UNLOCKING LARGE-SCALE ACCESS TO COMBINED MOBILITY THROUGH A EUROPEAN MAAS NETWORK.

Deliverable D2.1
Requirement specification and analysis

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 723314.

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Deliverable number:	**D2.1**
Deliverable responsible:	Softeco Sismat SRL
Work package:	WP2
Main editor:	Alessandro Barisone

Editor name	Organisation
Marco Gorini	Softeco Sismat SRL
Jose David Fernández	Mosaic Factor SL
Hans Arby	UBIGO Innovation AB
Massimiliano Curto	Urbannext SA
Corrado Alesso	Urbannext SA
Michal Jakob	Ceske Vysoke Uceni Technicke V Praze
Michal Certicky	Ceske Vysoke Uceni Technicke V Praze
Rafael Cuesta	Transport For Greater Manchester
Sam Li	Transport For Greater Manchester
Vassilis Psaltopoulos	Institute of Communication and Computer Systems
Nikolaos Tousert	Institute of Communication and Computer Systems

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Executive Summary

This document, Deliverable D.2.1, reports on the outcomes of the system requirements analysis phase conducted in Task T2.1 about functional and technical specifications of IMOVE Software Enablers.

The goal of T2.1 is the synthesis of general and specific requirements elicited in cooperation with the other running work packages, providing insights, guidelines and constraints to drive the following tasks of system architecture definition and components design.

In the process, requirement elicitation methodologies described in chapter 2 have been followed to interact in the most effective way with the different work packages and extract valuable information from their relevant peculiar point of view of the project domain.

More in detail, substantial contribution to this document content has been provided by work packages:

- WP1, providing a business model overview with the key concept of levels of integration and an insider view of the processes underlying a running MaaS day-to-day operation
- WP3 for data management aspects
- WP4, with the definition of a set of scenarios that express in common language a narration of a person or organization interacting with the system

Chapter 3 summarizes the scenarios presented in D4.2 ([4]) to derive for each one a set of user stories: short sentences that express self-contained actions and expectations for users and organizations interacting in the system domain. User story format is a part of the agile modelling approach ([2]) and is designed to make the system functionality easy to understand and discuss.

Chapter 4 takes advantage of the IMOVE partners' expertise and WP1 efforts to review and identify key aspects of MaaS business processes.

In Chapter 5, the IMOVE system requirements are identified and presented in a comprehensive and structured way.

Conclusions in chapter 6 synthetize the process results and explain how the outcomes of the elicitation pave the way for the subsequent WP2 activity of architecture design and Open API specification to target Software Enablers development.

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Abbreviations and Acronyms

DoA	Description of the Action
EC	European Commission
NFC	Near Field Communication
PT	Public Transport
QoS	Quality of Service
QR	Quick Response code
WP	Work Package

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1 INTRODUCTION

"Mobility as a Service" is the emerging trend that will shape the future of transportation and the way people will travel in the near future. It builds on recent advances in ITS technologies and the rise of the sharing economy, in order to extend the "as a service" paradigm to the mobility sector, with the provision of combined mobility packages; and seamless integration between networks and different means of transport to overcome the existing market fragmentation and go beyond the car ownership model.

IMOVE leverages on existing experiences in the MaaS landscape (such as UBIGO in Gothenburg) to develop and validate in Living Labs novel solutions to refine applicable business models and address technological challenges in the Maas ecosystem.

1.1 WORK PACKAGE 2

As stated in the DoA ([1]), *"the goal of Work Package 2 is to define an integrated technical specification for the full IMOVE system, focusing on the Software Enablers' envisioned core capabilities […] In order to support the different deployment scenarios of the Living Labs (which will be different in size, population, existing mobility services and existing MaaS initiatives) the IMOVE system architecture will apply state-of-the-art techniques and technologies to ensure extensibility, scalability, openness and ease of adaptation to different environment"*.

In the context of IMOVE, a suite of targeted ITS components, namely Software Enablers, will be designed and developed in a system architecture shaped from the requirements gathered in the early stage of the project.

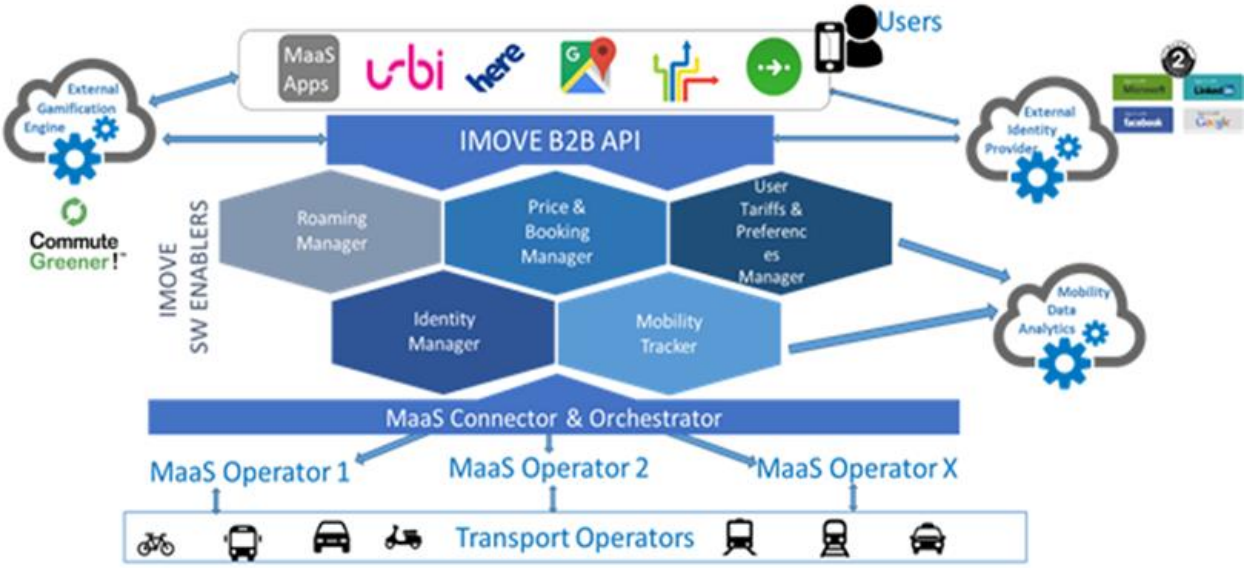

Figure 1. IMOVE software enablers (source: IMOVE DoA [1])

1.2 TASK 2.1

This document pertains to Task T2.1 about functional and technical specifications of IMOVE Software Enablers.

The expected output is a comprehensive and consistent set of general and specific requirements elicited in cooperation with other WP2 tasks and other work packages active in parallel. To this aim, specific

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methodologies have been followed for requirement elicitation, according to the different focus of each work package:

- An iterative approach has been applied to scenarios defined in WP4 to derive user stories and to obtain functional requirements.
- A top-down process has been adopted to collect non-functional requirements.

Elements identified as outcomes of this task, in terms of recommendations and constraints along with their importance and prioritizations, are valuable guidelines for a successful T2.2 system architecture definition and components design.

1.3 DELIVERABLE STRUCTURE

This introduction chapter positions the document in the context of the project and the relevant work package.

Chapter 2 explains in detail the methodologies adopted for requirement elicitation, depending on the contributions of the other work packages and relevant information sources.

Chapter 3 reports about scenarios sketched up in WP4 activities. In the process, user stories are extracted from their description, in order to isolate intentions and/or actions performed by subjects (e.g. persons and organizations) in the system scope.

Chapter 4 is based on WP1 efforts in business model analysis and the state-of-the-art IMOVE mobility providers' knowledge of the "Mobility as a Service" domain to review real-world MaaS operation and empower technical and research partners with a deeper understanding of the MaaS-related business processes.

Chapter 5 consists primarily of a set of tables where functional and non-functional requirements gathered in the process are categorized and listed. They are also evaluated in terms of their importance for individual Living Labs. Their overall importance for the project is expressed in MoSCoW notation ([3]).

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2 REQUIREMENT ELICITATION METHODOLOGY

Capturing the IMOVE system requirements is a key stage, not only to describe as a comprehensive list of what the system components are expected to provide, but also to collect and feed a series of significant and structured inputs to other tasks of the WP2 running in parallel, especially the ones devoted to the functionalities design.

