



AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

D.6.1: Business logic for the matchmaking platform

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List of Acronyms

Abbreviation / acronym	Description
API	Application Programming Interface
EC	European Commission
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EEA	European Economic Area
CSS	Cascading Style Sheets
D1.1	Deliverable number 1 belonging to WP 1
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
GUI	Graphical User Interface
ID	Identifier
LSP	Logistics Service Provider
MLP	Matchmaking Logistics Platform
ORM	Object Relational Mapping
SSS	Short Sea Shipping
TEU	Twenty-foot Equivalent Unit
URI	Uniform Resource Identifier
VAT	Value Added Tax
WP	Work Package
XML	Extensible Markup Language

Executive Summary

The MOSES matchmaking platform, which is one of the innovations in the MOSES project, aims to offer match-making services to shippers, transport operators and other stakeholders. The purpose of this document is to present an outline of the business logic of the MOSES matchmaking platform through the provision of information about stakeholders that are involved, system requirements and architectural design. Firstly, the step-by-step methodology that has been followed for specifying the MOSES matchmaking platform business logic is described, while relevant use cases and scenarios that were presented in deliverable D2.2 are analysed. Subsequently, an overview of the MOSES Platform concept is presented, along with a state-of-the-art analysis and the overall business logic. The stakeholder groups that are associated with the platform are identified and the results of relevant stakeholder interviews are presented. Existing matchmaking platforms/products and initiatives are analysed and involved stakeholders are documented and classified into core and external stakeholders. Based on the use cases' analysis and the state-of-the-art analysis, as well as the interviews' results, a list of system requirements and the architectural design of MOSES Platform are defined, covering technical aspects (functional, non-functional requirements) and other relevant aspects, such as security/privacy and legal/regulatory requirements. The deliverable concludes with a summary of the significant outcomes of the aforementioned process.

1. Introduction

1.1 Purpose of the document

This deliverable presents the business logic of the MOSES matchmaking platform through the provision of information about involved stakeholders, system requirements and architectural design. It focuses on providing an overview of the use cases' and scenarios' analysis that were reported in Task 2.2 and presenting the business logic of the developed platform, based on a state-of-the-art analysis of current initiatives. In addition, this report targets to document the stakeholders involved, based on the main stakeholder groups that have been identified in deliverable D2.1 and analysed in deliverable D2.2, classify them and identify the ones that could serve as potential users of MOSES Platform. Finally, the main objective of the document is to describe the system requirements that the platform needs to fulfil in order to be operative and satisfy its scope and its stakeholders' needs, as well as to present the architectural design of the platform.

1.2 Intended readership

This deliverable is public and therefore it is addressed to all readers that are interested, targeting both members of the MOSES Consortium and external stakeholders of the MOSES project. The external stakeholders may include among others parties involved in the logistics industry, policy makers, research bodies and potential users of the MOSES matchmaking platform.

1.3 Document Structure

The document is structured in six chapters.

Chapter 1 introduces the purpose and scope of the document, as well as the intended readership and the document structure.

Chapter 2 describes the methodology that is followed for the definition of the MOSES matchmaking platform business logic.

Chapter 3 presents the analysis of the use cases and scenarios that have already been defined and will serve as the basis for the MOSES Platform concept.

Chapter 4 outlines the overview of the MOSES Platform concept, including a state-of-the-art analysis, the definition of the business logic, the identification of core stakeholders and the relevant interviews conducted.

Chapter 5 provides the system requirements of the MOSES Platform, both functional and non-functional, the architectural design, as well as the security/privacy and legal/regulatory requirements.

Chapter 7 summarizes the concluding remarks of the MOSES Platform business logic.

2. Methodology

In order to define the business logic of the MOSES Platform, a thorough analysis was conducted, through the collection and assessment of information extracted from several sources. The first step consisted of the analysis of the use cases and scenarios that were described in D2.2 “MOSES Use Cases and scenarios” and are related to the platform. Based on this analysis, potential functionalities were extracted, covering some of the features that the platform should support. The next step was a state-of-the-art analysis of existing matchmaking platforms and initiatives, presenting an extensive list of available tools and services. Through this process, potential gaps and barriers were identified, as well as best practices and lessons learnt that are valuable and can be further studied.

In addition, the pool of stakeholders was presented and each stakeholder group's role in the shipping process was analysed. Based on the identified stakeholder groups, dedicated stakeholder interviews were conducted, aiming to clearly shape current processes and procedures, as well as to extract useful information and insights about tasks that could be improved and/or simplified through the MOSES Platform. Based on the results of the interviews, additional potential functionalities of the platform were extracted. In parallel, a refined list of stakeholders that can serve as potential users was defined and their workflows' breakdown and rights were described, along with current communication channels used.

Based on this approach, a set of user needs and required functionalities was collected and consolidated, stemming from the following three (3) sources:

- the user requirements defined in D2.1;
- the analysis of the use cases and scenarios from D2.2;
- the stakeholder interviews.

Furthermore, these user needs and functionalities were combined with the requirements related to the platform that have been defined in D2.4 “Specifications and requirements for MOSES innovations”. This led to the definition of relevant system requirements that MOSES Platform needs to meet in order to implement and support these functionalities. The system requirements were separated into functional and non-functional and prioritised, while the architectural design of the platform was defined. In addition, relevant security/privacy requirements have been described, as well as legal and regulatory aspects that need to be considered.

3. Use Cases' and Scenarios' Analysis

In order to identify the interactions between the MOSES Platform and its potential users, some high-level scenarios and relevant use cases were defined. These are presented in detail in deliverable D2.2 “MOSES Use Cases and scenarios”. These scenarios and use cases mainly focus on the user’s perspective, aiming to highlight the expectations of potential users of such a tool. In this deliverable, these use cases are analysed from the platform’s perspective and the associated processes and interactions are translated into relevant functionalities and system specifications that the platform needs to fulfil.

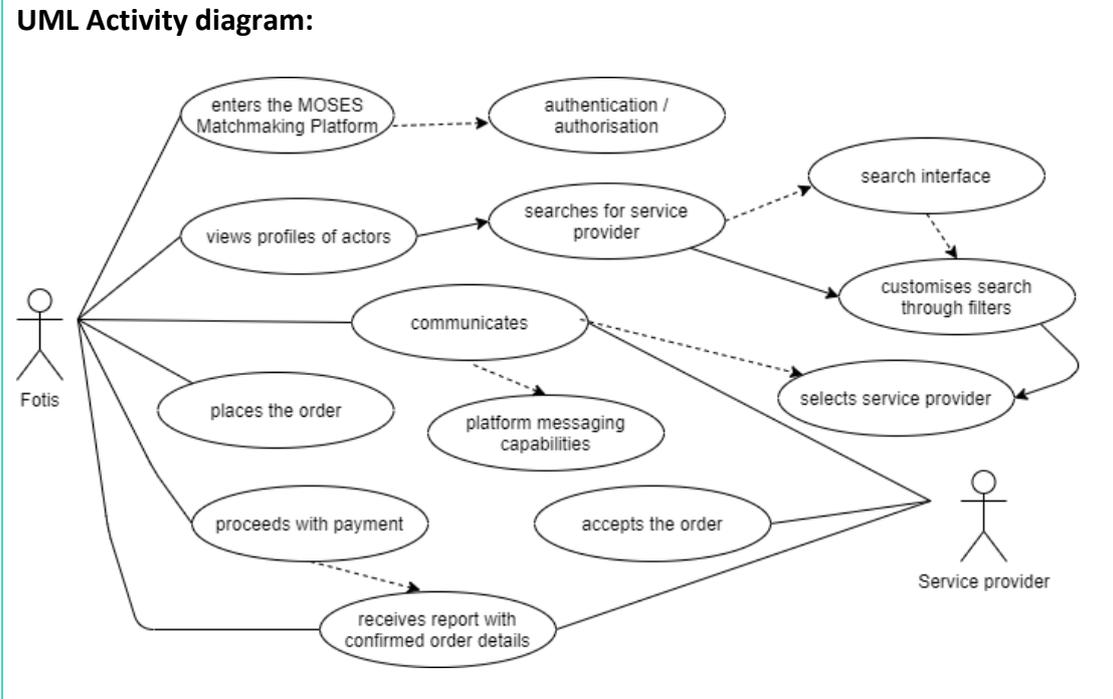
In D2.2, four different use cases are associated with the MOSES Platform. The template that is for their analysis is similar to the initial template of the use cases and depicts the title, the short description and the relevant UML activity diagram, as they were defined in D2.2. In addition, each use case was associated with relevant operational scenarios defined in D2.4 “Specifications and requirements for MOSES innovations”. Furthermore, the main processes foreseen for each use case were replaced by relevant functionalities that the platform should provide to perform the assigned activities.

<p>UCS2a</p> <p>Assessment of optimal routing in supply chain management</p>	
<p>Short Description:</p> <p>The Use Case covers the interaction of a shipper with the MOSES matchmaking platform aiming to assess and identify optimal routes during the cargo sending process.</p>	
<p>UML Activity diagram:</p> <pre> graph LR Actor[Fotis] --> A1(enters the MOSES Matchmaking Platform) Actor --> A2(initiates order) Actor --> A3(finalises the order & receives report) A1 -.-> F1(authentication / authorisation) A2 --> F2(cargo & transportation characteristics; optimisation criteria) A3 -.-> F3(selects preferred transportation route) F2 --> F4(view alternatives of transportation modes) F2 --> F5(CRUD operations) F4 --> F3 </pre>	
<p>Relevant Operational Scenarios:</p> <p>SC_MLP_1, SC_MLP_2</p>	
<p>Main functionalities required:</p> <ul style="list-style-type: none"> – Authentication/ authorization 	

- Dedicated interface for insertion of cargo details and transport characteristics
- Selection of optimization criteria
- Available transport options ranking
- Order editing and route recalculation
- Reporting of order details

UCS2b
Inter-actors order assignment and acceptance

Short Description:
The Use Case covers the interaction between different actors involved in the supply chain management towards the assignment and acceptance of orders for cargo transportation. It focuses on the “shipper” persona.

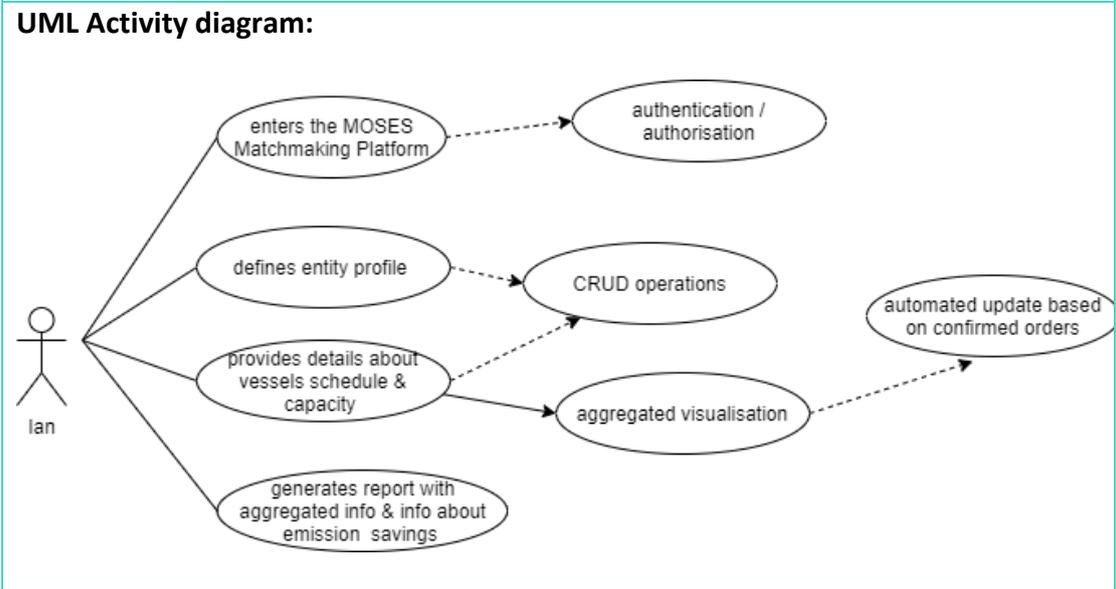


Relevant Operational Scenarios:
SC_MLP_5

- Main functionalities required:**
- Authentication/ authorization
 - Actor profiles
 - Interface with search capabilities and service selection
 - Dedicated interfaces for insertion of cargo details and transport characteristics
 - Available service filtering
 - Price request
 - Messaging capabilities
 - Reporting of order details

UCS3
Addressing demand-supply for carrier services

Short Description:
The Use Case covers the interaction of a carrier with the MOSES matchmaking platform aiming to ensure viable and balanced product supply-demand and container flow.



