] The RFID is not recognized by the back-office application and the process is ended without completing. [8.a] The user is not recognized by the back-office application and the process is ended without completing.

Table D-3 Use Case NEW_UC_02 CS access by RFID

Use Case	Code NEW_UC_03	CS Access by IVR
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	
Contributing Partners	Gabriela Trandafir – TeamNet International	
Description	The EV driver wishes to charge his/her car using IVR	
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office	
Pre-condition		
Actors	The driver, the charging station, IVR, back-office application	
Services involved	EV-charging station management	
Trigger	The driver wishes to charge his/her car	
Basic path/Main Flow	1. The driver calls the IVR number 2. IVR obtains from the driver the payment data and the charge point identification. 3. User is validated. (Use case NEW_UC_13) [3.a] 4. The back-office application unlocks the charge point 5. The charging is initialized. (Use Case NEW_UC_05: Charging initiation)	
Post-condition	The charging is initialized	
Exception path/Alternate Flow	[3.a] The user is not recognized by the back-office application and the process is ended without completing.	

Table D-4 Use Case NEW_UC_03 CS access via IVR

Use Case	Code NEW_UC_04	CS Access by SMS
Version	01	
CIP Project Id	smartCEM	

Pilot	Newcastle
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College
Contributing Partners	Gabriela Trandafir – TeamNet International
Description	The EV driver wishes to charge his/her car using an SMS
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office The driver must have a mobile phone able to send SMS The driver's phone number must be registered to Charge Your Car The SMS must contain the code of the charge station
Pre-condition	The driver, the charging station, SMS-enabled phone, back-office application
Actors	The driver, the back-office, the charging station, the mobile phone
Services involved	EV-charging station management
Trigger	The driver wishes to charge his/her car
Basic path/Main Flow	1. The driver sends an SMS using the mobile phone. (the SMS must contain the code of the charge point) 2. The Back-office identifies the user by the phone number 3. The Back-office identifies the charge station by the code 4. The Back-office unlocks the charge station. 5. The charging process starts. (Use Case NEW_UC_05: Charging initiation)
Post-condition	The charging is initialized
Exception path/Alternate Flow	

Table D-5 Use Case NEW_UC_04 CS access by SMS

Use Case	**Code NEW_UC_05**	**Charging Initiation**
Version	01	
CIP Project Id	smartCEM	

Pilot	Newcastle
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College
Contributing Partners	Gabriela Trandafir – TeamNet International
Description	The EV-charging process
Constraints	The cable cannot be removed during the charging process
Pre-condition	The EV is working properly The CS has the correct socket The driver has the correct cable
Actors	The driver, the EV, the charging station
Services involved	EV-charging station management
Trigger	The vehicle needs a top up / full charge
Basic path/Main Flow	1. The driver unlocks the charging station (Use Case NEW_UC_02 - Use Case NEW_UC_02) 2. The driver plugs in the cable 3. The driver sets in the "Start charging" command 4. The charge station locks the cable 5. The charging starts.
Post-condition	At the end of the session the car has been charged. Power has been consumed by the vehicle, the back-office is able to identify that a charge has taken place and how much power has been consumed over what period of time (date, etc.)
Exception path/Alternate Flow	

Table D-6 Use Case NEW_UC_05 charging initiation

Use Case	**Code NEW_UC_06**	**Charging Conclusion**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author	Dorin Palanciuc – TeamNet International and Alexandra Prescott	

(Name/Organization)	- CYC Gateshead College
Contributing Partners	Gabriela Trandafir – TeamNet International
Description	After the charging process is ended, the status of the charge station is updated
Constraints	
Pre-condition	The EV is charging in a charging station
Actors	The driver, the back-office, the charging station, the EV
Services involved	CS Back-Office, EV-charging station management
Trigger	The EV is recharged
Basic path/Main Flow	1. The driver issues the command to interrupt the charging process 2. The charging station unlocks the cable 3. The charging station signals to the back-office application that the charging process is concluded 4. The back-office application notifies the driver that the charging process is completed, including information regarding the time and the cost of the charge 5. The back-office application updates the status of the charge station in the database. (Use Case NEW_UC_08: Charging station state-change notification)
Post-condition	The status of the charging station is updated
Exception path/Alternate Flow	