In this sense, the requirement set defines a complete description of the behaviour of a system component, describing what it is expected to perform (e.g. a specific action) rather than how this is to be accomplished.

Requirements emerge from several project tasks, running simultaneously in different work packages, each one addressing a specific view of the system:

- Business models described in WP1 provide insights and abstractions to collect requirements from.
- The system definition and design process in WP2 produces basic requirements.
- Data management aspects are covered in WP3.
- WP4 provides operational requirements both at a general level and for each living lab according to their specific scope and the ambitions reported in the deliverables.

Furthermore, IMOVE requirements can be sub-divided according to the classification described below:

- Functional requirements, describing the core functionalities of system components.
- Non-functional requirements, describing architectural/technical aspects of the system (related to its design and implementation).

A suitable methodology has been adopted to gather elements that belong to each category in an effective way.

2.1 FUNCTIONAL REQUIREMENTS ELICITATION METHODOLOGY

IMOVE functional requirements have been collected with an iterative elicitation methodology, involving WP2 partners in the evolutionary editing of a collaborative document. Preliminary task 2.2 activities supplied some basic prerequisites as well.

Other work package activities running in parallel provided substantial contribution: WP1 business analysis and consortium expertise in MaaS domain and operation resulted in chapter 4 about Business Process Analysis.

WP4 contribution to this process consists mainly of user scenarios and Living Lab ambitions described in Deliverable D4.2 ([4]).

User scenarios have been thoroughly analysed to get a detailed and structured set of user stories. These are the basis to derive the comprehensive list of functional requirements.

Living Labs ambitions have been considered in a first preliminary stage of per-Living Lab prioritization of the requirements, leaving the final word about this to another iteration with the involvement of each Living Lab relevant partners and stakeholders.

Requirement definitions have been refined and merged to filter out duplicate ones. The list was then grouped and organized according to their functional areas. Finally, the collaborative document has been submitted to individual Living Labs partners for validation and prioritization.

WP2 partners then performed a further evaluation of requirements' overall importance for the Living Labs as a whole and globally for the project.

Chapter 5 shows the outcome of the process, a list of requirements along with their prioritization and importance (global and for each Living Lab).

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2.2 NON-FUNCTIONAL REQUIREMENTS ELICITATION METHODOLOGY

Non-functional requirements can be grouped in two broad areas related to the system and the data management; in the scope of IMOVE project, the first is addressed in WP2 and the second pertains to the dedicated WP3.

Non-functional requirements have been gathered for each system functionality following a top-down approach; in particular, the system requirements (presented in section 5.2.1) include:

- Performance/reliability requirements.
- Interoperability requirements (system interface/integration).
- Extensibility/maintainability requirements,
- Usability requirements.
- Standard compliance requirements.

Data management requirements (presented in section 5.2.2) include:

- Security/privacy requirements.
- Data quality, availability and reliability requirements.

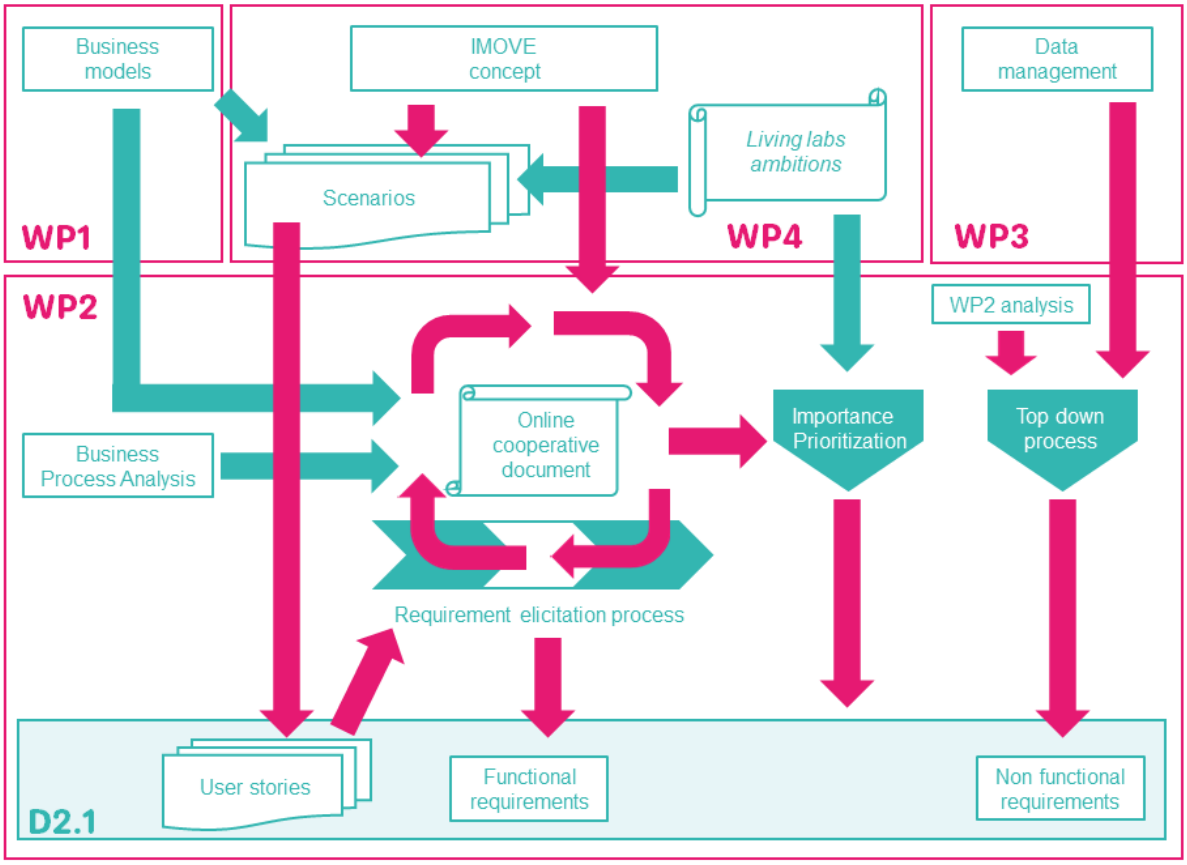

Figure 2. Requirement elicitation process

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3 SCENARIOS AND USER STORIES

As described in the methodology, scenarios are the primary information source to extract user stories, as inputs for the IMOVE software enablers' requirements elicitation process. They are an outcome of tasks T4.2-T4.6 and their comprehensive description is reported in deliverable D4.2 ([4]).

3.1 SCENARIOS

A scenario is a narrative: a short text describing how one or more people or organizations interact with the system. It is usually expressed in a common language, in order to be easily understandable by all the different stakeholders during the design and the development. Furthermore, scenarios may help the end user to understand which high-level functionalities can be performed in the system.

WP4 activities specified 10 scenarios, and all of them have been analysed for user story derivation and in the requirement elicitation process:

- Scenario S1 – Joseph – Office worker businessman.
- Scenario S2 – Nicole – University student.
- Scenario S3 – Mark – Millennial worker.
- Scenario S4 – John, Mary, Tim and Hannah – Family routine.
- Scenario S5 – Helena – Business Woman.
- Scenario S6 – Florian – Family break.
- Scenario S7 – Paola – Luxury user.
- Scenario S8 – B2B between MaaS and a private company.
- Scenario S9 – Maas operator & Public transport company or public authority.
- Scenario S10 – Cooperation between MaaS operator & transport operator.

3.2 USER STORIES

In terms of Agile Modelling ([2]), "A user story is a very high-level definition of a requirement, containing just enough information so that the developers can produce a reasonable estimate of the effort to implement it".

Rephrasing the definition, each user story summarizes in a single sentence one specific action that a user can perform in the system. User stories are usually expressed in business language to be understandable by technical and non-technical audience involved in the development process and to be a reference for deriving system requirements and defining system functionalities.

A typical user story is structured in the following form:

As a [role] I want [something] so that [benefit]

Where:

- *[role]* is the role the actor (subject of the sentence, typically myself) belongs to.
- *[something]* represents what the actor likely wants to happen in order to get some benefits (consuming a service, making a choice, etc.)
- *[benefit]* is the reason driving the actor to use the system we are trying to describe.