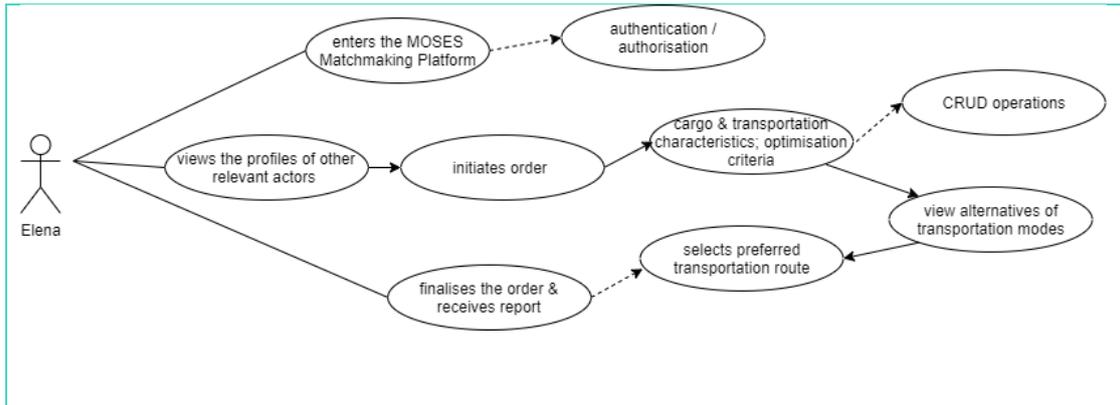
Relevant Operational Scenarios:
SC_MLP_3, SC_MLP_4

- Main functionalities required:**
- Authentication/ authorization
 - Dedicated interfaces for insertion and update of profile details
 - Insertion of vessel schedule, capacity and cost details
 - Visualization of transport services details
 - Order confirmation and capacity update
 - Reporting of transport services, including emission savings

UCS4
Addressing demand-supply for freight forwarder services

Short Description:
The Use Case describes the interaction of an Operations Manager of a freight forwarder with the MOSES matchmaking platform towards the selection of the most suitable cargo transportation route.

UML Activity diagram:



Relevant Operational Scenarios:

SC_MLP_1, SC_MLP_2

Main functionalities required:

- Authentication/ authorization
- Dedicated interfaces for insertion of cargo details and transport characteristics
- Provision of alternative transport modes and associated costs
- Friendly representation of results
- Combination of different transport modes
- Display of route characteristics (timing, stops, costs, etc.)
- Web visualization of logistics routes
- Order editing and route recalculation
- Reporting of order details

Based on the above analysis, an initial list of functionalities extracted by the use cases is presented in Table 1.

Table 1: Use cases' functionalities

ID	Functionality
MLP_FUNC_01	Authentication/ authorization
MLP_FUNC_02	Actor profiles
MLP_FUNC_03	Dedicated interfaces for insertion of cargo details and transport characteristics
MLP_FUNC_04	Dedicated interfaces for insertion and update of profile details
MLP_FUNC_05	Interface with search capabilities and service selection
MLP_FUNC_06	Insertion of vessel schedule, capacity and cost details
MLP_FUNC_07	Selection of optimization criteria
MLP_FUNC_08	Available transport options ranking
MLP_FUNC_09	Available service filtering

ID	Functionality
MLP_FUNC_10	Price request
MLP_FUNC_11	Messaging capabilities
MLP_FUNC_12	Order confirmation and capacity update
MLP_FUNC_13	Order editing and route recalculation
MLP_FUNC_14	Provision of alternative transport modes and associated costs
MLP_FUNC_15	Friendly representation of results
MLP_FUNC_16	Combination of different transport modes
MLP_FUNC_17	Visualization of transport services details
MLP_FUNC_18	Display of route characteristics (timing, stops, costs, etc.)
MLP_FUNC_19	Web visualization of logistics routes
MLP_FUNC_20	Reporting of transport services, including emission savings
MLP_FUNC_21	Reporting of order details

This list is extended based on the outcomes of the stakeholder interviews presented in chapter 4.5.1.

4. MOSES Matchmaking Platform

In this chapter, an overview of the MOSES Platform concept is presented, along with a state-of-the-art analysis and the overall business logic. The stakeholder groups that are associated with the platform are identified and the results of relevant stakeholder interviews are presented.

4.1 Overview

The purpose of the MOSES Matchmaking Logistics Platform (MLP) is to support digital and horizontal collaboration among shippers and carriers, aiming to maximize Short Sea Shipping (SSS)¹ demand and balance backhaul traffic. The platform that is currently under development will be a cloud-based digital marketplace that employs an advanced matchmaking logic for optimal cargo allocation and tools for further analysis of logistics process, tailored to each stakeholder type. The matchmaking should ensure high load factors for the SSS for both direction of travels, implying cost reduction and lower environmental footprint.

Many platforms and initiatives have been introduced in the last years, aiming to fill the gap between supply and demand and optimise the shipping process by getting shippers and carriers in contact and automating some of the communication procedures. The following chapters provide a state-of-the-art analysis of current platforms and initiatives, along with best practices and lessons learnt that could be adopted and further studied, enhancing the value of such tools. Subsequently, the business logic of the MOSES Platform is defined, highlighting the advancements of the platform compared to existing tools and current initiatives. Moreover, relevant stakeholders are identified, providing also valuable input for the definition of system requirements of the platform.

4.2 State-of-the-Art Analysis

The MOSES Platform needs to be functional, useful for its stakeholders and competitive in relation to relevant tools. For this reason, a state-of-the-art analysis has been performed, in order to examine current tools and products, assess their performance and benefits and identify gaps and opportunities for further research. The following chapters present the analysis of existing matchmaking platform and initiatives, the results of their assessment, the best practices that are identified and the lessons learnt. The business concept of the MOSES Platform is based on the outcomes of this analysis and is described in Chapter 4.3.

¹ SSS refers to the transportation of goods over relatively short distances, as opposed to the intercontinental cross-ocean deep-sea shipping.

4.2.1 Existing Matchmaking Platforms and Initiatives

Currently, several matchmaking platforms/products and initiatives are used for horizontal collaboration and data sharing between stakeholders involved in freight logistics processes. These platforms may target shipping companies, port authorities, terminal operators, warehouses and transport hubs and any other entity involved in the freight logistics process. An extensive list of such platforms/products is the following:

- Cluster Community System – Clusters2.0 project²
Cluster Community System (CluCS) is an IT platform developed under the EU-funded research programme Clusters2.0 that manages the resources within a cluster and the synchronization of operations in the cluster network of hubs, terminals and warehouses. CluCS supports shippers to visualise and book services and logistic service providers (LSPs) to publish and make their services available. In parallel, it enables cargo bundling at the cluster level, integrating transport services with terminal operations and value-added services, allowing also monitoring and notification of unexpected events, and dynamic re-planning and execution. CluCS can be defined as a “physical platform”, as it offers services strictly related to physical facilities and within the defined geographical boundaries of a Proximity Terminal Network (PTN). The main beneficiaries of CluCS are shippers, LSPs, freight forwarders and different companies active in a cluster. Especially for SMEs, CluCS represents the advantage of digitising their transport chain, making them more competitive. CluCS coordinates and optimises the logistics resources and infrastructure of a cluster through a cooperative booking and planning of transport, handling and services. This leads to reduced logistics costs, due to consolidation of shipments; shorter lead times, due to synchronised multimodal solutions; increased volumes; and increased reliability, due to visibility and monitoring functions at cluster level.
- CargoStream³ - Clusters2.0 project
CargoStream is an independent Pan-European platform developed under Clusters2.0 project that helps participating shippers to reduce their truck transportation kilometers by bundling their regular transportation needs with other shippers. In this way, vehicle fill rates can be improved, distribution routes can be optimised and use of multi-modal transportation can be improved. CargoStream provides an interconnected, neutral and open network on which shippers, intermodal terminals, logistic service providers and optimizing trustees collaborate by synchronizing supply chain

² <https://www.clusters20.eu/>

³ <http://www.cargostream.net/>

requirements with the right combination of transport modes, leading to reduction of road transport volume. Moreover, this modal shift results in congestion avoidance, CO₂ reduction and minimization of transportation cost, improving in parallel the quality level of the provided services and the overall sustainability.

- Mix-Move-Match⁴

The Mix-Move-Match platform is an innovative Software as a Service (SaaS) solution for supply chain collaboration that integrates multiple suppliers and logistic service providers into an open cooperation network. Re-thinking the classic approach to logistic, it contributes to cheaper and cleaner transport and greater margins to both suppliers and the logistic service providers, based on hyper-connectivity, stakeholder collaboration and cargo consolidation. It provides resource optimisation through horizontal / vertical collaboration, logistic network optimisation and last-mile distribution. The Mix-Move-Match provides supply chain control and visibility, stock visibility across locations, loading unit optimization and performance monitorization to shippers, as well as transport management, contract logistics, cross-docking and receiving planning and scheduling to transport hubs. In parallel, it supports bookings, customer service, operations control, mobility, claims, linehails and other services for carriers.

- NEXTRUST⁵

The main objective of the EU-funded research programme NEXTRUST was to increase efficiency and sustainability in European logistics by developing interconnected trusted collaborative networks along the entire supply chain. These trusted networks, built both horizontally and vertically, fully integrate shippers, logistics service providers (LSPs) and intermodal operators as equal partners. The C-ITS cloud-based smart visibility software that was developed supports the re-engineering of the networks, improving real-time utilization of transport assets. Through this tool, the freight volumes are not only bundled, but also shifted off the road to intermodal rail and waterways, leading to increased sustainability.

- AEOLIX⁶

Under the EU-funded research programme AEOLIX, a cloud-based collaborative logistics ecosystem for configuring and managing (logistics-related) information pipelines was established. The AEOLIX Platform represents a critical way forward of supply chain visibility and interoperability through decentralized information sharing. AEOLIX cloud services provide

⁴ <https://www.gs1pt.org/wp-content/uploads/2018/03/MIX-MOVE-MATCH-VI-SEMIN--RIO-BPC.pdf>

⁵ <https://ec.europa.eu/inea/en/horizon-2020/projects/h2020-transport/logistics/nextrust>

⁶ <https://aeolix.eu/>

connectivity to multi-actor data and in-house or cloud-based applications, processes and services, thus enhancing collaboration and interoperability, potentially across the entire transport and logistics sector. Through this platform, services such as enhanced supply chain visibility, automation of data flow and optimised transport services are supported, leading to fewer costs and CO₂ emissions, increased load factors, efficiency and resilience and improved transport management in general.

- SELIS⁷

The EU-funded research programme SELIS was aimed at delivering a “platform for pan-European logistics applications”. The developed Shared European Logistics Intelligent Information Space (SELIS) is a network of logistic communities’ specific shared intelligent information spaces, called SELIS Community Nodes (SCN). Individual logistics communities construct SCNs to facilitate the next generation of collaborative, responsive and agile green transportation chains. SCNs link with their participants’ existing systems through a secure infrastructure and provide shared information and tools for data acquisition and use, according to a 'cooperation agreement'. Connected nodes provide a distributed common communication and navigation platform for Pan European logistics applications. Each Node decides what information wishes to publish and what information wants to subscribe to.

- ALICE roadmaps⁸

The European Technology Platform (ETP) ALICE is set-up to develop a comprehensive strategy for research, innovation and market deployment of logistics and supply chain management innovation in Europe. One of its main activities is to define research and innovation strategies, roadmaps and priorities agreed by all stakeholders to achieve the ETP on Logistics vision. Five different thematic groups have been established in order to promote ALICE mission and vision and support research and innovation over the logistics field. The thematic group 3 dedicated to “Systems & Technologies for Interconnected Logistics” is focused on achieving real-time (re)configurable supply chains in (global) supply chain networks with available and affordable ICT solutions for all types of companies and participants. Some of the main topics that are addressed in this thematic group refer to visibility of end-to-end supply chains, seamless data interoperability, ownership & governance, intelligent objects, smart devices, IoT & ITS, Big Data & Data Analytics, Blockchain applications to logistics, autonomous logistics operations, transshipment technology and handling of logistics units. In parallel, a market

⁷ <https://ec.europa.eu/inea/en/horizon-2020/projects/h2020-transport/logistics/selis>

⁸ <http://www.etp-logistics.eu/>

watch for commercial logistics platforms is performed dynamically to identify relevant tools and promote such initiatives.

- TradeLens platform⁹

TradeLens is an open and neutral supply chain platform underpinned by blockchain technology. Through this platform, data sharing and collaboration across supply chains are feasible, aiming to increase industry innovation, reduce trade friction and promote global trade. TradeLens is targeted to traders, freight forwarders, inland transportation, ports and terminals, ocean carriers, customs and other government authorities, supporting their collaboration and enabling digitization and automation of cross-organizational business processes.
- Naviporta¹⁰

Naviporta is an online platform that provides tools and services for easy, transparent and reliable supply chain management for shippers and cargo owners. It connects trading partners (shippers & cargo owners), service providers, regulators, ports, insurance companies and financial institutions, enabling them to share data and digital assets, market their services and develop new applications. Based on blockchain technology, it supports interoperability between the various parties in the supply chain.
- DTLF - CEF projects¹¹

The Digital Transport and Logistics Forum (DTLF) is a group of experts that brings together stakeholders from different transport and logistics communities, from both the private and the public sector, intending to build a common vision and road map for digital transport and logistics. The DTLF also contributes to identifying needs for measures at EU level and supporting their development and implementation where relevant. Two CEF projects have been funded in order to deploy the concepts developed in DTLF: FEDeRATED and FENIX. FEDeRATED is an EU project for digital co-operation, aimed to deliver the foundations for a trustworthy and interoperable business and administrative data-sharing infrastructure for freight transport and logistics. FENIX is an EU project developing a federated architecture for data sharing, serving the European logistics community of shippers, logistics service providers, mobility infrastructure providers, cities, and authorities in order to offer interoperability between any individual existing and future platforms.