Table D-7 Use Case NEW_UC_06 charging conclusion

Use Case	**Code** **NEW_UC_07**	**CS Search**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	

Contributing Partners	Gabriela Trandafir – TeamNet International
Description	Checking if a charge post is working / in use
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office
Pre-condition	
Actors	The driver, the back-office, web interface
Services involved	CS Back-Office, EV-charging station management
Trigger	The driver wishes to locate an available, fully functioning charge point
Basic path/Main Flow	1. The driver is accessing the charging station application (Use Case NEW_UC_01) 2. The driver selects the "search" function from the application 3. The application displays the available search criteria (geographical area, address, status of CS, time period) 4. The driver enters the desired search results 5. The charging station application performs the search using the back-office application 6. The back-office application sends the search results to the charging station application 7. The charging station application displays the results to the driver
Post-condition	The driver is seeing the charging station information
Exception path/Alternate Flow	

Table D-8 Use Case NEW_UC_07 CS search

Use Case	**Code NEW_UC_08**	**CS State-Change Notification**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	

Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College
Contributing Partners	Gabriela Trandafir – TeamNet International
Description	Back office updates the status of the charge point, notifies the next driver
Constraints	Only available in mobile application (see Use Case NEW_UC_01: Charge post application access)
Pre-condition	The driver must have a smart phone with Internet connection
Actors	The back-office application, the charge station mobile application, the driver
Services involved	EV-charging station management
Trigger	Use Case NEW_UC_06: Charging conclusion
Basic path/Main Flow	1. The back-office application sends a message on the CS's display that the charging process is completed and that the CS can be freed [1.a] 2. The driver frees the CS 3. The back-office application updates the status of the CS and notifies the next driver in the intention queue that the CS is free
Post-condition	Next driver knows the charge point status
Exception path/Alternate Flow	[1.a] The message sent by the back-office application is that the charging process just started 1.a.1 The back-office application notifies the next driver in the intention queue that the CS is occupied 1.a.2 The charge station application helps the next driver in the intention queue to find another free charge station. (Use Case NEW_UC_07: Charging Station search)

Table D-9 Use Case NEW_UC_08 CS state-change notification

Use Case	**Code NEW_UC_09**	**CS Status Polling**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	

Contributing Partners	Gabriela Trandafir – TeamNet International
Description	The back-office application is periodically asking for a status update from all charge stations in the network
Constraints	
Pre-condition	
Actors	The back-office application, the charge station, back-office database
Services involved	EV-charging station management, back-office application
Trigger	Polling timeout expires
Basic path/Main Flow	1. Polling timeout expires 2. The back-office application picks up the first charge station from the "timeout" list 3. The back-office application requests status update from the charge station (Use Case NEW_UC_08) 4. The charge station replies with a predefined message to the back-office application [4.a] 5. The back-office application updates the status of the charge station based on the message received 6. The back-office application continues with step 2 of the Use Case until all CS's are polled 7. After all CS's are polled, the back-office application awaits the specified timeout and moves to step 1 of the Use Case
Post-condition	All charging stations are polled and the timeout expires
Exception path/Alternate Flow	[4.a] No status update is received from the charge point 4.a.1 The back-office application marks the charging station as "defective" in the database 4.a.2 The back-office application reports the defected charging station to the back-office administrator and moves to point 2 of the Use Case

Table D-10 Use Case NEW_UC_09 CS status polling

Use Case	Code NEW_UC_10	CS Status Visualization
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	
Contributing Partners	Gabriela Trandafir – TeamNet International	
Description	The driver of an EV wishes to see the updated status of a charging station	
Constraints	Quality of communication method between post / back-office Post status refresh services of back-office	
Pre-condition		
Actors	The back-office application, the charging station, the driver	
Services involved	EV-charging station management, back-office application	
Trigger	Use Case NEW_UC_07: Charging Station search	
Basic path/Main Flow	1. The charging station search is initialized (Use Case NEW_UC_07: Charging Station search) 2. The driver selects one charging station and requests the current status using the charging station application 3. The charging station application connects to the back-office database and extracts the latest status of the selected charging station 4. The charging station application displays the status to the driver	
Post-condition	The drivers sees the updated status of the charging station	
Exception path/Alternate Flow		