Due to the specific nature of IMOVE, this template has been slightly adapted in order to capture aspects and features not directly related to an individual (human actor), but rather to one or more generic actors:

As a [role] the [actor] wants [something] so that [benefit]

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Under this perspective, the actor could be an individual (as in previous case) as well as an abstract entity (an organisation, a system component, etc.), while the benefit gets a broader meaning (e.g. obtaining data, triggering actions, etc.); this is particularly suitable for B2B scenarios (S8, S9, S10),

The user stories have been grouped by the originating scenario and identified with the notation USX-SY that refers to the user story number X for the Scenario Y.

3.2.1 SCENARIO S1 – JOSEPH – OFFICE WORKER BUSINESSMAN

The first scenario describes daily commuting of an office worker businessman.

3.2.1.1 USER STORIES

US1-S1 - As **transportation providers**, companies are willing to **offer multiple service packages** with different prices, modes, QoS guarantees and usage limits, because **customers have different preferences**.

US2-S1 - As a **traveller**, Joseph wants to be able to **choose between all transport choices**, including less reliable and cheaper options (e.g. public transport), as well as more expensive, but fast options (e.g. Taxi), because his priorities can vary.

US3-S1 - As a **MaaS user**, Joseph wants **the transport offers to match his own preferences** so that he receives a **personalized service**.

US4-S1 - As an **urban citizen**, Joseph is willing to **easily access different travel services** so that he can always **choose the one best for the circumstances**.

US5-S1 - As a **busy businessman**, Joseph wants to **find fast travel options** so that he can complete his **daily busy meeting schedule**.

US6-S1 - As a **traveller**, Joseph wants to be **notified about the service disruptions**, because he needs to be able to **quickly re-arrange his trips**.

US7-S1 - As a **business commuter**, Joseph can **use public transport most of the time** when it works well, but he does not want to be worried about **reaching his destination on time**.

US8-S1 - As a **busy businessman**, Joseph wants to be **offered an alternative travel service in the case of disruptions**.

US9-S1 - As a **Premium MaaS user**, Joseph wants **guaranteed QoS (travelling time)** to be declared in advance so that he **can assess the effectiveness of the solution (through feedbacks)**.

US10-S1 - As a **private-car user**, Joseph wants to be able to **share his ride** so that i) he can **benefit from discounted parking** and ii) he can **use the fast lane** and get to my work faster.

US11-S1 - As a **traveller**, he sometimes wants to be able to **request / join a shared ride** to his destination, because it is a **money saving** and **environmental friendly** option.

US12-S1 – As a **ride-sharing user**, Joseph receives MaaS **proposals for possible candidates** to share the trip with, according to his origin, destination and departure time.

US13-S1 - As a **public authorit**y, the municipality wants to be able to **offer parking price discounts** for ride-sharing drivers, because it **incentivizes car sharing**.

US14-S1 - As a **driver**, Joseph wants to be **informed about the** best **possible parking options** near his destination, in terms of convenience and price.

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3.2.1.2 KEYWORDS

Commuter, public transport, package subscription, customer preferences, disruptions, quality of service, feedbacks, private car, ride sharing, incentives.

3.2.2 SCENARIO S2 – NICOLE – UNIVERSITY STUDENT

This scenario shows Nicole, a university student moving from her hometown to a bigger city nearby to attend her classes and take her exams.

3.2.2.1 USER STORIES

US1-S2 - As a **student**, Nicole **commutes every day from her town to a big city** few kilometres away to reach the university.

US2-S2 - As a **student**, Nicole is interested in **sustainable transport modes** and **cares about the price**.

US3-S2 - As a **commuter**, Nicole **combines walking/cycling + train + bus/cycling**.

US4-S2 - As a **young student**, Nicole **prefers to use the bike rather than walking and using the bus,** because it lets her do some exercise and **save time and money**.

US5-S2 - As a **young commuter**, Nicole usually **carries her bike on the train** because she **goes biking the first and last mile**.

US6-S2 - As a **commuter** during **peak hours**, when there is a **high demand** or **service disruptions,** Nicole cannot use her own bike because the **train is too crowded** to bring it inside.

US7-S2 - As a **MaaS subscriber**, Nicole wants a package that lets her **use bike sharing and public transport** every day, and **access the car-pooling utility**, because she is looking for **sustainable and cost efficient mobility** modes.

US8-S2 - As a **commuter**, Nicole would like to be **advised in real-time about the service disruptions or high occupancy levels** to **change her trip plans**.

US9-S2 - As a **MaaS subscriber**, Nicole wants to have the possibility **to join a car-pooling on the fly** because it is an **efficient way to reach her destination,** especially when there is a disruption on the public transport.

3.2.2.2 KEYWORDS

Bike sharing, public transport, package subscription, public transport information, car-pooling, “real-time” booking.

3.2.3 SCENARIO S3 – MARK – MILLENNIAL WORKER

Mark is a young worker, accustomed to public transport in his student years and is now looking for an effective but sustainable travel experience. As a digital native, he has a positive attitude towards opportunities in sharing economy and is willing to participate in user engagement and incentivisation campaigns.

3.2.3.1 USER STORIES

US1-S3 - As a **former student**, Mark was accustomed to use **the public transport,** because it was **cheap** and he was **less sensible to transfer time**.

US2-S3 - As a **junior worker**, Mark wants to **reduce the transport time,** even by paying more, because now **he is more sensible to transport time than the price**.

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US3-S3 - As a **junior worker**, Mark **sometimes needs to use his own car** to go directly to his work, but is willing to drive in a sustainable way because he **cares not only about transport time, but also about sustainability**.

US4-S3 - As a **junior worker**, Mark is interested in a **MaaS package** with **unlimited use of public transport** and **incentives to people that share his/her own car** by car-pooling or vehicle sharing, because he is interested in **sustainable and effective mobility** modes.

US5-S3 - As **policy makers**, the public authorities could be interested in offering **incentives like leisure activities** to the MaaS users that **share their own cars,** because they want to **implement sustainable mobility policies**.

US6-S3 – As **private organizations**, companies may offer **bonuses** for **marketing purposes** to improve their **sustainability profile**.

US7-S3 – As a **mobility provider**, the MaaS platform wants to **implement a gamification system** that ranks and **gives incentives** to the most sustainable transport users, because they want to **promote sustainable mobility** modes.

3.2.3.2 KEYWORDS

Package subscription, public transport, private car, “real-time” ride sharing offering, “real-time” car-pooling booking, public policies, marketing campaign, incentives programme, gamification techniques, user engagement.

3.2.4 SCENARIO S4 – JOHN, MARY, TIM AND HANNAH – FAMILY ROUTINE

Scenario S4 shows the daily routine of a family with children. During workdays, the main destinations are workplaces for the parents and schools for the children. Family movement in leisure time is also described, both during working days and on the weekend. The description is split into the current situation, with a prevalent use of private car as means of transport, and into what it will look like in the future, when a MaaS mobility family package is available.

3.2.4.1 USER STORIES

US1-S4 - As a **family**, John and Mary are interested in **keeping the family budget under control**.

US2-S4 - As a **family** with children, John and Mary are **sensible to health and environment protection**.

US3-S4 - As a **family**, each component has a **daily mobility pattern**.

US4-S4 - As a **family**, John and Mary **own two cars**.

US5-S4 – As **parents**, John and Mary **have to guarantee safe and reliable transportation** for their children.

US6-S4 - As a **public authority**, municipality have to **provide school transport service** (public, walking bus).

US7-S4 - As a **car driver**, Mary has to **look for** on-street parking or to pay for a public **parking**.

US8-S4 - As a **family**, they will **move together in the weekend** (to Tim football match, to grandma...).

US9-S4 - As a **family**, they are **interested in a collective mobility package**.

US10-S4 - As a **family**, they **like to collect points** in a common balance to **receive rewards** for their biking/walking commitment.

US11-S4 - As a **MaaS subscriber**, John **receives trip schedule / suggestions** based on his profile.

US12-S4 - As a **MaaS subscriber**, the family is **entitled to receive trip options offers, in-trip assistance and navigation information**.

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US13-S4 - As a **MaaS subscriber**, John enjoys a **MaaS planned ride-sharing** to the office.

US14-S4 - As a **MaaS subscriber** and **shopper**, Mary get **promotions linked to MaaS services use**.