⁹ <https://www.tradelens.com/>

¹⁰ <https://naviporta.com/>

¹¹ <https://www.dtlf.eu/#>

- eCustoms¹²
eCustoms is an online cloud platform for international shipping, automating processes and transactions based on blockchain technology. It provides data sharing and documentation services, enhancing the digital transformation in the logistic processes and simplifying customs clearance process.
- ENTRANCE EU Matchmaking Platform¹³
ENTRANCE EU Matchmaking Platform is a platform that is under development as part of ENTRANCE project, aims to: (i) connect a critical mass of relevant stakeholders from the “supply-demand-finance” triangle in the entire transport and mobility sector, including all transport means and modes; (ii) create an increased visibility of “first-of-a-kind” transport solutions, foreseen replacement plans and schedules of major buyers and public and private financing opportunities; (iii) do an automatic matchmaking that will facilitate the scale up, market uptake, and access to finance.

4.2.2 Results and Barriers

All the aforementioned platforms, tools and initiatives have been developed and implemented in the last years, aiming to improve shipping process and increase logistics efficiency. As the digitalization of shipping and logistics procedures is a quite new and complex task, these initiatives serve as a first step towards developing advanced tools and providing automated solutions that will boost the supply chain role and performance. For this reason, most of these platforms only deal with a specific issue or procedure of the supply chain, leaving aside other important aspects and services that directly affect the logistics process’ performance.

One major shortcoming of current platforms and initiatives is the exclusion of SSS services and the lack of relevant transportation. According to the current state-of-the-art analysis, the freight-exchange platforms currently in operation focus on road transport, so they are not suitable for SSS services. At the same time, there are growing efforts – both in the context of research projects, as well as in commercial products – for cargo consolidation and collaboration among logistics stakeholders, but they have so far predominantly addressed road and rail transport. Such efforts support horizontal collaboration of shippers, carriers, distributors etc., aiming to increase long-term freight consolidation over road and rail, but none of these consider water-based transport modes nor the specificities of SSS.

In parallel, many of the platforms developed focus on specific stakeholder groups, providing services that support their duties, but they do not allow them to communicate and collaborate with other stakeholder groups. This leads to a

¹² <https://myecustoms.com/en/home/>

¹³ <https://www.entrance-platform.eu/>

degradation of the services provided, as the users of current tools are forced to use different tools for their tasks or execute some of them manually. The provision of a tool that could serve as a single communication point covering all required activities for different stakeholder groups would be beneficial for the whole industry, enhancing the overall logistics performance.

In addition, the lack of combined and multimodal options is quite common in the majority of current tools and initiatives, as the combination of transport modes and the automation of such a process is quite complex, so most of them are designed to provide information about services of single transport means. However, multimodality as a concept can be of great importance for the enhancement of supply chain flow, productivity and capacity, while in parallel it can promote the cooperation among logistics stakeholders, reduce the overall cost and time required for the transportation of cargo and goods and improve the associated environmental footprint.

4.2.3 Best practices and Lessons Learnt

Based on the state-of-the-art analysis of current platforms and tools and relevant results that were presented in the previous chapters, a set of best practices is extracted, covering all functionalities and provided services that have been proved to be useful in the logistics sector and improve daily procedures and overall efficiency of the shipping process, optimizing freight transport and logistics. The most common but also important best practice of all aforementioned tools is the provision of data sharing services, covering data related to infrastructure, digital assets, documentation, transportation services, etc. In this way, these tools serve as a marketplace, where the service providers can share relevant information, market their services and reach potential clients through a transparent and interoperable channel, while entities that are interested in finding transportation services can easily assess available options and communicate with relevant providers. This common communication environment can simplify and accelerate current time-consuming procedures, reducing the use of several means and channels and thus the associated risk of missed information or mistakes.

In parallel, these tools enhance the cooperation among stakeholders, serving as open cooperation networks and supporting services such as booking and transport planning in a cooperative and transparent way. Following the same approach, the enhancement of supply chain control and visibility of end-to-end supply chains is one of the most important and useful practices that have been implemented through these tools, increasing the transparency of transportation services, the company's sustainability performance and the overall consumer trust. Among the best practices extracted from the state-of-the-art analysis is the digitalization and automation of

shipping procedures and cross-organizational business processes, optimizing the assessment of available transport services and supporting advanced decision making.

Furthermore, the consolidation and bundling of transportation needs is the future of logistics sector. It can reduce time and cost, increase vehicle fill rates, optimise distribution routes and empty container management and improve the environment footprint. Combining this with a modal shift off the road to intermodal rail and waterways can optimise the transportation and distribution of freight cargo and improve the supply chain performance. In order to go beyond current state-of-the-art and provide innovative services, the adoption and implementation of these best practices is crucial for any tool that is currently developed, serving as a starting point for further evolution of provided services, efficiency improvement and enhancement of the value of such tools and initiatives.

4.3 Business Concept

The MOSES Platform that is under development will be a digital collaboration and matchmaking platform that aims to maximise and sustain SSS services in the container supply chain by matching demand and supply of cargo volumes by logistics stakeholders using data driven-based analytics. It can dynamically and effectively handle changing of freight flows, increase the cost-effectiveness of partial cargo loads and boost last-mile/just-in-time connections among the transport modes and backhaul traffic. In this way, its users will experience the benefits of a collaboration and optimisation tool that prioritises SSS and is able to deliver impactful results for all stakeholders involved.

The advancements of the MOSES Platform compared to current state-of-the-art are focused on supporting cargo consolidation (at container level) and fully exploiting the bundling potential among different shippers to enable multimodal transport routes containing at least an SSS leg. This is done in existing but underutilised SSS routes, currently not preferred by shippers due to increased costs or low service frequency and reliability. The platform aims to serve as a single communication channel between shippers and carriers and support negotiations and order monitoring.

The MOSES Platform will focus on collecting available information and datasets related to logistics supply and demand from relevant stakeholders, such as shippers, carriers, freight forwarders, shipping lines etc. Through the combination of these datasets, valuable information can be extracted, supporting the optimization of the logistics process. The main logic of the platform is not the production of any data, but the assessment of current datasets and the provision of advanced and targeted information to interested parties through data analytics. The main benefit of this analysis is the provision of multimodal transportation options, combining different transportation means and modes that can reduce the delivery time and the overall

cost. In parallel, the combination of multimodal transport services with freight cargo bundling can increase the efficiency of transport operators and improve the management of empty containers.

Furthermore, the platform's user interface that is currently under development will support custom sorting and filtering of available options, according to each user's criteria. This can be very useful in cases where the available options are so many that the user cannot easily check and assess them in order to find the most suitable one. Each user can define some search constraints to filter the results that will be presented based on cost or time, by selecting the desired cost window or delivery time window. In parallel, the results have several attributes such as the associated environmental footprint, the number of transshipments, the estimated times of arrival and departure (EtA, EtD), the turnover time (ToT) etc., based on which the user can sort the results and assess the preferable ones.

Another advancement compared to current tools and platforms is that the MOSES Platform calculates the estimated times of arrival/ boarding/ departure taking into account the transshipment windows or buffer times required for each transport mode or stakeholder group, providing more accurate estimations and thus more reliable transport options. In parallel, the platform is designed in such a way that it can interact and exchange information with federated logistics platforms and public authorities.

4.4 Core Stakeholders

In order to define the direct and indirect stakeholders of the MOSES matchmaking platform, firstly some general stakeholder categories from the shipping industry were selected to serve as core stakeholders that constitute the ecosystem of the matchmaking platform. These stakeholders were selected based on the main stakeholder groups that were identified in deliverable D2.1 "MOSES stakeholder and end-users needs" and analysed in deliverable D2.2 "MOSES Use Cases and scenarios". From these main stakeholder groups, potential users of the matchmaking platform were selected, including but not limited to the following categories: shippers, carriers / transport operators, freight forwarders, shipping lines, operators of connecting transport modes, local SMEs and industry and others. As already mentioned, these stakeholders will serve as the basis for the definition of the MOSES Platform concept, as they will benefit from the platform services.

MOSES matchmaking platform will be a key tool for horizontal collaboration among shippers, liner agents, freight forwarders and carriers, as it is expected to face uprising demands and at the same time to balance backhaul traffic. The platform will also serve as a useful tool for logistics stakeholders within the entire supply chain to consolidate and match cargo flows in both directions, book/trade containers with shippers/ freight forwarders, communicate freight cost with shippers and arrange/ track container

movements. In addition, truck drivers in transport/logistic companies for container to/from quay side will also be benefitting from the autonomous container handling system as they will get notifications in advance about container availability status for transportation. In this chapter, a general description of each category of the core stakeholders is presented, in order to provide an overview of their roles, responsibilities and needs.

4.4.1 Shippers

A shipper is a person who is entrusted with the responsibility of transportation of goods and commodities, ensuring that no complications arise during the cargo-sending process. The shipper is the cargo owner, dealing with all the necessary administrative procedures to complete the transportation, including the bill of lading¹⁴. The shipper is mainly responsible for transport booking, cargo packaging and communication with the freight forwarder or directly with the carrier. In general, shippers are in charge of the first leg of the shipping process, undertaking to check, pack, mark and prepare the goods for delivery, while in some cases, they may also obtain the proper licenses for export and import, carry out the requirements needed for customs clearance at the origin port or destination port and contract carriage for the delivery of the goods¹⁵. Among other activities, the shipper's duties include: classification and declaration of goods; packaging in compliance with relevant regulations; labelling items with the proper shipping name, UN number, hazard labels and, when appropriate, a marine pollutant label; certification about correct packaging, labelling and suitability for transportation by sea; ensuring that incompatible goods are not stowed in the same transport unit; and issuing a stowage certificate when stowing in a container or hold¹⁶.

4.4.2 Carriers / Transport Operators/ LSPs

A Carrier or Transport Operator or Logistics Service Providers (LSPs) is a person or company that is legally authorised and responsible for the transportation of cargo from one place to another using different modes of transport systems (e.g. feeder vessels, rail, trucks, road transportation etc.), either directly or using a third party. The main role of carrier firms is to provide transportation services, typically owning and operating transportation equipment. Several transport means can be used for cargo transportation, so carriers can be trucking companies, railroads, airlines, steamship lines, parcel/express companies etc. In the shipping industry, cargo is mainly moved by water, so typically carriers are:

¹⁴ <https://www.marineinsight.com/>

¹⁵ <https://www.shipafreight.com/>

¹⁶ <https://www.royalarcticline.com/>

- Terminal operator: company that contracts with the port authority to move cargo through a port, managing the movement of cargo containers between cargo ships, trucks and freight trains and optimizing the flow of goods through customs to minimize the amount of time a ship spends in port. The main responsibilities of a terminal operator include the receipt and delivery of containers to and from landside partners arriving by road or rail; the receipt and delivery of containers to and from seaside partners arriving by barge or ship; the transfer of containers between sea and land, and, finally, the storage of containers waiting to go or come¹⁷. In parallel, the terminal operator is in charge of supervising incoming and outgoing shipments, performing quality control inspections and making sure terminal equipment is in good working condition and is also responsible for managing paperwork, leases, safety and port security.
- Trucking company: company in charge for the movement of cargo and goods before embarking on its international or long-distance journey. Local truckers collect the freight from the storage facility (warehouse) and bring it to the place where it must undergo processing and handling (port). Trucking companies are also responsible for the last part of the cargo transportation after the disembarkation from the vessel towards the warehouse or logistics hub where it will be re-loaded to another transportation means or distributed to the customer¹⁸.
- Logistics operator: company that designs, manages and controls the supply chain of another company. Depending on the commercial agreement between both companies, the logistics operator can operate during supply, transport, storage and/or distribution¹⁹.
- Liner agent: person or company responsible for securing cargo for the line or ship operator. The liner agent is in regular contact with local shippers and ready to provide information on vessel schedules, competitive rates and carriage conditions, undertaking also inland transportation, customs clearance and other related services²⁰.
- Broker: person or company acting as an intermediate entity between a ship owner and a cargo owner, being in charge of coordinating the negotiation between ship owners and charters to arrange ocean transport of goods and

¹⁷ <http://www.globeinst.org/>

¹⁸ <https://www.asianausa.com/role-local-trucking-company-freight-forwarding/>

¹⁹ <https://www.airpharmlogistics.com/en/the-logistics-operator-what-it-is-and-what-its-functions-are/>

²⁰ <https://www.fonasba.com/wp-content/uploads/2012/10/Role-of-Agent-Final1.pdf>

commodities by sea. The broker is also responsible for buying and selling of ships, along with the negotiation and transaction details²¹.