Table D-11 Use Case NEW_UC_10 CS status visualization

Use Case	Code NEW_UC_11	Efficient Driving
Version	02	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International; Yvonne Hübner, Graeme Hill – UNEW	
Contributing Partners	Gabriela Trandafir – TeamNet International, Alexandra Prescott - CYC Gateshead College	
Description	Providing information to the driver on how they can improve their driving efficiency and how to extend the range of the vehicle	
Constraints	The route chosen might dictate the speed at which the driver has to drive. Very high or low temperatures might mean that drivers have to use A/C or heating.	
Pre-condition	Second-by-second measurements of energy use and driving style	
Actors	The driver, the back-office (BO) application, Eco-driving application, charging station application	
Services involved	Eco-driving software, data loggers	
Trigger	The need to extend the range for a long trip or to avoid range anxiety. To enable more informed driver behaviour	
Basic path/Main Flow	1. The driver drives as normal. 2. The data is recorded, logged and processed by the system during the drive. 3. The driving style is analysed and logged on the back office system. 4. When possible, the driver starts the efficient driving application on either a mobile or desktop device 5. The application displays improvement hints for the range of the trip on the OBU.	
Post-condition	The driver carries out a post trip analysis of their trip using PC or smartphone	

Exception path/Alternate Flow	

Table D-12 Use Case NEW_UC_11 efficient driving

Use Case	**Code NEW_UC_12**	**Intention of Charging**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	
Contributing Partners	Gabriela Trandafir – TeamNet International	
Description	The process of informing the system that a driver wishes to charge his/her car to a charging station	
Constraints		
Pre-condition	The driver must have access to the charging station application	
Actors	The driver, the back-office application, charging station application	
Services involved	EV-charging station management, back-office application	
Trigger	Use Case NEW_UC_07: Charging Station search	
Basic path/Main Flow	1. The driver is searching for the desired charging station (Use Case NEW_UC_07: Charging Station search) 2. The driver selects the desired charging station and specifies the intention to use it. Information regarding the time and duration of use must be specified 3. The back-office application informs the user about the status of the charge point for the period he/she wishes to use the CS 4. The back-office application inserts the driver into the CS notification list	
Post-condition	The BO is aware of a driver's intention to charge	
Exception path/Alternate		

Flow	

Table D-13 Use Case NEW_UC_12 intention of charging

Use Case	Code NEW_UC_13	User Validation
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Alexandra Prescott - CYC Gateshead College	
Contributing Partners	Gabriela Trandafir – TeamNet International	
Description	The process to validate the user (driver) before the charging process starts	
Constraints		
Pre-condition	The driver is in the process of accessing the charging station	
Actors	The driver, the back-office application, charging station application, the bank server	
Services involved	EV-charging station management, back-office application	
Trigger	Use Case NEW_UC_02 - Use Case NEW_UC_04	
Basic path/Main Flow	1. The driver uses the RFID to access the charging station and he/she has a subscription [1.a], [1.b] 2. The back-office application checks the status of the user 3. The user status is “OK” [3.a] 4. The payment is authorized 5. The user is validated	
Post-condition	The user is validated	
Exception path/Alternate Flow	[1.a] The driver uses the RFID to access the charging station and he/she is a member of the prepaid scheme 1.a.1 The back-office application checks the user’s current balance and continues with step 4 from the Use Case. [1.a.1.a] [1.a.1.a] The user does not have enough money in the account and the use is not validated [1.b] The user is anonymous and he/she uses SMS or IVR to	

	access the charging station 1.b.1 The back-office application checks with the bank server if the payment is authorized 1.b.2. The bank says the payment is authorized and the back-office validates the user [1.b.2.a] [1.b.2.a] The bank says the payment is not authorized and user is not validated