US15-S4 - As a **MaaS subscriber** and **schoolgirl**, Hannah can **enjoy a walking-bus service**.

US16-S4 - As a **MaaS subscriber**, Hannah get **information on a service disruption** and an **advice to change transport mode** and walking **navigation information**.

US17-S4 - As a **Maas subscriber**, the family can **obtain a car for the weekend**.

US18-S4 - As a **MaaS subscriber**, the family **receives notifications about their usage and payments via email or phone**.

US19-S4 - As a **public authority**, national/regional/local governments can **provide incentives for dropping private car** and **contribute to buy MaaS subscription**.

3.2.4.2 KEYWORDS

Family, daily routine, public transport, collective mobility package, incentives, notification, private car.

3.2.5 SCENARIO S5 – HELENA – BUSINESS WOMAN

A businesswoman's day is the subject of Scenario 5. Helena is a very active person with a lot of daily tasks, people to meet and places to reach. The MaaS service can assist her in planning her day and providing reliable and effortless trips, reserving some time for herself and her personal activities.

3.2.5.1 USER STORIES

US1-S5 - As a **commuter**, Helena is **affected by delays and service disruptions**.

US2-S5 - As a **dynamic person**, Helena **likes to choose the mean of transport** that best fit her trip.

US3-S5 - As a **regular traveller/commuter**, she is **interested in a subscription package**.

US4-S5 - As a **MaaS subscriber**, Helena **pre-pays a flat sum** to have **access to a flexible portfolio of mobility offers**.

US5-S5 - As a **MaaS user**, Helena can **book options and access services**.

US6-S5 - As a **MaaS subscriber**, Helena **pays her services with her subscription credits**.

US7-S5 - As a **mobility planner**, the MaaS **suggests travelling options according to different factors** (trip purpose, her profile, the hour of the day, the weather).

US8-S5 - As a **MaaS subscriber**, she **accumulates points** according to her use of the service, since the **points earned depend on distance and travelling mode**.

US9-S5 – A **public authority** can finance MaaS incentives program to encourage modal shift and sustainability.

US11-S5 – As **private organizations**, companies can establish **partnerships with MaaS providers** for **participating in the incentivisation** schemes for **targeted marketing** initiatives and to reinforce **corporate identity**.

US11-S5 – As a **sustainable mobility endorser**, the MaaS operator **informs Helena about earned points** and the closest targets in the **reward catalogue**.

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US12-S5 - As a **sustainable mobility endorser**, the MaaS operator **delivers rewards** achieved and selected by users.

3.2.5.2 KEYWORDS

Commuter, trip planning, pre-paid subscription, booking, bike sharing, rewards.

3.2.6 SCENARIO S6 – FLORIAN – FAMILY BREAK

This scenario portraits a MaaS subscriber and his family, having a short holiday in another European city.

3.2.6.1 USER STORIES

US1-S6 - As a **MaaS user**, Florian knows his **hometown MaaS system application and services**.

US2-S6 - As a **family leisure traveller**, Florian is **interested in collective travel packages**.

US3-S6 - As a **family leisure traveller**, Florian has to **decide places to visit** and **how to reach them, balancing expenses and ease of travel**.

US4-S6 - As an **abroad MaaS subscriber**, Florian receives **targeted information from local roaming-enabled MaaS**.

US5-S6 - As an **abroad MaaS subscriber**, Florian can **access specific mobility packages** provided by **local roaming-enabled MaaS**.

US6-S6 - As **mobility services aggregators**, MaaS providers are interested in **increasing the customer base** promoting **tourism** and fostering **public transport and shared mobility**.

US7-S6 - As **mobility services aggregators**, MaaS can **make roaming agreements** with counterparts serving other areas, in order to **broaden services provided** to their local users and **expand their business to incoming people**.

US8-S6 - As a **sustainable mobility endorser**, IMOVE **rewards MaaS touristic usage** with tickets for local attractions.

3.2.6.2 KEYWORDS

Collective travel packages, trip planning, roaming agreement, user profile/preferences, roaming services, public transport, shared mobility, incentives programme, car rental.

3.2.7 SCENARIO S7 – PAOLA – LUXURY USER

In this scenario Paola is a businesswoman who likes luxury services and is very reluctant to use public transport. Her car sits idle for most of the day, most days.

3.2.7.1 USER STORIES

US1-S7 - As a **business commuter**, Paola travels every day with **tight schedule**.

US2-S7 - As a **business commuter**, Paola is interested in **limiting her driving time** and **private car use for work purposes**.

US3-S7 - As a **business commuter**, Paola appreciates **extra services** that can let her **save time** (breakfast, reserved parking, etc.) or to **better enjoy the travel experience** (1st class seat, chance to work or be entertained with books and videos).

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US4-S7 - As a **businesswoman**, Paola can have **meetings while moving** between appointments with an **executive ride service**.

3.2.7.2 KEYWORDS

Business, extra services, booking, meeting, ride sharing.

3.2.8 SCENARIO S8 – B2B BETWEEN MAAS AND A PRIVATE COMPANY

This scenario addresses a private company that is a "Mobility as a Service" customer, managing its employees' work time mobility.

3.2.8.1 USER STORIES

US1-S8 - As a **business owner**, Angelo wants solutions that **save time** of his employees and **reduce overall costs** of running operations.

US2-S8 - As an **accountant**, the company administrative department prefers **employees' mobility billing to be centralised**, **to avoid dealing with multiple providers, contracts, invoices and subscription renewals**.

US3-S8 - As an **accountant**, the company administrative department prefers **not to handle bills and receipts**, and **expects this process to be digitalized, comprehensive and simple**.

US4-S8 - As an **accountant**, the company administrative department needs an **instantaneous overview** of the **current mobility usage and expenses of the employees**, with **useful breakdowns and exports**.

US5-S8 - As **travelling employees**, program managers **do not want to deal with payments** and expect that **business mobility is handled transparently by the company**.

US6-S8 - As **travelling employees**, program managers like increases in available mobility options **without having to manage subscriptions to multiple services**.

3.2.8.2 KEYWORDS

Trip planning and navigation, public transport ticketing, subscription services, car rental, taxi booking, integrated billing.

3.2.9 SCENARIO S9 – MAAS OPERATOR & PUBLIC TRANSPORT COMPANY OR PUBLIC AUTHORITY

A regional, metropolitan or city-wide area is the scope of this scenario, where public authorities determine policies, apply regulations and provide public transport services. Private initiatives, such as transportation providers, sharing services and MaaS operators, complement the global collective mobility offer for the population and tourists.

3.2.9.1 USER STORIES

US1-S9 - As a **municipality**, Turin is willing **to offer citizens high quality and innovative mobility solutions**.

US2-S9 - As a **municipality**, Turin aims to **support public transport growth**.

US3-S9 - As a **municipality**, Turin is **encouraging shared mobility** to foster **environmental sustainability and reduce pollution**.

US4-S9 - As a **municipality**, Turin is willing to **welcome tourists** allowing **novel city mobility packages** for an **easy and convenient access** to **public transport** and **shared mobility services**.

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US5-S9 - As a **transport operator**, GTT is willing to **improve interaction** with **subscribers and potential customers** via **digital technologies** like **smartphone apps**.

US6-S9 - As **GTT subscribers** and **smartphone users**, young students are **inclined to receive digital services**.

US7-S9 - As **non-resident travellers**, tourists are willing to **receive sightseeing** and **transportation options advice** and **targeted offers for local attractions**.

US8-S9 - As **daily commuters**, GTT subscribers want to **be informed about service disruptions**.

US9-S9 - As **a transport operator**, GTT values **knowledge about transportation usage patterns** in terms of geography, schedule and user preferences.

US10-S9 - As a **transport operator**, GTT is interested in **monitoring and improving corporate operation** and **commercial offers**.

US11-S9 - As a **technology provider**, 5T built up a **digital infrastructure** to **open access** to some GTT **back office services** to partners.

US12-S9 - As **MaaS operators**, mobility providers comply with **agreed policies** regulated by a **standard contract**.

US13-S9 - As **MaaS operators**, GTT partners are required to **provide information contextual to the services delivered in electronic form**.

3.2.9.2 Keywords

Public authority, commuting, tourism, public transport, shared mobility, subscription, mobility package, PT ticketing, private-public collaboration, profiling, data exchange, digital services.