4.4.3 Freight Forwarders

A freight forwarder, forwarder, or forwarding agent, is a person or company that organizes shipments for individuals or corporations to get goods from the manufacturer or producer to a market, customer or final point of distribution. Forwarders contract with a carrier or often multiple carriers to move the goods from one country to another. A forwarder does not move the goods but acts as an expert in the logistics network²². Freight forwarding companies arrange the whole process for their shippers, from storing the goods to shipping them internationally. Freight forwarders are intermediaries between the shippers and transportation services, negotiating with a range of carriers in order to achieve the most economical, reliable and fastest route. The carriers can use a variety of shipping modes, including ships, airplanes, trucks, and railroads, and often use multiple modes for a single shipment. International freight forwarders typically handle international shipments and have additional expertise in preparing and processing customs documentation and performing activities pertaining to international shipments. Information typically reviewed by a freight forwarder includes the commercial invoice, shipper's export declaration, bill of lading and other documents required by the carrier or country of export, import, and/or transshipment²³.

4.4.4 Shipping Lines

A shipping line is a company or organization that owns and operates vessels, responsible for the smooth transportation of the cargo aboard their ships. Shipping lines handle the cargo from the point of origin to the destination, majorly port to port, transiting regular routes on fixed schedules aboard their own vessels. They can act as carriers if they use their own containers, but they can also provide leasing services to other carriers to move their cargo using the shipping line vessels. Shipping lines also provide assistance to freight forwarders in terms of space availability, credit terms and regular communication²⁴.

4.4.5 Operators of connecting transport modes

The operators of connecting transport modes (or multimodal transport operators as they are usually called) are a special category of carrier/transport operator stakeholder group that provides transportation services combining two or more transport means (ship, truck, rail etc.). According to the Convention on International

²¹ <https://www.alchemyrecruitment.com/job-descriptions/ship-broker-careers>

²² https://en.wikipedia.org/wiki/Freight_forwarder

²³ <https://worldclassshipping.com/international-freight-forwarder/>

²⁴ <http://www.gwwlogistics.com/index.php>

Multimodal Transport²⁵, “international multimodal transport means the carriage of goods by at least two different modes of transport on the basis of a multimodal transport contract from a place in one country at which the goods are taken in charge by the multimodal transport operator to a place designated for delivery situated in a different country. The operations of pick-up and delivery of goods carried out in the performance of a unimodal transport contract, as defined in such contract, shall not be considered an international multimodal transport”.

Using different transportation means, the multimodal transport operators can execute of several legs of the transportation process, or even the whole cargo transfer, reducing transport cost and minimizing delivery time. The key responsibilities of a multimodal transport operator can be served by a freight forwarder or a carrier (logistics, truck, rail, air, sea or waterway). Even though the multimodal transport operator can sub-contract some services to other carriers, he still takes the full responsibility for the transported goods, the completeness, degree of damage, or encountered transport problems²⁶.

4.4.6 Local SMEs and Industry

The local SMEs and industry are indirect but important stakeholders for the overall supply chain sector, as they can affect and get affected by logistics processes daily and thus, their perspective is a key factor for decision making. This stakeholder group can include companies that are directly related to logistics, such as third parties that are involved in some of the processes or work on similar or supplementary activities, but also entities that work on a completely different domain and get affected by supply chain tasks due to their adjacency to a logistics hub, such as a port, a warehouse, a trucking company or a distribution centre. A typical case of logistics effect to the local community is the daily traffic congestion that can be created due to trucks entering and leaving a major port, having a strong impact on daily performance of companies located nearby. Another important aspect is the environmental footprint of logistics activities that affect people and companies that belong in the same ecosystem with a transport hub.

4.4.7 Port/ Airport authorities

In most countries, the port authority is a public or semi-public body responsible for managing and improving the port area through the construction and maintenance of infrastructure, the leasing or concessionary provision of this infrastructure to private companies, and the growth and competitiveness of the port cluster²⁷. Port Authority

²⁵ https://unctad.org/system/files/official-document/tdmtconf17_en.pdf

²⁶ <https://www.shiphub.co/multimodal-transport/>

²⁷

https://www.researchgate.net/publication/349846573_The_Role_of_Port_Authority_in_Port_Governance_and_Port_Community_System_Implementation

controls, legalizes and manages all the port and marine services, facilities and activities within the concerned country waters, it also includes management of vessel traffic, improvisation of navigational safety, and facilitation of security and environmental management at the port²⁸. On the other hand, the airport authority is usually an independent entity charged with operating and overseeing an airport or group of airports²⁹. In general, the port authorities are responsible for managing, maintaining and improving the ports, policing, safety and security matters within port limits, while airport authorities ensure that the requirements of international agreements on the security of air travel are met. Both authorities have a significant role in the shipping process, as they are in charge of all administrative issues related to the operation of ports and airports and serve as decision makers.

4.4.8 Warehouse operators

Warehousing refers to the provision of storage for the finished goods, along with packing and shipping of the order³⁰. A warehouse operator is responsible for monitoring the smooth running of the storage procedure, including processing orders, organising the dispatch and delivery of goods and ensuring goods are stored safely. The main duties of a warehouse operator refer to moving goods in and out of a warehouse or a depot. They carry out all product loading and unloading tasks, including preparation of outgoing stock for delivery, reviewing incoming deliveries of stock and operation of forklifts and order picking machines, which allow them to retrieve and store stock in high places. In parallel, they are responsible for scanning and tracking incoming and outgoing orders, receiving and processing new inventory, ensuring contents match manifest documents and inspecting receivables for defects, damages, or missing items. In addition, warehouse operators keep records of all the materials received and shipped and develop the mailing labels, as well as the shipping documents.

4.4.9 Other

Other stakeholder groups that could be potential users of MOSES matchmaking platform include persons or companies that are affected in an indirect way by the platform. Such stakeholders could be administration bodies or public services/authorities, statistic entities, customs etc. Administration bodies and public authorities focus on providing the policy framework under which the logistics industry shall operate, in terms of regulatory support and development, as well as contractual management and consultation. In parallel, statistical entities are responsible for the

²⁸ <https://www.marineinsight.com/>

²⁹ https://en.wikipedia.org/wiki/Airport_authority

³⁰ <http://www.santosintl.com/>

collection of data related to logistics and other domains, in order to analyse and interpret them and provide useful information about market values, trends, etc.

Customs is an authority or agency in a country responsible for collecting tariffs and for controlling the flow of cargo and goods³¹. Customs duty refers to the tax imposed on goods when they are transported across international borders, either imported or exported. The purpose of customs duty is to protect each country's economy, residents, jobs, environment, etc., by controlling the flow of goods, especially restrictive and prohibited goods, into and out of the country. The government uses this duty to raise its revenues, safeguard domestic industries and regulate movement of goods³². The customs authorities oversee the goods traffic entering and leaving the country, verifying that everything is legal and comply with the laws and regulations of the country. They are responsible for exercising customs control on the commercial international exchange, assessing and collecting customs duties and taxes in the part calculated at the State's border (VAT, excise), fighting against smuggling activity and counteracting customs fraud.

4.5 Stakeholder Interviews

The initial plan was to conduct physical and unstructured interviews with the stakeholders identified to discuss and collect information about their roles, responsibilities, interactions in the logistics process and needs and extract some insights into current procedures. In parallel, these interviews would allow to collect suggestions and features that these stakeholders would expect by a matchmaking platform. Due to COVID-19 pandemic and relevant restrictions that were in place in several European countries, it was impossible to conduct physical interviews and discuss face-to-face with the stakeholders. In order to overcome this barrier, online and semi-structured interviews were conducted. A structured questionnaire was designed and distributed to stakeholders, so they could fill it online prior to the online interview and then an open discussion based on their answers took place. The questionnaire was formed using open-ended questions, aiming to provide flexibility to the participants, requiring the respondents to elaborate on their points. In this way, it was possible to derive an overview of current procedures, challenges and needs from the stakeholders' perspective and collect their feedback in their own words, getting as closely as possible to the physical and unstructured interview approach.

At the beginning of the questionnaire, each participant was asked to define which one of the stakeholder groups presented in chapter 4.4 he/she represents. In case the "Other" category was selected, the participant was asked to specify his/her role. After the specification of the stakeholder group, the participants were asked to reply to

³¹ <https://www.wordreference.com/definition/customs>

³² <https://www.business-standard.com/about/what-is-customs-duty>

questions covering 3 main pillars: current practices, daily challenges and planning tools. In more detail, the goal was to identify the different stakeholder roles that are involved in the logistics process and collect detailed information about the current processes that are followed, the interactions among stakeholders, the data that are transmitted, the communication channels that are used and the risks associated in this process. In parallel, stakeholders were asked to provide feedback about any current planning software that they use, how the MOSES matchmaking platform could improve some of these processes and what would be requirements for such a tool. The detailed questionnaire is presented in Annex 1.

The targeted audience included participants from all aforementioned stakeholder groups, aiming to cover all aspects and identify potential needs or challenges that the developed MOSES matchmaking platform should address. The participants included the end-users of the MOSES project, i.e. VPF, CIRCLE, DANAOS and SEAB, as well as external stakeholders of the MOSES project that could be potential users of the platform and provide useful feedback. In parallel, the members of the MOSES Advisory Board were asked to participate in this activity and provide their insights and suggestions, as well as to disseminate the questionnaire to their networks to collect as much feedback as possible. This led to the collection of detailed answers from several participants, including representatives from the European Maritime Safety Agency (EMSA), covering all aforementioned stakeholder groups. These results and their analysis are presented in the following chapter.

4.5.1 [Results](#)

Through the interview process, the participants described current procedures and operations that are part of their daily duties, as well as associated risks and obstacles that may occur. Based on the feedback collected from the interviews, the participants mentioned several gaps identified during the state-of-the-art analysis as shortcomings and potential risks. One of the main risks they are called to face and that may obstruct the shipping process refers to the delays that may occur due to several reasons, such as bad weather, vehicle breakdowns, port delays or unforeseen route changes, cargo loss, cargo damage, cargo abandonment, fraud, risk of carrier's liability, improper documentation etc. All these variables can change at any point and disrupt the whole process.

In parallel, most of the participants claimed that both transport planning and control procedures are mainly done manually, increasing the required personnel, effort and time needed and leaving room for mistakes, inconsistencies and other associated risks. A typical example of this issue is the miscalculation of cargo transportation or storage assumptions, e.g. warehouse storage and relevant assumptions, leading to delays and increased cost. The automation of such procedures could improve daily operations, increase overall productivity and minimise inaccuracies.

A typical issue that all stakeholders in the shipping process meet is that data that is distributed among them may not follow the same data format or be incompatible with other tools that are used, leading to delays in the whole process and in most cases to mistakes made during the unification process. Currently, some general formats have been decided by international payers and are largely used for information exchange, such as EDIFACT messages, specific XML coding or other standards imposed by relevant players, but these standards are not adopted by all stakeholders, leading to variability of available formats. Such a case is the collection of data related to the rates of each available transportation means and route that are not published in a harmonized way. As a result, increased effort is required for their homogenization, in order to be able to compare them and select the most suitable one. The collection of all datasets in a specific and unique format for each data type could accelerate the assessment of available services, reduce the overall time needed and increase the efficiency of the shipping process.

A common remark from all stakeholders was related to the communication means currently used to give or get information about transport modes and their availability, schedules and rates, details of cargo that needs to be transported, order confirmation and editing, etc. Currently, the most common way to communicate with other stakeholders is through emails and even by phone. In some cases, mainly when small companies are involved, paper communication is still in use. The main risk related to this manual communication method is that sometimes responses are not immediate, leading to unnecessary delays, even for simple tasks such as getting information about available transport means and schedules. Bad or inadequate communication increases the risk of mistakes and associated uncertainties regarding ship arrivals and departures, port stays, cargo details etc., while language issues may occur through emails or phone impeding the communication even more. On the contrary, a harmonized approach ensures that although each stakeholder has a different perspective or different business objectives, all involved parties interpret the information in the same way, avoiding relevant inconsistencies.

Moreover, one of the main barriers in the logistics process is the continuous changing environment, as information about schedules, availability, rates, external factors are changing dynamically, affecting all activities and decisions related to the transportation of cargo. The majority of carriers do not have stable rates for the provided routes, while their availability may change without any notice. External factors and unexpected events such as road closure, vehicle breakdown or cargo damage are parameters that affect the delivery times and the agreed services. The inability to get feedback about the transport status may lead to delays and inaccuracies in estimated times of arrival, boarding and departure and thus to increased cost. The dynamic update of transport status based on this information in

real time is a key point for the efficiency of the shipping process, significantly enhancing the logistics industry's adaptability and sustainability.

Additionally, the transparency is considered important for the execution and efficiency of the logistics process. In most cases, the disclosure of the commercial tariffs is confidential and limited to clients that have requested a specific service or deal, leaving aside other parties that may take advantage of them. In this way, shippers have a limited overview of available service providers, while the carriers have a limited pool of clients. The publication of available transport services can ensure a broader offer of service providers and reduce the associated costs. Also, through the publication of such information, a shipper could select a multimodal option, while a carrier could combine two or more orders in one transportation route or service and improve the empty container management, optimizing the overall cargo stream. In parallel, the classification of carriers based on the provided services through a transparent rating scheme could optimize the quality of the provided services and reward the most efficient and reliable providers.