Table D-14 Use Case NEW_UC_13 user validation

Use Case	**Code NEW_UC_14**	**Integration with EV-Navigation**
Version	01	
CIP Project Id	smartCEM	
Pilot	Newcastle	
Author (Name/Organization)	Dorin Palanciuc – TeamNet International and Yvonne Hübner – Newcastle College	
Contributing Partners	Gabriela Trandafir – TeamNet International, Alexandra Prescott - CYC Gateshead College	
Description	Integration of the charging station application with the EV-Navigation	
Constraints		
Pre-condition		
Actors	The driver, the back-office application, charging station application, navigation application	
Services involved	EV-charging station management, back-office application, EV-Navigation, OBU	
Trigger	The OBU displays a message to the driver	
Basic path/Main Flow	1. The user wants to make a change to the trip and he/she accesses the charging station application search function [1.a], [1.b] 2. OBU searches and displays the charging stations meeting the driver's criteria 3. The driver selects the desired charging station 4. The navigation application calculates the new route to the charging station	

	5. The charging station application states the user is intent to use the new charging station and sends the data to the back-office application
Post-condition	The OBU, the back-office application and the CS application are successfully communicating. The driver is presented with a route to the selected CS
Exception path/Alternate Flow	[1.a] OBU detects low battery and informs the driver 1.a.1 The Use Case continues from step 2 [1.b] Notifications from the back-office application are available for the driver 1.b.1 Back-office application sends the notification to the charging station application 1.b.2 The Use Case continues with step 5

Table D-15 Use Case NEW_UC_14 integration with EV-Navigation

Appendix E – Reggio Emilia use cases

Use Cases List

The following table lists the Use Cases for the pilot site:

No. (UC Id)	Trip phase	Use Case name	Short Description
REG_UC_01	Pre-trip	EV-sharing registration	An employee of the Reggio Emilia Municipality is registered into the list of EV users that will be involved in the smartCEM data acquisition
REG_UC_02	Pre-trip	EV-sharing standard booking	A municipality employee driver books his trip driving an EV.
REG_UC_04	Pre-trip	EV-pick up	A municipality employee driver accesses to the CS and pick the EV up.
REG_UC_05	On-trip	EV-sharing driving	A municipality employee driver drives the EV using the navigation tool.
REG_UC_06	On-trip	EV trip ending	The booked EV trip has ended.
REG_UC_07	Post-trip	Car-sharing data report	Any interaction with the fleet is reported to the eCar Sharing Server where it is stored and processed
REG_UC_08	Post-trip	Real-time advice on efficient driving	The EV drivers are suggested on how they can improve their driving efficiency and how to extend the range of the vehicle

Table E-1 List of Use Cases for Reggio Emilia Pilot Site

Use Cases Description

The following tables provide a detailed description of each UC.

Use Case	Code: REG_UC_01	Title: EV-sharing registration
Version	02	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Guido Di Pasquale (Pluservice), Leandro Guidotti, Daniele Pinotti (UNIMORE), Pietro Mascolo (ICOOR)	
Contributing Partners	CRF, Pluservice, Unimore	
Description	User registration process to the car-sharing circuit internal at the municipality of Reggio Emilia. Twenty (20) employees will be involved with the smartCEM activities and will be assigned an ID. The service is free of charge for the personnel of the municipality of Reggio Emilia.	
Constraints	The eCar driver must be an employee of the Reggio Emilia municipality. A valid driving license.	
Pre-condition	An internet connection is required	
Actors	Car driver, EV-sharing service- Reggio Emilia municipality circuit, PC, smartphone,	
Services involved	EV-sharing management	
Trigger	none	
Basic path/Main Flow	- The eCar driver must go to Web site of Reggio Emilia Municipality. - The eCar driver must provide a driver's license number and an ID - eCar driver data (name, surname, birth date, e-mail, address, years of driving license) are stored into the	

	eCar sharing Server (back-office of Reggio Emilia municipality). - The system sends a confirmation to the user.
Post-condition	eCar driver is registered to the municipality Car-sharing system (eCar sharing Server).
Exception path/Alternate Flow	