3.2.10 Scenario S10 – Cooperation between MaaS operator & transport operator

The last scenario covers at different levels the relationships between individual mobility providers (public transport, private companies, and sharing agencies) and a MaaS operator they are partnered with.

3.2.10.1 User stories

US1-S10 - As a **company**, a transport operator is willing to **join a MaaS open platform** to reach **new customers**.

US2-S10 - As a **mobility provider**, a MaaS operator can propose a **subscription based service** to favour **shift from the private car ownership model**.

US3-S10 - As a **mobility provider**, a MaaS operator can **benefit from improved service efficiency**.

US4-S10 - As a **mobility provider**, a MaaS operator can **resell transport operator's services**.

US5-S10 - As a **mobility provider**, a MaaS operator **can exchange service data** with transport operators to build a **common data set** to build analysis on.

US6-S10 - As a **MaaS partner**, a service provider is interested in **service data analysis** for **strategy management**.

US7-S10 - As a **MaaS partner**, a service provider is interested in **service data analysis** to **support dynamic pricing**.

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US8-S10 - As a **MaaS partner**, a service provider is interested in **service data analysis** to **establish incentivisation policies**.

US9-S10 - As a **MaaS partner**, a sharing service is interested in **data analysis** to **support vehicle (re)location**.

US10-S10 - As an **already running business**, a MaaS operator can **promote additional services** or **partner services in new areas** effectively and at reasonable costs.

US11-S10 - As a **mobility provider**, a MaaS operator with **mobility patterns knowledge** can keep users informed and **suggest travel solution**, in a **planned** way and/or in **real-time**.

US12-S10 - As a **mobility provider**, a MaaS operator is willing to **promote modal shifts** to **enhance service quality** or **save resources**.

US13-S10 - As a **mobility provider**, a Maas operator can leverage on **behaviour change** (modal shifts, user choices) with **incentivisation policies**.

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4 BUSINESS PROCESS ANALYSIS

This section focuses on the processes underlying a "Mobility as a Service" operating environment, in order to review the state-of-the-art in the current implementations of this emerging paradigm. Leveraging the expertise of consortium partners such as UBIGO and URBI, this domain analysis consolidates a basic knowledge to envision the business areas that will be enhanced and developed through the IMOVE software enablers.

4.1 LEVELS OF INTEGRATION

Nowadays, MaaS scheme implementations encompass a wide range of business models, transportation modes and mobility related services for the end user.

The concept of levels of integration can be applied to a MaaS solution to evaluate its status and to compare it with similar experiences in other cities or countries. The same classification may represent a sequence of steps in the evolution of a MaaS service and so it may serve as a roadmap for further expansions and developments. It should be noted that level 4, integration of societal goals, may apply to levels 0-3, and that a level 3 service should take advantage of an advanced travel planner.

Table 1. MaaS levels of integration

Level	Integration
4	Societal goals integration: Governance & PP-cooperation
3	Integration of service offer: Bundling / subscription- responsibility
2	Integration of payment: Find, book and pay (single trip)
1	Integration of information: Multimodal travel planner, price info
0	No integration: Single, separate services

ICT technologies were first deployed in the transportation domain as a support for corporate operation. The rise of the Internet and smartphone apps usage brought in new channels of interaction between transport providers and end users, moving part of the interaction from paper time sheets and queues at ticket offices to the electronic provision of these services (level zero). The evolution of mapping software and the real-time news availability driven by big internet-economy corporation raised further users expectations, and novel technologies and standards in the mobility domain were developed to enable better information sharing and trip planning support (level 1).

MaaS Level 2 combines in a single workflow all the steps required to be ready to start the trip, offering the users an enhanced one-stop shopping experience as they are accustomed to in e-commerce while hiding the complexity of moving to different providers apps or websites.

As subscriptions to individual services are handy and convenient for commuters and frequent travellers, the same concept applies to a wider range of mobility demand and services, supplied by different players. To this end, the key aspect of Level 3 MaaS are mobility packages; they require contractual integration between transport operators to build a common offer not only from the commercial and mobility point of view but also in term of regulations, responsibilities and customer care.

At the top of the table, the MaaS system is an instrument to implement mobility policies agreed between public authorities and private operators. This win-win approach combines the environmental and quality of service benefits of a public-hand regulated mobility with the increased business opportunities and improved efficiency for private operators that are involved in this scheme. This could be exemplified with the PTA setting up

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prerequisites for allowing reselling of the public transport service making sure that the MaaS-operators reach new customers while preserving business margins.

4.2 MAAS OPERATION

This section focuses on the workflow of existing MaaS providers in their day-to-day operation and ICT support.

4.2.1 MAAS FRONTEND

For the final user, the frontend part of a generic MaaS-platform is often an application on a personal device like an Internet-connected smartphone. The user interacts in real-time and sometimes on the move with the MaaS system to access information, forward requests and make choices in order to negotiate and get access to mobility services.

A typical workflow starts with the user requesting trip solutions from an origin position (usually the current phone GPS coordinates) to a destination. The most suitable solutions are displayed along with their prices or feasibility according to user subscription. The user then confirms his choice and the number of steps in the booking and ticketing dialogue depends both on payment method and the type of service.

For payments methods:

- In pay-as-you-go models (credit card or account), the process may include both retrieving price information, confirmation by the user and the payment provider.
- In subscription-based models, the MaaS platform itself charges to the user subscription the amount for the trip.

For transportation modes:

- Finite resource modes like cars sharing and rental car need a much more tight integration on the front end, which includes the possibility to cancel, change the content and time of the booking in different ways.
- Unlimited (in principle) services with all responsibility staying with the provider such as public transport, and taxi/ride hailing, i.e. typical on-demand-services, usually don't require reservation and so are the less complicated from a transactional standpoint.

The ticketing phase can be complex as well, but electronic transport tickets can be delivered in form of vouchers, QR and NFC codes.

For MaaS level 3 services, at times the user knows in advance what type of service they will use for first trip segment (e.g. starting from home) and also where to pick it up (e.g. car sharing) and then the app will mainly be used to get access to that resource, i.e. to book or get a ticket. This means that sometimes the search for the best route (in terms of road and/or lines) is performed after the purchase and before the trip starts.

4.2.2 MAAS BACKEND

Business processes are usually performed in the backend part of the technological platform: in this context, supply-side tasks are performed and the importance and complexity of the backend functionality grows as the level of integration increases (e.g. when level steps up from 2 to 3).

Some of the business services performed at this level are targeted more towards the customer, such as subscription reporting, incentivisation management and trip planning, while others are more transportation business-oriented, such reservation, ticketing, settlement, analytics and roaming.

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4.2.2.1 CUSTOMER MANAGEMENT

Customer management activities comprise subscription management, mobility services pricing, invoicing and incentivisation.

Customer data, e.g. driver licenses, phone numbers, individual/family members/employees personal data, must be registered in the MaaS platform directly or through existing profiles in partner authorities and/or transport service providers systems.

MaaS operators can support bundling subscription services in package offers and apply different degrees of complexity in marketing policies and price models. The way this aspect is managed in the telecom world (mobile-systems) is a good blueprint. For example, a subscription based MaaS-service consists of different transportation modes/suppliers, supports some accounting schemes and multiple package levels. Users may be entitled to increment their service quota at additional charge.

The account model needs to handle different types of "currencies":

- Regular money-based account (also compatible with pay-as-you-go usage).
- Prepaid common or mode specific "tokens", such as fixed number of trips, included minutes (e.g. for public transport) and/or kilometres bundle (e.g. for car rental / vehicle sharing modes).

Starting from MaaS level 3, a distinction between end user and customer is possible:

- An end user may be linked to multiple accounts (individual, work, family) enabling different transportation services and payment modes (prepaid subscription, 3rd party payers etc.).
- A customer may be a self-managing individual or act as an account manager for a group of users (e.g. head of household, family, employer) unlocking different B2B schemes and markets (corporate travel, family account) and advanced commercial opportunities (custom offers, quantity discounts, corporate billing).

The user must be able to check the account status (balance, past and present bookings/tickets, etc.) and should be able to analyse his own mobility patterns and the system can suggest better packages or pre-settings. For some transportation modes, the MaaS operator may need to handle insurance products and coverage for the end user, e.g. CDW and CDR.