Another important conclusion is that the environmental impact of cargo transportation is not taken into account during the transport mode selection. Currently, the only parameters that affect the selection of a transport mode are the compatibility with the cargo type and its special characteristics, the delivery time and the overall cost, without considering any environmental factor. This is mainly due to the fact that there is no homogeneous way to calculate an GHG emissions, as most transport operators do not publish relevant data. The provision of such data and the estimation of associated GHG emissions could motivate users to select the most environmental-friendly transport mode in cases with similar delivery time and costs, leading to reduction of associated environmental footprint towards climate neutrality targets.

Apart from the gaps that were identified during the interviews and the benefits that the MOSES Platform could provide, many participants expressed their concerns regarding the foreseen role of freight forwarders. As the majority of their duties is planned to be executed automatically by the tool, they asked whether and how the implementation of such a platform could affect their jobs. Other participants claimed that covering all their duties through the platform will lead to the disappearance of freight forwarders from the market. However, as the shipping industry evolves, so do the players involved in the logistics market that adopt new technological tools and innovations to upgrade the provided services and increase their competitiveness. The role of freight forwarder is crucial for the execution of the whole shipping process and the MOSES Platform can assist in this process, by simplifying some of the daily operations of freight forwarders, increasing their efficiency and enhancing their status.

Based on the outcomes of the stakeholder interviews' analysis, some gaps and needs that could improve the shipping process and optimize the overall cargo transportation were extracted. MOSES Platform could address these gaps by providing relevant key functionalities and specifications that are summarised below:

Table 2: Interviews' functionalities

ID	Functionality
MLP_FUNC_22	Automation of transport planning and control procedures
MLP_FUNC_23	Template for unified data format
MLP_FUNC_24	Automated communication
MLP_FUNC_25	Direct access to information related to transport means and details – less manual communication
MLP_FUNC_26	Dynamic update of transport details
MLP_FUNC_27	Real-time information for unexpected events
MLP_FUNC_28	Feedback about transport status
MLP_FUNC_29	Transparency in available transport services
MLP_FUNC_30	Publication of all available service providers
MLP_FUNC_31	Provision of multimodal options
MLP_FUNC_32	Access to all transport routes and rates
MLP_FUNC_33	Combination of orders – empty container management
MLP_FUNC_34	Classification rating scheme for carriers
MLP_FUNC_35	GHG emissions estimation

4.5.2 Refined List of Stakeholders and Potential Users

According to the interview participants' feedback, it becomes clear that some stakeholders are key players in the logistics industry, while others may be involved in a less direct way. For this reason, the initial list of stakeholders that could be potential users of the MOSES Platform is refined to distinguish them based on their level of involvement to the shipping process and the ways they can benefit from the platform. Two distinct groups are identified, core stakeholders that can be potential users of MOSES Platform and external stakeholders.

The core stakeholder group consists of shipping agents, terminal operators, warehouse operators, freight forwarders, shippers, trucking companies and rail operators. The MOSES Platform directly impacts the daily operations and activities of these stakeholders. They can get significant benefits by its use, such as process simplifying, direct communication among them, calculation of estimated costs, support in decision making, etc. More specifically, the main user groups and their potential interconnections with the MOSES Platform are presented in Table 3.

Table 3: MOSES Platform potential users, tasks and interconnections

User group	MOSES Platform tasks	Interconnections
Shipping agents	Vessel routes, schedule & capacity publication Order execution & status monitoring Communication with other stakeholders	Shippers Freight forwarders
Terminal operators	Capacity update Order execution & status monitoring Communication with other stakeholders	Shipper Freight forwarders
Warehouse operators	Capacity update Order execution & status monitoring Communication with other stakeholders	Shipper Freight forwarders
Freight forwarders	Order request Information about available transport options Information about available matching options Communication with other stakeholders	Shipping agent Shipper Terminal operators Warehouse operators Trucking companies Rail operators
Shippers	Order request Information about available transport options Information about available matching options Communication with other stakeholders	Shipping agents Freight forwarders Terminal operators Warehouse operators Trucking companies Rail operators
Trucking companies	Truck services publication Order execution & status monitoring Communication with other stakeholders	Shipper Freight forwarders
Rail operators	Rail routes, schedule & capacity publication Order execution & status monitoring Communication with other stakeholders	Shipper Freight forwarders

On the other hand, the group of external stakeholders consists of logistics operators, liner agents, brokers, shipping lines, port/airport authorities, customs authorities, local SMEs and Industry. These stakeholders are part of a broader logistics approach as they can affect or get affected somehow by the actions and outcomes of the shipping process, but they are not directly involved in this process. Even if there is no direct relationship with the key services, the MOSES Platform can provide some functionalities that may affect the decision-making process of external stakeholder, such as the provision of information about supply and demand, shipping trends, available transport routes etc.

4.5.3 Workflows Breakdown and Stakeholders' Rights

In order to perform the associated duties, each stakeholder group follows a set of steps and procedures. In Table 4, a breakdown of the core stakeholders' workflows is presented, based on the feedback that was collected from the interviews.

Table 4: Breakdown of core stakeholders' workflows

Stakeholder group	Workflow breakdown
Shipping agents	<ul style="list-style-type: none"> • Communication with shippers and/or freight forwarders • Undertaking cargo transportation • Import of volume forecast • Transshipment options' evaluation • Accommodation on the first available feeder vessel
Terminal operators	<ul style="list-style-type: none"> • Communication with shippers, shipping agents and/or freight forwarders • Vessel loading and unloading • Collection of container data (weight, origin, destination, export, transshipment) • Container storage in port's yard
Warehouse operators	<ul style="list-style-type: none"> • Communication with shippers, shipping agents and/or freight forwarders • Provision of capacity information • Undertaking cargo storage • Development of Standard Operating Procedure (SOP) per job / project • Monitoring of SOP application • Measurements and optimization
Freight forwarders	<ul style="list-style-type: none"> • Communication with shippers and/or shipping agents • Undertaking cargo transportation • Export haulage • Export customs clearance • Origin handling • Import customs clearance

Stakeholder group	Workflow breakdown
	<ul style="list-style-type: none"> • Destination handling • Import haulage
Shippers	<ul style="list-style-type: none"> • Communication with shipping agents and/or freight forwarders • Preparation of cargo to be transported • Assignment to freight forwarder • Communication with carriers
Trucking companies	<ul style="list-style-type: none"> • Communication with shippers, shipping agents and/or freight forwarders • Provision of routes and time schedules • Cargo transportation
Rail operators	<ul style="list-style-type: none"> • Communication with shippers, shipping agents and/or freight forwarders • Provision of routes and time schedules • Cargo transportation

Furthermore, each stakeholder has specific rights and obligations based on the aforementioned activities and tasks. These rights and obligations may refer to legal, decision-making, scheduling and budgetary issues. Currently, most of the logistics stakeholders sign contracts with their clients and/or service providers to define the specific terms and rules that are in place for their collaboration and ensure that all parties' rights are properly managed. The cargo owners shall provide specific information regarding the goods that need to be transported and the services required. On the other hand, service providers shall provide information about services provided and in case a relevant contract has been signed they are obliged to accomplish the specific service at a minimum quality level, both defined in the signed contract. Such a case can be a contract between a shipper and a freight forwarder regarding the transportation of e.g. 1 container of electronics from origin A to destination B in a time frame of maximum 1 month. The shipper has provided all required information has assigned the freight forwarder to accomplish the transportation. The latter is in charge of finding available transportation option that fulfil the provided information about cargo type, quantity, route etc. and communicating with relevant service providers. In case the cargo transportation has not been completed within the agreed 1-month time frame, the shipper has the right to claim relevant fees for the delay. Correspondingly, if the cargo type or quantity is different than agreed and cannot be served by the provided service, the freight forwarder has the right to claim that the contract has been breached.

As the majority of activities and procedures refer to data exchange, the stakeholders' rights mainly cover aspects such as data ownership, exchange and processing, Intellectual Property Rights (IPR) management, proprietary rights and disclaimers. Data owners maintain the right to permit access to, edit or recall shared data and

define the way this data shall be used or processed by data users. In parallel, several rights are based on the signed contracts among stakeholders. Such a case is the right to confidentiality, where data owners can request that data provided to their clients cannot be shared with third parties without expressed consent. For example, in case a rail operator has signed a contract with a shipping agent and has provided confidential information about rail time schedules and costs, the shipping agent cannot share this information with other shipping agents or entities. Similar to that, a shipping agent that has requested the transportation of some cargo, providing details about cargo type, quantity, value etc., can request from the associated transport operator to keep this information confidential. The same approach is followed for permission and privacy issues, where the parties that are involved in data exchange shall agree on who can have access to what information and for what purpose. All this information, along with all terms, rules and conditions that are applied for an agreed activity shall be clearly defined in the contract that is signed by all parties involved.

4.5.4 Communication Channels

As already mentioned in the interviews' results chapter, the majority of participants claimed that they currently communicate with other stakeholders mainly through emails or by phone. This is independent of the stakeholder group they belong to, as no uniform communication channel can be used and cover their needs serving as an open, transparent and interoperable communication network. Emails support the exchange of pre-structured or unstructured messages in a simple and fast way, also enabling the synchronous data distribution to several recipients. It is a quite common communication tool for shipping agents, terminal operators, carriers (trucking companies, rail operators, etc.), warehouse operators, shippers and freight forwarders.

In parallel, communication by phone is still quite used, as they provide real-time direct communication between customers and service providers, which is valuable for rapid resolution of customer issues and requests. A typical issue for the terminal operators regarding communication and data exchange with other stakeholders is that the collection of schedules and information regarding the movement of cargo in the port is typically a quite difficult and complex task, due to the variety of stakeholders involved. Moreover, the paper communication is still adopted in some cases, mainly in small companies where the daily activities have not been digitised. All these communication means are practical and direct, but they are associated with significant risk of inconsistencies, missed information, confusion and mistakes.

With regards to the freight forwarders, they usually sign formal contracts with clients covering the transportation of specific cargo from origin to destination, while in some cases these contracts may also be informal. They also communicate with service providers to arrange the transportation details. This communication is mainly digital

through emails as for the majority of stakeholders, but again they may communicate by phone or other informal ways. Electronic Data Exchange (EDI) messages are largely used in digital communication, but there are also some other standards that are adopted by relevant players. In this way, a template is followed leading to a more consistent communication and data exchange that reduces the associated risks.

5. System Requirements and Architectural Design

Based on the methodology defined in Chapter 2 and followed for the definition of system requirements for the MOSES Matchmaking Platform, the key functionalities and specifications that the platform needs to fulfil were collected and consolidated, serving as the reference list used to define relevant system requirements. These requirements, either functional or non-functional, have been correlated with the user requirements of D2.1 that have been collected through the stakeholder engagement activities (workshops and online survey for user needs) and were reported in D2.1 “MOSES stakeholder and end-users needs”. The full list of the user requirements for the MOSES Matchmaking Platform as they were defined in D2.1 can be found in Annex 1.

In addition, a prioritization process was conducted and each requirement has been assigned a priority level, based on the MoSCoW method³³. There are three levels of priority, based on the MoSCoW prioritization method.

- **MUST:** mandatory specifications absolutely needed to provide the core value of the MOSES Matchmaking Platform.
- **SHOULD:** specifications that add essential functionalities that will ensure better performance and increased market business value of the platform.
- **COULD:** Interesting specifications that are nice to have and bring in added value if present, but do not hamper the business value of the platform if absent. They nevertheless augment the pertinence of the platform and reinforce its potential success.

The prioritization of the system requirements was based on the prioritization of the relevant user requirements, along with the feedback that was collected from the stakeholder interviews. In addition to the definition of functional and non-functional requirements, the architectural design has been described, providing the overall structure of the MOSES matchmaking platform, along with the interactions of its sub-components. Moreover, apart from the system specifications of the MOSES Matchmaking Platform, some general requirements have been defined, describing the security/privacy and legal/regulatory requirements that need to be addressed.

5.1 Functional Requirements

The functional requirements are the requirements that the user specifically demands as basic facilities that the system should offer. All these functionalities need to be incorporated into the system to be operative and accomplish the assigned tasks. These

³³ More information about the MoSCoW prioritization method at: https://en.wikipedia.org/wiki/MoSCoW_method

are represented or stated in the form of input to the system, the operation performed and the expected output. In Table 5: MOSES Platform functional requirements Table 5, the functional requirements of the MOSES Platform are presented. Each functional requirement has an ID, a description and a priority level and it is correlated with relevant user requirements collected from the users that have been reported in D2.1, specifications that have been written in D2.4 and functionalities extracted from the analysis of use cases and interviews.