Table E-2: Use Case REG_UC_01: Title: EV-sharing registration

Use Case	**Code: REG_UC_02**	**Title: EV-sharing standard booking**
Version	01	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Guido Di Pasquale (Pluservice), Leandro Guidotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	CRF, Pluservice, Unimore	
Description	Process to book an electric vehicle to drive a round way trip.	
Constraints	The eCar driver will have the vehicle fully charged or must explicitly accept different charging conditions and autonomy.	
Pre-condition	The driver is registered into the eCar Sharing Server. The eCar must be accessible at any time of their actual availability, thus excluding the time required to recharge the vehicles to ensure the usability.	
Actors	eCar driver, eCar Sharing Server , OBU_eCar, Smartphone, PC	
Services involved	EV-sharing management	
Trigger		
Basic path/Main Flow	***1***. The registered eCar driver accesses his/her own private area of the Web site of eCar Sharing Server through username and password; ***2***. The eCar driver inserts the desired driving parameters (trip time, trip start and end); ***3***. The system (eCar Sharing Server) shows the available EVs and the related free slots time;	

	4. The eCar driver selects the option. ***5***. The eCar driver books the eCar for a period of time specified which is a fraction of the operating time of fully charged batteries; ***6***. The system locks the vehicle in the booked time slot ***7***. Booking confirmation to the user is sent;
Post-condition	An eCar is booked.
Exception path/Alternate Flow	If no eCar is available within the specified parameters, the system proposes alternative time slots (e.g. after 30 minutes).

Table E-3: Use Case REG_UC_02: Title: EV-sharing standard booking

Use Case	**Code: REG_UC_04**	**Title: EV-pick up**
Version	01	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Guido Di Pasquale (Pluservice), Leandro Guidotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	CRF, Pluservice, Unimore	
Description	Process to pick the vehicle up in the charging station, after booking.	
Constraints	The eCar driver will only be allowed to get the assigned eCar, not any other.	
Pre-condition	The eCar is booked in that specific time. The booked eCar must be picked up in the place and at the time indicated by the system during the booking.	
Actors	eCar, eCar driver, eCar Sharing Server, smartphone, CS	
Services involved	EV-sharing management, EV-charging station management	
Trigger		
Basic path/Main Flow	- The user picks up the key at the office in charge of the vehicles - The booked vehicle must be picked up in the place and at the time indicated by the system during the booking - The key is used to open and start the vehicle	

	- The eCar driver must unplug the electric power wire - Once on board, the user must be able to connect his/her personal mobile device (e.g. smartphone, tablet) to the vehicle with a wireless connection, to get data and act as an OBU. - The user check-in to the service via smartphone user interface - OBU shows the battery level of charge - The eCar driver starts the trip
Post-condition	The eCar driver starts the trip.
Exception path/Alternate Flow	

Table E-4: Use Case REG_UC_04: Title: EV-pick up

Use Case	**Code: REG_UC_05**	**Title: EV-sharing driving**
Version	02	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Guido Di Pasquale (Pluservice), Leandro Guidotti, Daniele Pinotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	CRF, Pluservice, Unimore, PTV	
Description	The eCar driver starts driving the picked up EV.	
Constraints	The eCar driver must be supported by an on-board user interface (Tablet/Smartphone) during the trip. The eCar driver must be supported by the EV-navigation service during his/her trip.	
Pre-condition	The eCar driver booked the EV The eCar driver picked up the EV	
Actors	eCar, eCar driver, OBU_eCar, Smartphone	
Services involved	EV-sharing management, EV-navigation, EV-efficient driving, Eco-driving application	
Trigger	none	
Basic path/Main Flow	***1***. The eCar driver drives toward the destination using the EV-Navigation service.	