B2B customers can be provided advanced reporting per cost centre and additional mobility management tools enabling economic and environmental analysis and evaluation for benchmarking, control and improvement of costs and sustainability.

Different bonus and incentivisation schemes may be associated to the subscription account, either environmental based or encouraging off peak-hour usage, sharing of private vehicles or usage of shared resources, i.e. when the customers are becoming prosumers.

4.2.2.2 MAAS MANAGEMENT

The MaaS platform stand as a mobility broker between partner transport service providers and the user and so it regulates different levels of access for users and enforces established aggregation and offer policies for mobility options.

A bidirectional interface between the MaaS platform and the transport service providers manages booking/ticketing requests and usage modification or cancellation for mobility options that require a reservation.

At higher MaaS integration levels, settlements with the transport service providers may be cleared through ICT technologies, but nowadays many transport service providers are still missing advanced digital settlement interfaces (electronic data interchange, etc.) to support this.

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The settlement process may also include compensations for partnership related activities, e.g. for distribution and use of incentives and bonuses.

B2B customers will already have contracts with transport service providers that need to be implemented in the platform. This requires a flexible system or adaptations. For the B2B business case, it will also be necessary to interface with business trip systems like Amadeus and include GDS company and traveller profile.

A comprehensive and consistent registration of details in the MaaS operation (user behaviour, subscription choices, mobility patterns, transport service providers performance, etc.) is a key aspect to enable business data analysis.

On top of this, an analytics module capable of “big data” handling and analysis is beneficial to MaaS partners in many business areas:

- Mobility offer improvement.
- Quality of service monitoring.
- Service usage reports.
- Feedback on implemented policies.
- Transport resources (capacity) allocation.
- Urban infrastructure planning.
- Cost optimization and pricing models.

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5 REQUIREMENTS SPECIFICATION

Requirements describe single essential features or recommendable properties of the IMOVE Software enablers. IMOVE requirements have been gathered with different methodologies according to their functional or non-functional nature. An evaluation of their relevant overall importance and Living Lab priority has been performed; next sections specify requirements with the following descriptive fields:

- **ID:** Unique identifier for the specific requirement following the notation, AA-BB-NNN, where:
  - AA: Requirement type: FR for the functional and NF for the non-functional requirement.
  - BB: Requirement category. IMOVE comprises 12 categories for functional requirements category and 7 categories for the non-functional ones.
  - NNN: Incremental unique number for each AA-BB category.
- **Requirement:** Short description of the requirement.
- **Scenarios:** Comma separated list of the scenarios to which the requirement is related. The notation Sx-Sy represent an ordered set of scenario from Sx to Sy. This field is empty for the functional requirements coming from the WP1 or WP2. For the non-functional ones this information does not apply.
- **Turin, Manchester, Berlin, Gothenburg, Roaming:** Level of the requirement importance expressed by Living Lab and selected between three different grades (High, Medium and Low).
- **Importance:** represents the overall importance for the requirement. As explained in the methodology section, the overall importance is the outcome of the second round of the prioritization process taking into account both the prioritization of the living labs and the general project scope. This overall importance is expressed in MoSCoW notation that uses the following 4 different values:
  - **Must** - Features that absolutely have to be present in the system are categorized as Must.
  - **Should** - Features that are important to the success of the project, but are not mandatory are categorized as Should.
  - **Could** - Features that are nice to have but are not core features are categorized as Could.
  - **Won't** - Features that are not going to be implemented in the project are marked as Won't.

The declared overall importance does not take into consideration the technical feasibility of the requirements. The overall importance will be a reference for the subsequent task of architecture definition, where the technical feasibility will be further investigated and evaluated.

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5.1 FUNCTIONAL REQUIREMENTS

Functional requirements express functionalities IMOVE software enablers are expected to provide. They have been collected and analysed following the methodology described in the chapter 2. In that way, 69 functional requirements have been gathered and classified in 12 main functionalities.

These 12 main functionalities have been grouped in the following macro categories:

- User management.
- Mobility services management.
- Global system requirements.

5.1.1 USER MANAGEMENT

The following section contains functional requirements related to user management, grouped by functionality:

- User identity (ID).
- User preferences (UP).
- User subscription (US).
- User tracking (UT).
- User information (IN).
- User incentives management (NC).

5.1.1.1 USER IDENTITY

Table 2. User identity requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-ID-001	IMOVE defines a unique identifier for a person accessing the services	S1-S7	High	High	High	High	High	Must
FR-ID-002	Anonymous access to part of IMOVE functionalities is allowed	S1-S7	High	High	High	High	High	Must

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FR-ID-003	A valid IMOVE identity is required for personal and mobility services provision	S1-S7	High	High	High	High	High	Must
FR-ID-004	IMOVE user identity can be associated with IMOVE credentials (username/password) or third-party authentications	S1-S7	High	High	Medium	High	Medium	Must
FR-ID-005	IMOVE defines authorization levels for services	S1-S10	High	High	Medium	High	Medium	Could
FR-ID-006	In IMOVE, a group account can aggregate IMOVE identities (family or corporate groups) for centralized management of mobility services	S4,S8	Medium	High	High	Medium	Low	Must

5.1.1.2 USER PREFERENCES

Table 3. User preferences requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-UP-001	Mobility and service preferences for IMOVE users are stored in the system	S1-S7	Medium	High	Medium	Medium	Medium	Should
FR-UP-002	User's mobility app can request access and modify user preferences	S1-S7	Medium	High	Low	Medium	Medium	Could
FR-UP-003	Some user preferences are inferred from user choices and usage patterns	S1-S7	Medium	High	Low	Medium	Medium	Could

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5.1.1.3 USER SUBSCRIPTION

Table 4. User subscription requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-US-001	IMOVE manages service subscription information (included services, mobility balance, etc.) for a user	S1-S7	High	High	High	High	Medium	Must
FR-US-002	In IMOVE, a subscription balance can be expressed by an amount of money	S1-S10	High	High	Medium	High	Medium	Should
FR-US-003	In IMOVE a subscription balance can be expressed as available mobility units (ride count, minutes, kilometres)	S1-S10	High	High	Medium	High	Medium	Could
FR-US-004	IMOVE provides subscription usage information	S1-S7	High	High	High	High	Medium	Should
FR-US-005	User can receive advice on subscriptions based on his profile information	S4-S5	Medium	High	Low	Medium	Medium	Could
FR-US-006	Custom subscription package composition is supported	S3,S4,S5	High	Medium	Low	Medium	Low	Could

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5.1.1.4 USER TRACKING

Table 5. User tracking requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-UT-001	IMOVE records service requests submitted by the user mobility apps	S1-S101	High	High	Medium	High	High	Should
FR-UT-002	IMOVE registers requested trip origins / destinations	S1-10	High	High	Medium	Medium	Medium	Should
FR-UT-003	IMOVE registers favourite trip origins / destinations for an IMOVE identity	S1-S7	High	High	Medium	High	Medium	Could
FR-UT-004	IMOVE registers mean of transport choices for an IMOVE identity	S1-10	High	High	Low	High	Medium	Could
FR-UT-005	IMOVE keeps track of user mobility time / location patterns	S1-10	High	High	Low	High	Medium	Should

5.1.1.5 USER INFORMATION

Table 6. User information requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-IN-001	IMOVE generates informative messages to be delivered to the user	S1-S7	High	Medium	Medium	Medium	Medium	Should
FR-IN-002	IMOVE message generation depends on time and/or user location	S1-S7	High	High	Medium	High	Medium	Could

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FR-IN-003	IMOVE generates messages about user subscription status, usage and offers	S1-S7	Medium	High	Medium	Medium	High	Could
FR-IN-004	IMOVE generates messages about mobility services status and delays	S1-S5	High	High	Medium	High	Medium	Could
FR-IN-005	IMOVE generates personal mobility suggestions	S1-S6	Medium	High	Low	Medium	Medium	Should
FR-IN-006	IMOVE generates user targeted commercial messages (new services, marketing partnerships)	S1,S3-S10	Low	Medium	Low	Low	Low	Won't