Table 5: MOSES Platform functional requirements

ID	Description	Priority level	Relevant User Requirement, Specification or Functionality
MLP_FR_01	The MOSES Platform receives transport requests and supports the insertion of information about an order (cargo type, volume, weight, destination, departure/arrival dates etc) through a properly designed GUI.	MUST	MLP_3, RQ-MLP-3, MLP_FUNC_05, MLP_FUNC_10, MLP_FUNC_22
MLP_FR_02	The MOSES Platform provides specific search criteria (e.g. delivery time, cost etc.), inserted through a suitable GUI and taken into account by the platform's back-end search algorithms.	MUST	MLP_FUNC_07
MLP_FR_03	The MOSES Platform supports editing of order details and searching criteria through a dedicated GUI and pertinent database updates.	SHOULD	MLP_FUNC_13
MLP_FR_04	The MOSES Platform supports the insertion/uploading of vessel schedules (destination, stops, capacity, etc.) in a dedicated database through a pertinent GUI. Each vessel schedule should be uploaded in a specific file format and taken into account when building/updating the internal representation of the transport network.	MUST	MLP_2, RQ-MLP-2, MLP_FUNC_03, MLP_FUNC_06
MLP_FR_05	The MOSES Platform calculates the available routes according to the details of an order and by taking into account buffer times of transport modes, through the internal representation of the transport network and properly parametrized search algorithms.	MUST	RQ-MLP-5
MLP_FR_06	The MOSES Platform suggests multiple transportation options and filters them according user-defined criteria (e.g. delivery time, cost etc.), through suitable post-processing of search results.	MUST	MLP_FUNC_08, MLP_FUNC_09, MLP_FUNC_14, MLP_FUNC_16,

ID	Description	Priority level	Relevant User Requirement, Specification or Functionality
			MLP_FUNC_25, MLP_FUNC_29, MLP_FUNC_30, MLP_FUNC_31, MLP_FUNC_32
MLP_FR_07	The MOSES Platform provides sorting capabilities for the suggested transportation options according to user-defined optimality criteria (time of departure, time of arrival, duration, cost, emissions etc.), through suitable post-processing of search results.	SHOULD	MLP_FUNC_08, MLP_FUNC_09, MLP_FUNC_35
MLP_FR_08	The MOSES Platform presents similar or supplementary order requests that can be matched by suitable search in a database of already suggested schedules for still pending (i.e. unconfirmed) orders.	MUST	RQ-MLP-5, MLP_FUNC_33
MLP_FR_09	The MOSES Platform allows order confirmation, cancellation or keeping as pending by updating a pertinent order database through a pertinent GUI.	MUST	MLP_FUNC_12, MLP_FUNC_24
MLP_FR_10	The MOSES Platform updates dynamically route capacity after order confirmation by updating pertinent parameters of the internal transport network model.	MUST	MLP_FUNC_12
MLP_FR_11	The MOSES Platform aggregates orders at container level according to capacity, availability, user-defined criteria, legal and practical constraints by storing/extracting pertinent data in suitable databases.	MUST	RQ-MLP-4, MLP_FUNC_33
MLP_FR_12	The MOSES Platform allows updates about transport status (completion of transport leg, unexpected event) through a suitable GUI and database updates.	SHOULD	MLP_FUNC_27, MLP_FUNC_28
MLP_FR_13	The MOSES Platform supports route recalculation for remaining legs in case of unexpected events by redirecting the user in the order placement interface.	SHOULD	MLP_FUNC_22

5.2 Non-Functional Requirements

The non-functional requirements are the quality constraints that the system must satisfy and they are also called non-behavioural requirements. They usually refer to issues related to usability, security, scalability, performance, etc. In Table 6, the non-functional requirements of the MOSES Platform are presented. Each functional

requirement has an ID, a description and a priority level and it is correlated with relevant user requirements collected from the users that have been reported in D2.1.

Table 6: MOSES Platform non-functional requirements

ID	Description	Priority level	Relevant User Requirement or Specification
MLP_NFR_01	The MOSES Platform provides different levels of access rights based on the user role by implementing suitable authentication/authorization services.	MUST	MLP_1, RQ-MLP-1
MLP_NFR_02	The MOSES Platform supports data anonymization and complies with GDPR rules by implementing suitable authentication/authorization services.	MUST	MLP_1
MLP_NFR_03	The MOSES Platform maintains appropriate databases enabling the provision of on-demand reports about the order statistics or historical data about services or interactions.	SHOULD	RQ-MLP-6
MLP_NFR_04	The MOSES Platform maintains a database with historical data for each profile.	SHOULD	MLP_FUNC_02
MLP_NFR_05	The MOSES Platform sends automatic messages about transport status (notification, email, etc.) by implementing suitable automations.	SHOULD	MLP_FUNC_28, MLP_FUNC_29
MLP_NFR_06	The MOSES Platform provides a user-friendly interface.	SHOULD	MLP_FUNC_03, MLP_FUNC_04, MLP_FUNC_05, MLP_FUNC_15
MLP_NFR_07	The MOSES Platform offers a combined tabular and web-mapping interface.	SHOULD	RQ-MLP-7
MLP_NFR_08	The MOSES Platform supports the rating of service providers through a transparent rating scheme.	SHOULD	MLP_FUNC_34

5.3 Legal/Regulatory Requirements

Apart from the functional and non-functional requirements, the platform shall ensure that all provided data and services are compliant with current regulations and rules, providing sufficient information about legal and regulatory aspects related to its use. All users shall be aware of their rights, obligations and responsibilities and follow all regulations related to data ownership and sharing. The content providers need to give their consent for their data to be published and grant certain rights to the platform about their use, while keeping the ownership of the data (copyright holder) and the right to edit or recall them. In parallel, content users need to accept specific terms and

conditions regarding the use of these data. For this reason, all users need to accept the terms of a dedicated legal agreement, describing the conditions under which the MOSES Platform shall operate, the ownership of data, proprietary rights, disclaimers, liability etc. This legal agreement shall be easily accessible in the platform and include among others the following:

- General terms and conditions: permissions, proprietary notices, authorizations, copyrights, intellectual property rights, license terms, disclosures etc.;
- Disclaimers/ Warranties: accuracy and validity of published information, warranty in case of technical inaccuracies or typographical errors, platform's warranty;
- Confidential information: restrictions in case of confidential data, permissions and free use;
- Limitation of liability;
- Security and confidentiality terms;
- Privacy rights.

In addition, special attention shall be given to personal data and the way they are treated. As some of the content providers may be natural persons and not legal entities (e.g. service providers established as sole proprietorship companies), the provided data might also be personal data and require special treatment. In relation to this, many regulations and directives related to the protection and processing of personal data have been established in EU, with the General Data Protection Regulation (GDPR) being the most known one. The following list presents some of the established regulations and directives:

- Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation);
- Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons concerning the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC;
- Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and protecting privacy in the electronic communications sector (Directive on privacy and electronic communications);

- Charter of Fundamental Rights of the European Union (2012/C 326/02), became legally binding on the EU institutions and on national governments on 1 December 2009, with the entry into force of the Treaty of Lisbon;
- Trade and Cooperation Agreement Between the European Union and the European Atomic Energy Community, of the One Part, and the United Kingdom of Great Britain and Northern Ireland, of the Other Part (24 December 2020).

Many of these regulations might have overlapping principles and rules, but all of them aim to the provision of guidelines towards the protection of personal data. More specifically, the General Data Protection Regulation (EU) 2016/679 (GDPR), which has been widely in force, is a regulation in EU law on data protection and privacy in the European Union (EU) and the European Economic Area (EEA). The GDPR's primary aim is to give individuals control over their personal data and to simplify the regulatory environment for international business by unifying the regulation within the EU. Controllers and processors of personal data must put in place appropriate technical and organizational measures to implement the data protection principles. Business processes that handle personal data must be designed and built taking into account these principles and provide safeguards to protect data (for example, using pseudonymization or full anonymization where appropriate). Data controllers must design information systems with privacy in mind.

5.4 Architectural Design

The architecture of the MOSES matchmaking platform includes the front-end module (i.e. the user interface), the storage/database module, where all collected resources and intermediate results are stored, and the back-end module where the search and matching algorithms run. The interactions of these components are depicted in the architectural design graph in Figure 1.

The platform's architecture needs to meet the functionalities extracted by stakeholders and subsequently formalized as proper functional and non-functional requirements for the platform. As it was mentioned in D2.4, the MOSES Platform components are the server, the user interface, the database, the web-mapping component and the optimization component. These components can be grouped in the following three main modules:

- front-end module, consisting of the user interface and the web-mapping component;
- storage/database module, where all collected resources and intermediate results are stored;
- back-end module (i.e. server and optimization component), where the search and matching algorithms run.

Each module is designed to address specific end user needs. More specifically and depending on the specific role (see below, user roles), each user needs to be able to upload/update data pertaining to vessel schedules and availability (as a service provider) or set details of a transport request (as an end user). Each user also expects pertinent outputs, i.e. shipping and/or matching suggestions for the end users, the ability to interactively monitor a currently adopted transport schedule for the involved service providers and end users, plus the provision of aggregate periodic reports. These functionalities will be implemented by appropriate user interfaces, altogether consisting the front end of the platform.

For the calculation of shipping schedules according to a transport request's specification, the platform needs a mathematical/algorithmic model of the underlying transport network. The model is build based on the data uploaded by the service providers (e.g. vessel schedules, availabilities and capacities) and is regularly updated by any new incoming pertinent information. The back-end of the platform uses this model to calculate feasible routes satisfying an end user's transport request and sort them according to the end user's defined optimality criteria. These routes are stored and subsequently used for finding potential matchings between end users.

Any of the aforementioned user data, either intermediate and/or final results concerning suggested shipping schedules and matchings, are stored in properly designed databases, from where they are retrieved either from the user interface or from the back-end when needed. The following chapters present an overview of the main user roles of the platform, front-end's primary and secondary inputs and outputs, storage, communications, back-end matching engine and an indicative use case scenario. It shall be noted that the content of the following chapters is quite technical, in order to describe the several aspects of the MOSES Platform's architecture in detail.

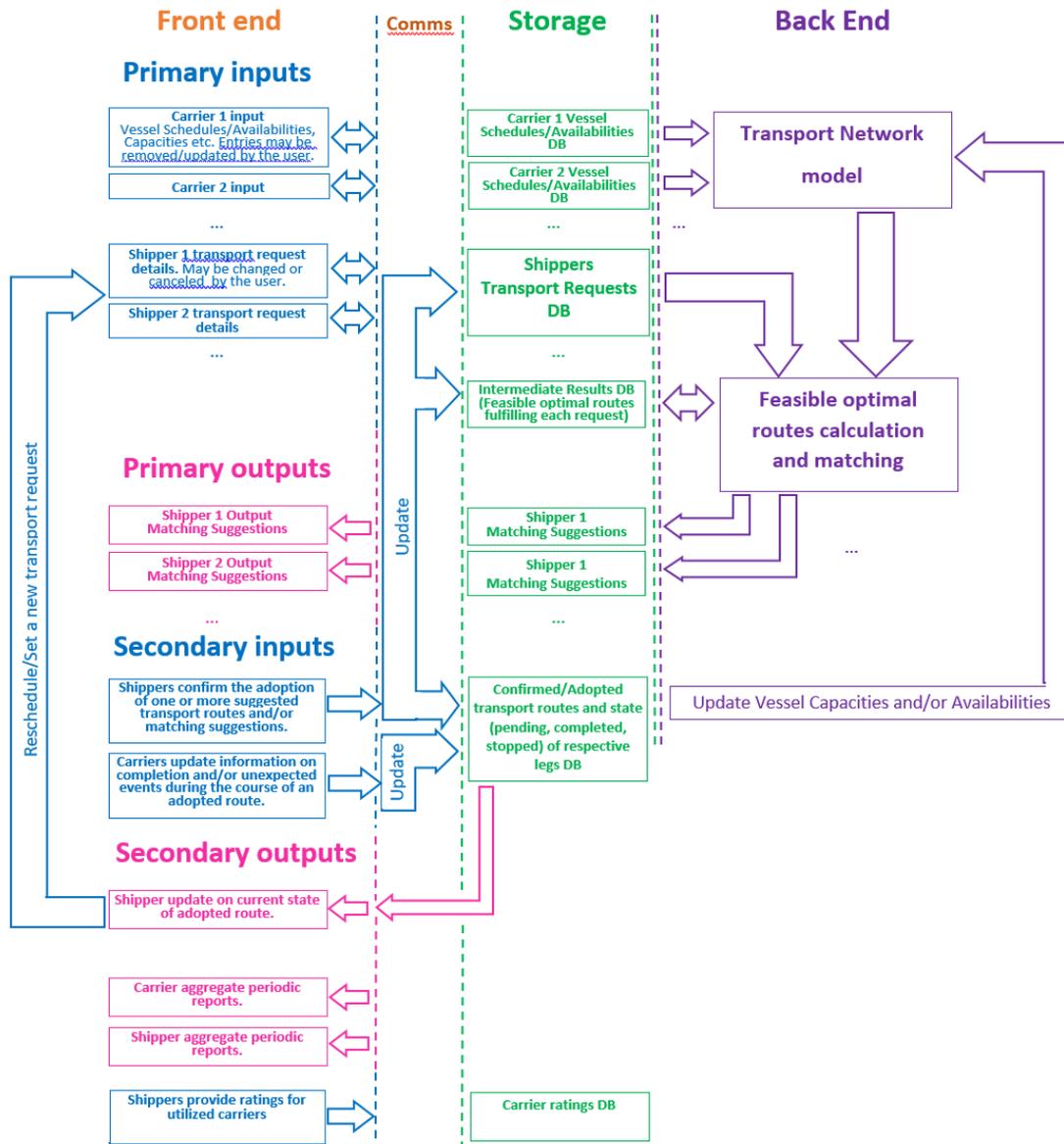


Figure 1: MOSES Matchmaking Platform’s architectural design

5.4.1 User Roles

The platform distinguishes between two discrete user groups:

- 1) The logistics services supply group (**service providers**), i.e. the owner of transport means (ships, trains, trucks) offering transport services.
- 2) The logistics services demand group (**end users**), i.e. owner of cargo to be containerized and shipped, placing transport requests.