	2. eCar driver is allowed to change his/her predefined destination (set when booking), taking into account the range estimation provided by EV-navigation. ***3***. The OBU_eCar should make it possible the communication of the charging level during the trip, in order to detect an eventual anomalous consumption (long uphill full regime runs, etc) that could create problems at the time of the drop-off or could not be compatible with the duration of the booking done. ***4***. The OBU_eCar should remind the driver (through the user interface - Smartphone), in the case of anomalous consumption, the basic rules for a more suitable utilization of the vehicle (eco-driving style, efficient parameters)
Post-condition	The driver reaches his destination
Exception path/Alternate Flow	

Table E-5: Use Case REG_UC_05: Title: EV-sharing driving

Use Case	**Code: REG_UC_06**	**Title: End EV-trip**
Version	01	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Guido Di Pasquale (Pluservice), Leandro Guidotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	CRF, Pluservice, Unimore	
Description	eCar driver returns back to the starting point and ends his/her trip.	
Constraints	The eCar driver should drop the EV off in the same car park it had been taken.	
Pre-condition	The eCar driver has finished his/her trip	
Actors	eCar, eCar driver, OBU_eCar, CS, Smartphone, eCar Sharing Server	
Services involved	EV-Sharing, EV-Navigation, EV-charging station management	
Trigger	none	
Basic path/Main Flow	***1***. The eCar driver accesses to the CS of Reggio Emilia	

	municipality. ***2***. The eCar driver connects the plug to the CS ***3***. The eCar driver performs the log-out (OBU/smartphone) ***4***. OBU_eCar/Smartphone must communicate the allowed drop-off after the insertion of the plug ***5***. The user returns the key to the managing office
Post-condition	The eCar driver should log out from the OBU/smartphone and leave the EV at the appropriate parking place, depending whether the EV is assigned to a specific CS or not. The eCar is available and a message is sent to the eCar Sharing Server.
Exception path/Alternate Flow	In case of any problem occurs and the eCar driver is unable to return the vehicle in the foreseen parking area, the fleet operator will manage for the return of the vehicle.

Table E-6: Use Case REG_UC_06: Title: End EV-trip

Use Case	**Code: REG_UC_07**	**Title: Car-sharing data analysis**
Version	01	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Leandro Guidotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	Unimore	
Description	Any interaction with the fleet is reported to the eCar Sharing Server where it is stored and processed. This describes this data analysis.	
Constraints	Only the reported information could be analysed.	
Pre-condition	The logged data is available	
Actors	OBU_eCar, eCar Sharing Server.	

Services involved	EV-sharing
Trigger	
Basic path/Main Flow	***1***. Any interaction with an OBU_eCar (tracking, check-in, check-out, etc) is logged and transmitted to the eCar Sharing Server. ***2***. This data arrives to eCar Sharing Server and is appropriately stored. The EV sharing Operator performs any kind of analysis of the Car-Sharing/fleet.
Post-condition	The historic data will not be modified.
Exception path/Alternate Flow	None

Table E-7: Use Case REG_UC_07: Title: Car-sharing data analysis

Use Case	**Code: REG_UC_09**	**Title: Real-time advice on efficient driving**
Version	01	
CIP Project Id	smartCEM	
Pilot	REG	
Author (Name/Organization)	Leandro Guidotti (UNIMORE), Pietro Mascolo (ICOOR).	
Contributing Partners	CRF, Unimore, PTV	
Description	Providing information to the eCar driver on how they can improve their driving efficiency and how to extend the range of the vehicle	
Constraints	The route chosen might dictate the speed at which the driver has to drive; very high or low temperatures might mean that drives have to use A/C or heating	
Pre-condition	Second-by-second measurements of energy use and driving style	

Actors	eCar driver, OBU_eCar, eCar, eCar Sharing Server, Eco-driving application
Services involved	EV-efficient driving, EV-sharing, EV-navigation
Trigger	The need to extend the range for a long trip or to avoid range anxiety
Basic path/Main Flow	1. The eCar driver starts the Eco-driving application in the car (smartphone) 2. The eCar driver starts driving 3. The Eco-driving application records and analyses the driving style and gives advice to the driver in real-time on how to increase his/her range
Post-condition	N/A
Exception path/Alternate Flow	The eCar driver uses Eco-driving web interface for information on his/her driving style

Table E-8: Use Case REG_UC_08: Real-time advice on efficient driving