5.1.1.6 USER INCENTIVES MANAGEMENT

Table 7. User incentives requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-NC-001	MaaS operators define in IMOVE a set of rules for mobility incentives based on marketing or environmental policies	S1-S7	High	High	Low	Medium	Low	Should
FR-NC-002	MaaS operators define in IMOVE a set of rules for user incentives dependant on the current time and / or user location and mobility request	S1-S7	Medium	High	Low	Medium	Medium	Could
FR-NC-003	MaaS operators define in IMOVE a set of rules for user incentives based on personal mobility indicators (metrics, patterns)	S4-S5	Medium	High	Low	High	Low	Could

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FR-NC-004	IMOVE automatically associate achievements (badges, virtual awards) to a user identity when specific conditions occur	S4, S5	Medium	Medium	Low	Low	Low	Could
FR-NC-005	IMOVE manages points/credits balance for an IMOVE user	S4, S5	Medium	High	Low	High	Medium	Should
FR-NC-006	IMOVE automatically increases point balance when specific conditions are met	S4, S5	High	High	Low	High	Medium	Could
FR-NC-007	IMOVE can request the delivery of electronic rewards (coupons, mobility vouchers) for users	S1-S6	Medium	Medium	Low	Medium	Medium	Could
FR-NC-008	IMOVE can assign mobility rewards to users in their mobility balance (discounts, credits, tickets)	S1-S6	Medium	Medium	Low	Medium	Medium	Could
FR-NC-009	IMOVE keeps track of the points/credits and rewards history for an IMOVE user	S4, S5	Medium	High	Low	Medium	Medium	Should

5.1.2 MOBILITY SERVICES MANAGEMENT

The following section contains functional requirements related to mobility services management, grouped by functionality:

- Trip planning (TP).
- Mobility services booking and ticketing (BT).
- Pricing and payment (PP).
- Roaming (RO).

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5.1.2.1 TRIP PLANNING

Table 8. Trip planning requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-TP-001	MaaS user phone app has to provide contextual information (location, destination) to request IMOVE services	S1-S7	High	High	High	High	High	Must
FR-TP-002	IMOVE provides a trip plan on request by user favourite mobile apps	S1-S7	High	High	Medium	Medium	Medium	Could
FR-TP-003	IMOVE provides trip plans taking into account user subscription services and constraints	S1-S7	High	High	Low	High	Medium	Could
FR-TP-004	IMOVE provides trip plans according to user preferences	S1-S7	High	High	Low	High	Medium	Should
FR-TP-005	IMOVE composes trip plans according to business policies (e.g. ranking trip solutions according to transport operator efficiency criteria)	S9,S10	High	High	High	High	Medium	Could
FR-TP-006	IMOVE provides full intermodal trip plans	S2,S4	High	High	High	High	Medium	Should
FR-TP-007	When applicable, IMOVE provides trip solutions with the relevant pricing information	S1-S7	High	High	High	High	Medium	Should

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5.1.2.2 MOBILITY SERVICES BOOKING AND TICKETING

Table 9. Booking and ticketing requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-BT-001	When applicable, IMOVE can request a reservation to public transport operators for segments of an IMOVE trip solution	S1-S7,S10	High	Medium	High	High	High	Should
FR-BT-002	When applicable, IMOVE can require a reservation for a shared ride for segments of an IMOVE trip solution	S2-S4,S7	High	Medium	High	High	High	Must
FR-BT-003	When applicable, user can offer to share a ride on his private car through IMOVE services	S1,S3	High	High	Low	High	Medium	Could
FR-BT-004	When applicable, IMOVE can request a shared vehicle reservation for segments of an IMOVE trip solution	S2-S3, S5	High	High	High	High	High	Should
FR-BT-005	When applicable, IMOVE can request public transport operator to issue electronic tickets/vouchers services for segments of an IMOVE trip solution	S1-S8, S10	High	High	High	High	High	Could
FR-BT-006	When applicable, IMOVE can request vehicle sharing providers to issue electronic tickets/access codes for segments of an IMOVE trip solution	S1-S8	High	High	Medium	High	High	Could

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5.1.2.3 PRICING AND PAYMENT

Table 10. Pricing and payment requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-PP-001	IMOVE provides pricing information for trip segments to public and private operators	S1-S7, S9,S10	High	High	High	High	High	Should
FR-PP-002	In IMOVE a trip solution price can be expressed by an amount of money	S8,S10	High	High	Medium	High	High	Should
FR-PP-003	In IMOVE a trip solution price can be evaluated by a ride count or by resources consumption (e.g. minutes, kilometres)	S1-S5,S7	Medium	High	Low	High	High	Should
FR-PP-004	IMOVE can apply pricing policies for pay-per-use and subscriptions	S1-S8	High	High	Medium	High	High	Could
FR-PP-005	IMOVE can ask MaaS operators to require payments	S1-S10	High	High	Medium	High	Medium	Could

5.1.2.4 ROAMING

Table 11. Roaming requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-RO-001	User favourite mobility apps on the smartphone can access roaming services through the integration of its backend services with IMOVE enablers	S6	High	High	Low	High	High	Should

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FR-RO-002	IMOVE evaluates user location to identify roaming MaaS operators	S6	High	High	Low	High	High	Must
FR-RO-003	IMOVE trip plans include different MaaS operated segments depending on trip start and end location	S6	High	High	Low	High	High	Should
FR-RO-004	For roaming, IMOVE considers MaaS services geographic coverage	S6	High	High	Low	High	High	Must
FR-RO-005	For each roaming partner, IMOVE stores information about transportation modes available for specific foreign MaaS customers	S6	High	High	Low	High	High	Should
FR-RO-006	For each roaming partner, IMOVE stores information about service levels available for specific foreign MaaS customers	S6	High	High	Low	High	High	Should
FR-RO-007	For each roaming MaaS couple, IMOVE stores agreed clearings for exchanged services	S6	High	High	Low	High	High	Could

5.1.3 GLOBAL SYSTEM REQUIREMENTS

The following sections contains functional requirements related to global system requirements:

- Open API (OA).
- System administration (SA).

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5.1.3.1 Open API

Table 12. Open API requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-OA-001	IMOVE receive mobility services information (availability, usage) from external service providers	S9,S10	Medium	High	High	Medium	High	Must
FR-OA-002	IMOVE B2B API are accessible from the Internet network through standard REST web services	S8,S9,S10	Medium	High	High	High	Medium	Must
FR-OA-003	IMOVE provides secure access to its B2B services via API key mechanism	S8,S9,S10	High	High	High	High	Medium	Must
FR-OA-004	IMOVE monitors B2B APIs usage	S8,S9,S10	Medium	High	High	Medium	Medium	Must
FR-OA-005	IMOVE provides a B2B API development kit and complete documentation	S8,S9,S10	High	High	High	High	Medium	Must

5.1.3.2 System administration

Table 13. System administration requirements

ID	Requirement	Scenario	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
FR-SA-001	IMOVE provides services for system administration tasks	S9,S10	High	Medium	Medium	High	Low	Could
FR-SA-002	IMOVE provides services for system configuration tasks	S9,S10	High	High	Medium	High	Low	Could

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FR-SA-003	IMOVE provides services for system and components monitoring	S9,S10	High	Medium	Medium	High	Low	Could
FR-SA-004	IMOVE provides a logging functionality to track system operation	S9,S10	Medium	Medium	Medium	High	Medium	Should
FR-SA-005	IMOVE produces global statistics of system usage	S9,S10	Medium	High	Low	Medium	Medium	Should

5.2 NON-FUNCTIONAL REQUIREMENTS

Non-functional requirements, also known as Quality Attributes, are the requirements that usually define system attributes such as performance, responsiveness, interoperability, privacy, data quality and other related aspects.

In their matter they describe how the system should work, place constraints on the system behaviour and elaborate characteristics of the system.

This section gives an overview regarding the non-functional requirements for the system.

5.2.1 SYSTEM NON-FUNCTIONAL REQUIREMENTS

System non-functional requirements have been organized in the following categories:

- Performance/reliability (PR).
- Interoperability, system interface, integration (SI).
- Extensibility/maintainability (EM).
- Usability (US).
- Standards compliance (SC).

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5.2.1.1 PERFORMANCE/RELIABILITY

The following table contains non-functional requirements related to the reliability of the system, its performance and error-recovery mechanisms.