The platform is planned to offer specific functionalities in terms of input/output to each of the aforementioned roles, which are described in the chapters below. For each user role, we distinguish between primary and secondary inputs/outputs.

5.4.2 Front-end – Primary inputs & outputs

Primary inputs

Service providers: Primary inputs contain the initial information upon which the Transport Network model is built for the service providers.

Ship and train owners will be able to upload specific information concerning each of their vessels. For each vessel, the corresponding information includes the following:

- Stopping locations (e.g. ports of call, in the case of ships) for the forthcoming period;
- Arrival and departure times for each stopping location (date and time);
- Remaining vessel capacity for each container type, for each transition between two stopping locations (in TEUs);
- Cost of transportation between any two consecutive stopping locations.
- Any information relating to the CO₂ emissions of the vessel (e.g. CO₂ emissions per hour for a specific speed and level of fullness).

The platform will also enable each ship or train service provider to update each entry of this information, more specifically to:

- update the remaining vessel capacity;
- update arrival and departure times for each stopping location;
- update pertinent costs;
- remove the vessel's schedule entirely;
- upload information concerning a new vessel.

Truck owners are considered to operate between ports and specific inland destinations. Therefore, they will be able to upload the location pairs, i.e. pairs of the form (port → inland location) or (inland location → port) on which they operate, plus any additional information regarding each such pair, i.e. cost of transportation, CO₂ emissions, required time to destination. Due to truck transportation services' on-demand nature and aperiodicity, a more systematic and comprehensive consideration of pertinent fleet capacities including timely vessel availabilities and corresponding available transport capacities remains elusive and a subject to be further investigated.

End users: End users will be able to upload information concerning the details of their transport requests. These include *request specifications* and *request preferences*. More specifically, *request specifications* include basic information of the request, i.e.

- origin and destination;
- amount of product to be transported (in TEUs);
- latest possible date of delivery to the destination.

Depending on the available information, the design may also consider the following:

- type of product to be transferred;
- type of container needed (e.g. refrigerated, insulated etc.).

Request specifications essentially define the request. They are used to parametrize the transport network search algorithms and filter out any resulting routes that do not meet them.

Request preferences consider the request's criteria of optimality, e.g. total cost, turnover time, earliest date of delivery, CO₂ emissions etc. Each end user will have the ability to change the specifics of the order, cancel the order, or declare the order as closed or fulfilled.

Primary outputs

The platform will apply parametrized search algorithms on the Transport Network model to calculate routes that meet the end user's request specifications. The routes resulting from this searching/filtering process are called *feasible routes*. Request preferences are subsequently used to sort the resulting feasible routes according to the preferred criteria of optimality.

Primary outputs concern only end users. The platform will send a set of transport and matching suggestions (optimally) to each end user, satisfying the end user's request. The suggestions will be of the following form:

(Headhaul shipping schedule, Backhaul shipping schedule, matching shippers)

Where:

A suggested shipping schedule (Headhaul or Backhaul) contains a timely ordered sequence containing for each one of the involved legs:

1. Identifier, type (i.e. ship, train or truck) and owner of the corresponding vessel.
2. Leg origin and destination.
3. Departure time from origin and arrival time to destination in case the corresponding vessel is a ship or train. In the case of trucks, the output simply provides the time required to reach the destination.

Plus:

4. The total cost of the schedule for the end user.
5. Total CO₂ emissions of the schedule.

The matching shippers field contains a set of other end user, each one with orders "matching" the request of the end user under consideration. "Matching" is perceived in the following two-fold sense:

Headhaul matching: i.e. matching end users may utilize the same shipping schedule, or the sea/rail parts of it, in the same direction to fulfil their requests (i.e. their requests have the same origin and destination and nearby shipment/delivery date and times).

Backhaul matching: i.e. one end user may utilize the empty containers coming from another end user's order once the second end user's order has been delivered (in its

simplest form, this means that the destination of the first end user is the origin of the second, and vice versa, plus the shipping date for the second end user is after and nearby the delivery date of the first end user).

In case the end users match in the headhaul sense, the Headhaul shipping schedule contains details (i.e. involved vessels, stopping locations and arrival/departure datetimes, CO₂ emissions) of a candidate shipping schedule fulfilling their requests. The Backhaul shipping schedule is blank.

In case the end users match in the backhaul sense, the Headhaul shipping schedule contains details of a candidate shipping schedule fulfilling the first end user's requests and the Backhaul shipping schedule details of a shipping schedule utilizing the empty containers for the second end user once the first end user's order has been delivered.

Notifications: Each user will be notified with the appropriate output in case a new request matching their input has been received or in case a request already matching their input gets closed/fulfilled or cancelled.

5.4.3 Front-end – Secondary inputs & outputs

In Table 7, the secondary inputs and outputs for the front-end component are presented for each user role.

Table 7: *Front-end – Secondary inputs & outputs*

Secondary inputs	
End users	<ul style="list-style-type: none"> Once an agreement between involved matched end users and service providers has been reached, end users confirm the adopted transport schedule. End users may also rate their corresponding service providers on their quality of services.
Service providers	Service providers are expected to monitor the fulfilment of the agreed adopted transport schedule, updating information on the completion of pertinent legs of the route or in case of unexpected events hindering the completion of the schedules.
Secondary outputs	
End users	<ul style="list-style-type: none"> In case of reported unexpected events during an ongoing transport schedule, the involved end users are notified and enabled to post new requests for alternative routes completing the remaining unfulfilled legs of the initial schedule. Aggregate periodic reports concerning a end user's activity on the platform.
Service providers	Aggregate periodic reports concerning a provider's services usage and adoption on the platform.

5.4.4 Storage

The collected resources (vessel schedules, transport orders, etc.) will be stored in a PostgreSQL database. PostgreSQL is the world's most advanced open-source relational database. It is a powerful, open-source object-relational database system with over 30 years of active development that has earned it a strong reputation for reliability, feature, robustness and performance.

On top of the database, Django will be deployed. Django will provide a database-abstraction API that will let the creation, retrieval, update and deletion of objects (i.e. records in a database table). This database-abstraction API belongs to the ORM (relational mapping layer), a layer useful for the interaction with MOSES data. Then, on top of Django is the Django REST framework that is a powerful and flexible toolkit for building Web APIs. Django REST framework serializes data from the Django ORM and allows access/updates via a RESTful API. The APIs can then be consumed by a pertinent Javascript framework (e.g. Vue.js, Angular, React, etc.), in order to extend the system's capabilities or connect with other systems. The workflow described above is depicted in Figure 2.

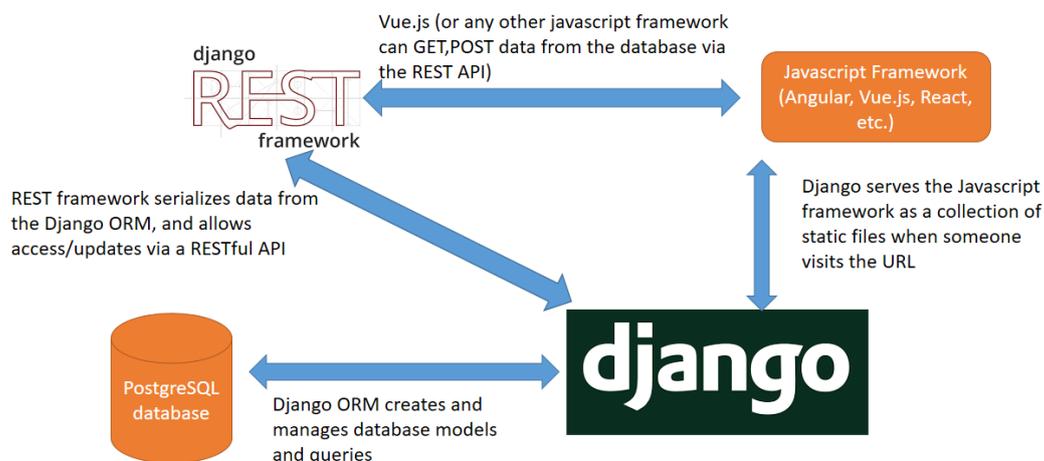


Figure 2: Interaction between the main components of MOSES Platform.

Regarding the database schema of MOSES Platform, a relevant data model has been created. It is an abstract model that organizes the elements of MOSES Platform data and standardizes how they relate to one another and to the properties of real-world entities. In the cases of MOSES, the main entities are the service providers and the end users. However, more data elements exist in order to define and organize the relationships between vessels and ports of call, the relationship between the transport orders and the ports, etc. It has to be noted that each entity corresponds to a table in the PostgreSQL database and each attribute corresponds to a column in the

table. Furthermore, the relationships between the entities are materialized with foreign keys as far as the database design is concerned. The main entities of the data model of MOSES Platform are the following:

- **Service Provider:** The name, address, phone and email are the attributes of this entity that describe uniquely a Service Provider.
- **Vessel:** This entity represents information concerning a vessel. The attributes are: type (ship, train, truck) name, CO₂ emissions, total capacity, current remaining capacity, status (on sea, in port, out of service).
- **Location of Call:** Locations (of call) are the locations that a specific vessel stops for a certain period of time through their journey so as to load or discharge cargo before departure. The attributes of this entity are: arrival date, departure date, available remaining capacity before departure, status (departed, arrived, arriving), journey status (start, intermediate, end). It has to be noted that the entity “Location of Call” associates a vessel with a location (i.e. that a specific vessel has stopped in a given location at certain time).
- **Location:** The entity Location represents information concerning a registered location within the platform. The name and the coordinates of the location are being used as attributes.
- **End User:** The entity End User represents the owner of cargo placing transport orders. The pertinent attributes are: name, address, phone, email.
- **Transport Order:** Transport Order is about a cargo capacity that an end user wants to transfer. The attributes are: origin location, destination location, amount of product to be transferred, amount of product in TEUs, latest possible delivery date, type of product, type of container, status (fulfilled, cancelled, open). This entity is associated with the end user who placed this order and with the entity “Location” (since the attributes origin and destination, both refer to locations).
- **Suggested Shipping Schedule:** The Suggested Shipping Schedule refers to the candidate shipping schedules for a given transport order. It is about the Transport Network model search output, which is stored in the database for later reference. In other words, it is about caching the search output in order not to execute the model for the same input again. This entity is associated with the Transport Order Entity. The attributes are the following: transport order (a foreign key to “Transport Order” entity), locations of call (a list of IDs representing the various locations that the cargo will go through), total cost (total cost of the suggested schedule), total CO₂ emissions, matching transport orders (a list of IDs of other matching transport orders of other end users).

5.4.5 [Communications](#)

Python Django framework will be used to expose the content of the database to the front-end or to other clients if needed. As stated in chapter 5.4.4, these APIs will be

developed with Django REST framework library. Some of these APIs are appropriate for storing content to the database (through HTTP POST methods), some others for updating the database (e.g. updating vessel schedule through HTTP PATCH) and others for deleting some content (e.g. deleting a vessel entry through HTTP DELETE method). In all services, we have only path parameters and the request body is always in JSON format (i.e. HTTP request header “content-type” should always have the value “application/json”). Response bodies are also in JSON format.

5.4.6 Back-end – Matching Engine

The platform’s back-end executes the modelling the information provided by the shipping companies inputs in a large graph. Each port is a vertex, each transition of each vessel is an edge with specific properties (i.e. departure/arrival dates, available capacity, etc). An alternative approach (remains to be determined) is to use vertices to represent space-time points, i.e. each vertex will represent a port at a specific time point.

Given the end users’ orders, the (possibly filtered) graph will be processed by suitable graph topology algorithms to provide shipping schedules for candidate feasible and optimal graph paths that satisfy each transport order. The candidate shipping schedules will be stored in an intermediate results database for reuse, any time a new transport order arrives, and will form the basis on which the matching between end users and between end users and service providers will be carried out. Results will be stored to the corresponding Matching Suggestions databases, from where they would be made available to each user through the platform’s front-end user interface.

5.4.7 Indicative Use Case Scenario

The platform is assumed to be initialized by the data provided by the shipping companies, which are expected to inform the platform for vessel schedules for an at least 2-month rolling period and which are not expected to change significantly. End users are expected to place transport orders and declare them closed or fulfilled once an agreement with a service provider has been made.