Table 14. Performance/reliability requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-PR-001	Continuous accessibility at any time all year round	High	High	High	High	High	Should
NF-PR-002	Programmed service outages at night-time with the corresponding announcement at least 1 day before on the IMOVE site	High	High	Medium	High	Medium	Should
NF-PR-003	System fails less than 12 hours per year	Medium	Medium	High	High	Medium	Must
NF-PR-004	System is restored within 12hours in case of server goes down	High	High	High	High	Medium	Should
NF-PR-005	System is rolled back in previous version in case of fatal error spot within 12hours, after versioned update.	High	High	High	High	Medium	Should
NF-PR-006	System can scale to growing number of users without the increase in response times.	High	High	High	High	Medium	Should
NF-PR-007	Error log reports are generated and user is prompted to submit them in case of failure	High	High	High	High	Medium	Should

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5.2.1.2 INTEROPERABILITY, SYSTEM INTERFACE, INTEGRATION

This subsection deals with non-functional requirements related to integration of Living Labs and third party partners into the system.

Table 15. Interoperability, system interface, integration requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-SI-001	Architecture allows third-party partners to join the platform	High	High	Medium	Medium	High	Must
NF-SI-002	Common data model supports all Living Labs with minimum mandatory fields	High	High	High	High	Medium	Should
NF-SI-003	Data model is extensible to allow future improvements	High	High	High	High	High	Must
NF-SI-004	IMOVE common data model should be as generic and flexible as possible in order to timely support additional 3rd party partners in the future (e.g. the IMOVE Living Labs expansion)	High	High	Medium	High	High	Should
NF-SI-005	B2B APIs needs to follow the best practices and guidelines for API design.	High	High	High	High	Medium	Must

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5.2.1.3 EXTENSIBILITY/MAINTAINABILITY

Following table enumerates the non-functional requirements dealing with the future of the system - especially with the ease of maintenance and extensibility.

Table 16. Extensibility/maintainability requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-EM-001	Ease of understanding and implementation	High	High	High	High	Medium	Should
NF-EM-002	System supports the addition of new features	High	High	High	High	Medium	Must
NF-EM-003	System architecture not complex	Medium	Medium	High	High	Medium	Should
NF-EM-004	Quick and simple maintenance procedures	High	High	High	High	Medium	Should
NF-EM-005	Extensive system documentation	High	High	High	Medium	Low	Must
NF-EM-006	Modular system structure	High	High	High	High	Medium	Should

5.2.1.4 USABILITY

This subsection outlines the non-functional requirements related to the usability of system services. Specifically, the usability of B2B APIs are considered.

Table 17. Usability requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-US-001	Quick and easy user error recovery	High	High	Medium	High	Medium	Should
NF-US-002	Clear organization of information on the system	High	High	Medium	High	Medium	Must
NF-US-003	Clearly stated error messages - in web interfaces, as well as in B2B APIs	High	High	Medium	High	Medium	Must

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5.2.1.5 STANDARDS COMPLIANCE

System implementation should comply with a collection of industry standards. Following table contains the details.

Table 18. Standards compliance requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-SC-001	IMOVE web interface follows the most common accessibility standards	High	High	Medium	High	Medium	Must
NF-SC-002	IMOVE web services comply with well-established standards (SOAP, WSDL, etc.)	High	High	Medium	High	Medium	Must
NF-SC-003	IMOVE makes use of widely accepted standards (e.g. GTFX, NeTEx, GDF, etc.) with respect to mobility services, public transport network, points of interest, etc.	High	High	Medium	High	Medium	Should
NF-SC-004	Well established formats regarding data exchange are used (e.g. XML, JSON)	High	High	Medium	High	Medium	Must
NF-SC-005	Front end development adheres to the requirements and standards determined by the W3C consortium (DOM, CSS, XPath, etc.)	High	High	Medium	High	Medium	Must
NF-SC-006	Data and Service Model follows ITS and EU Guidelines	High	Medium	Medium	High	Medium	Should
NF-SC-007	IMOVE complies with well-established specifications concerning security (authentication, validation, authorization, encryption, etc.). Such standards include TLS, SSL, SAML, OAuth, etc.	High	High	Medium	High	Medium	Must

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5.2.2 DATA MANAGEMENT NON-FUNCTIONAL REQUIREMENTS

Data management non-functional requirements have been subdivided in:

- Privacy/security (SE).
- Data quality, availability and reliability (AR).

5.2.2.1 PRIVACY / SECURITY

Requirements enumerated in this subsection are related to the privacy of end users and information security.

Table 19. Privacy / Security requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-SE-001	System data backed up every 24h	High	High	Medium	High	Medium	Must
NF-SE-002	Data backups are stored securely	High	High	Medium	High	Medium	Should
NF-SE-003	IMOVE data replicated across a configurable number of servers in different physical locations for fault tolerance	High	Medium	Medium	High	Medium	Could
NF-SE-004	Communications between system data server and clients is encrypted	High	High	Medium	High	High	Must
NF-SE-005	The system allows for multiple user levels with different permissions, including operators/providers, travellers, etc.	High	High	Medium	High	High	Must
NF-SE-006	The access permissions for system data can only be changed by the system administrator	High	High	Medium	High	High	Must
NF-SE-007	Passwords are never viewable	High	High	Medium	High	High	Must
NF-SE-008	Unsuccessful login attempts are recorded on audit trail	High	High	Medium	High	High	Should

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NF-SE-009	Passwords expire in certain period (6 months).	Medium	High	Medium	Medium	Medium	Could
NF-SE-010	Passwords follow regular expression	Medium	High	Medium	Medium	Medium	Should
NF-SE-011	B2B API authentication uses API keys / secrets or API tokens instead of passwords.	Medium	High	Medium	Medium	Medium	Should
NF-SE-012	Security protocols are adopted	High	High	Medium	High	High	Must
NF-SE-013	User data is anonymized where applicable	High	High	Medium	High	High	Should
NF-SE-014	Users are allowed to have control over their own private information	High	High	Medium	High	High	Should

5.2.2.2 DATA QUALITY, AVAILABILITY AND RELIABILITY

This subsection deals with the non-functional requirements related to data: how the data should be maintained, referenced and used.

Table 20. Availability and reliability requirements

ID	Requirement	Turin	Greater Manchester	Berlin	Gothenburg	Roaming	Importance
NF-AR-001	The persistent layer of IMOVE implemented and designed with innovative solutions in order to ensure flexibility, scalability and performance with respect to database operations (e.g. data clean up, simplified schema, proper use of indexes, etc.)	High	High	Medium	High	Medium	Should
NF-AR-002	Data has to be fresh enough to guarantee correct solutions	High	Medium	Medium	High	Medium	Must
NF-AR-003	The reference data model should be structured by using well established standards in order to address reliability	High	High	Medium	High	Medium	Should

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NF-AR-004	The data translators and interfaces properly designed in order to ensure the reliability of data across different MaaS schemes (reliability of data between service providers, third party services, etc.)	High	High	Medium	High	Medium	Must
NF-AR-005	Persistent layer designed in a way to optimally and effectively address the IMOVE data analytics requirements (e.g. optimize persistent layer's query performance in order to optimally infer information related to mobility patterns, common places, user interests, etc.)	High	High	Medium	High	Medium	Could

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CONCLUSIONS

This document presents the requirement analysis and specification for the IMOVE software enablers, performed in the scope of WP2.

To gather requirements, a suitable approach has been established and agile methodologies have been followed, leveraging also on the contribution of other work packages running in parallel:

- WP4 produced 10 scenario definitions, which were used to derive most of functional requirements (through agile user stories).
- WP1 partners and domain experts contributed with MaaS business processes analysis (levels of integration, etc.), which in turn led to the identification of additional functional requirements.
- WP3 conveyed views and guidelines about data management (almost non-functional requirements).

In Task T2.1, an iterative process elaborated these inputs to collect, evaluate and prioritize functional requirements. Non-functional requirements have been defined through a top down workflow.

The analysis phase identified more than 100 requirements (including both functional and non-functional requirements).

Requirements have been evaluated by Living Labs partners for importance and prioritization, and an overall relevance grade for the project has been expressed in MoSCoW notation, providing a valuable input for subsequent work package activities. So far, the evaluation doesn't consider the technical feasibility of all of the requirements, as this will be further investigated and assessed in further activities that will be performed in the task 2.2, focused on the initial definition of IMOVE architecture.

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