The usage of the platform by a specific end user consists in the following sequence of steps/functions.

1. Any time an end user places an order, the platform is triggered to find feasible, optimal transport schedules satisfying the specification of the order.
2. The transport schedules found in the previous steps, along with already found transport schedules concerning other orders (i.e. the intermediate results) are used to find matching orders in the sense described above.
3. Once matchings are found, the end user is notified and can download or have them sent.

4. Service providers and end users involved in the matchings found in step 3 are notified.
5. As long as the order remains open, the end user will be regularly notified in case new orders matching his/her order are found or if any of the already matched orders are fulfilled/closed or canceled.
6. The platform aims at a near real-time to periodic response, i.e. end users are notified at periodic basis.

5.5 Security/Privacy Requirements

The back-end of the platform that holds the MOSES resources (i.e. information concerning vessels, service providers, transport orders, etc.) will be secured and only authorized users will have access to the resources. The security protocol employed is the OAuth2 that is an open standard for access delegation, commonly used as a way to grant websites or applications access to internet users' information on other websites, but without giving them the passwords. Generally, OAuth2 provides users a "secure delegated access" to server resources on behalf of a resource owner. It specifies a process for resource owners to authorize third-party access to their server resources without providing credentials. Designed specifically to work with Hypertext Transfer Protocol (HTTP), OAuth2 essentially allows access tokens to be issued to third-party clients by an authorization server, with the approval of the resource owner. The third-party then uses the access token to access the protected resources hosted by the resource server.

In the case of MOSES Platform, we consider the third-party client to be the platform front-end. The resource server is considered to be the back-end of MOSES Platform that holds the information concerning transport orders, end users, service providers, etc. The resource owners are both end users and service providers that created the database content concerning shipping schedules and transport orders. Figure 3 depicts the interaction between the aforementioned components so as for the MOSES Platform front-end to be able to access MOSES protected resources (i.e. service provider details, transport orders, etc.). According to figure 2, the client (e.g. platform front-end) has to register itself to the MOSES authorization services by providing a client ID and a redirect URI. Then, the client is able to participate in MOSES OAuth2 workflow, which is the following:

- The user wants to login to the client (platform front-end) and therefore is redirected to MOSES login page;
- The user inserts his/her credentials to the form;
- After successful login, the access token is provided to the client from the authorization services;

- The user asks for a resource through the front-end (e.g. search for shipping schedules) and therefore, the access token is passed to MOSES resource server (MOSES back-end);
- The MOSES resource server validates the token and then it passes the resource to the client;
- The user is then able to view the given resource through the front-end (details about a shipping schedule).

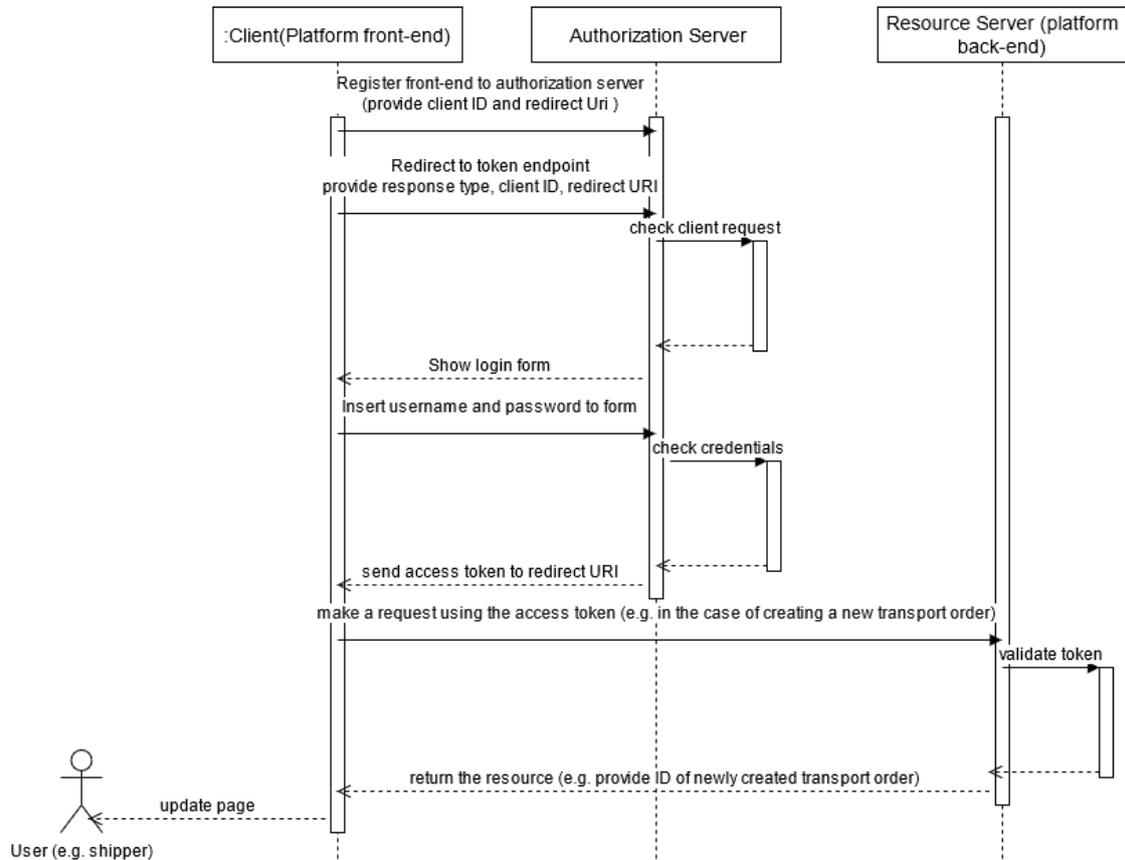


Figure 3: Sequential diagram depicting MOSES front-end, Authorization Server and Resource Server (i.e. back-end) interactions

Since MOSES Platform front-end will be based on the Python Django framework, including use of javascript, css and images (i.e. static content), the platform will use the Django authentication methods to give the appropriate permissions to the users. In this framework, the access token is immediately returned to the client (i.e. platform front-end) after the user logs in and it is used to keep the user’s session up. This workflow is often used in the so-called Single Page Applications, where it is not possible to keep the “client_secret” secret.

6. Conclusions

Summarizing all the above, this document collected and analysed all information related to the MOSES matchmaking platform and presented its business logic. The methodology followed consisted of a step-by-step analysis, where all possible sources of information were identified and studied, aiming to extract potential features and functionalities. The use cases that were associated with the platform from D2.2 were analysed and relevant functionalities were extracted. An extensive analysis of current platforms and initiatives was performed and its results were presented, providing an overview of current barriers, best practices and lessons learnt. The main barriers identified were related to exclusion of SSS services, limited or even absent communication and collaboration among stakeholders and lack of combined and multimodal services. Several practices currently implemented by developed platforms and tools were presented, such as the provision of data sharing services under a common communication environment, the visibility of end-to-end supply chains, the digitalization and automation of shipping procedures etc.

The most valuable lesson learnt that was extracted from the state-of-the-art analysis was the importance of the consolidation and bundling of transportation needs, towards the reduction of total duration and operational costs, the optimization of empty container management and the improvement of the environment footprint. In parallel, the modal shift off the road to intermodal rail and waterways is considered crucial for the transportation and distribution of freight cargo and the supply chain performance. Furthermore, an overview of the platform's business concept was presented, while the main stakeholder groups involved in the logistics process were identified and their roles were described in detail. Dedicated interviews were conducted with key stakeholders, leading to the collection of feedback and insights about current processes and potential features that could be supported by the platform and improve daily operations. Following this stakeholder engagement process, all these features, suggestions and potential functionalities were summarised and transformed into system requirements, in order to be implemented by the MOSES Platform.

The next steps related to the MOSES Platform include the release of the first prototype of the platform, where an alpha version of the marketplace will be developed based on the input of T6.1 and a subset of data. The outline of the MOSES Platform development and the description of the alpha version and its functionalities will be presented in D6.2 "Matchmaking Platform development". In addition, an open call will be conducted to invite interested parties matching the criteria for evaluation of the MOSES matchmaking platform through a third business case. The criteria will be that the business case belongs to a TEN-T corridor (other than the MED and Orient/East Med) and has an established yet underperforming SSS route. This open call aims to

attract at least 10 external stakeholders who will provide real logistics data (e.g. volumes of cargo flows of different stakeholders, current and potential ones, cost of transportation, estimated emissions etc) of their own enterprise and of collaborating organisations that will participate as external stakeholders. Their data will be used for the evaluation of the MOSES Platform with real business data in the context of this SSS route and the validation of platform's feasibility. During the second iteration of development, a set of small-scale tests will be defined and performed on the alpha version and the test outputs tests will be collected. In parallel the platform will be improved based on the collected feedback.

Annex 1: MOSES Matchmaking Platform Business Logic Questionnaire



AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

MOSES Matchmaking Platform Business Logic Questionnaire

This survey is conducted as part of WP6 of H2020 MOSES project, aiming to collect feedback regarding current logistics processes and potential requirements for the MOSES Matchmaking Platform that are considered useful by the identified stakeholders.

1. Please, define the stakeholder group you represent:
 - Shipper
 - Carrier / Transport Operator
 - Freight Forwarder
 - Shipping line / agent
 - Local SME
 - Other (please, specify):
2. What is your role in the shipping process?
3. What are your duties?
4. What is the process you follow for your duties?
5. What are the risks you have identified in this process?
6. What data do you need to perform your duties and how do you collect them?
7. What data do you produce and to whom do you distribute it?
8. What other stakeholder groups do you directly cooperate with and for what purpose?
9. How do you communicate with each one of the aforementioned groups?
10. What are the risks you have identified in the communication with other stakeholders?
11. How will a logistics matchmaking platform help you in your role? How do you intend to use it at your role? How are you going to use it?



12. When a shipment is received, does this shipment always have the same data format?
13. What are the data fields of a shipment request (e.g. incoming email format)?
14. What data fields are needed for transport planning?
15. Which data is needed about the freight characteristics? Please provide some data samples.
16. Are different modalities combined for the transport of a shipment?
17. How is transport planning done? Manual or via a planning software?
18. How many planners are employed?
19. Which planning application/software is currently used for planning? What are the optimisation parameters?
20. Does the planning application/software use real-time events, disruptions, consignments in-transit?
21. Does planning application/software provide feedback, for example, colour coding to see the transport status? What kind of feedback?
22. What are the steps that you take to create a transport plan?
23. Which data sources do you use for data (e.g. transport services: schedule, capacity, cost, GHG emissions)?
24. Which factors influence the decision to use a certain transport mode for a shipment?
25. What is the min/max/average time between an order request and booking of transport modes?
26. Do you have an internal rating scheme to classify services/carriers according to their reliability and quality of service?
27. How do you forecast the cost of a service?
28. How do you estimate the GHG emissions of a service?

Thank you for your participation!!

Annex 2: MOSES Matchmaking Platform

User Requirements

User Requirement ID	MLP_1
Requirement Type	NF
Requirement Class	Technical
Title	User roles, authentication and authorization
Description	Assign access rights (view, add, edit, delete users, orders and feature availability) to a user. GDPR rules apply
Priority	Must
Dependency	-

User Requirement ID	MLP_2
Requirement Type	F
Requirement Class	Market
Title	Transport schedules
Description	Provide details about destination and stops along a transport corridor (road, rail, maritime) including available capacity
Priority	Must
Dependency	-

User Requirement ID	MLP_3
Requirement Type	F
Requirement Class	Technical
Title	Order Details
Description	Provide the fields to hold the necessary information about an order (cargo type, volume, weight, destination, departure/arrival dates etc).
Priority	Must
Dependency	-

User Requirement ID	MLP_4
Requirement Type	F
Requirement Class	Market
Title	Transport Matchmaking
Description	Propose alternatives of available transport modes to reach a specific destination
Priority	Must
Dependency	MLP_2, MLP_3

User Requirement ID	MLP_5
Requirement Type	F
Requirement Class	Market
Title	Demand Aggregation
Description	Perform cargo pooling and consolidation. Assign orders to routes/services so as to minimise certain criteria within a network of supply chains based on a number of parameters (timely delivery, cargo types, volumes, weight etc)
Priority	Must
Dependency	MLP_2, MLP_3, MLP_4

User Requirement ID	MLP_6
Requirement Type	F
Requirement Class	Technical
Title	Select Optimisation Criteria
Description	Allow the user to select the criteria used in the multi-objective optimisation (e.g. GHG emissions and cost) and hard constraints such as custom metrics related to service quality and historical disruption levels etc.
Priority	Should
Dependency	MLP_2, MLP_3, MLP_4, MPL_5

User Requirement ID	MLP_7
Requirement Type	F
Requirement Class	Technical
Title	Order Management
Description	Add, view, edit, delete an order
Priority	Must
Dependency	MLP_2, MLP_3, MLP_4, MPL_5

User Requirement ID	MLP_8
Requirement Type	F
Requirement Class	Technical
Title	Data Interoperability
Description	Import/Export standard formats
Priority	Must
Dependency	-

User Requirement ID	MLP_9
Requirement Type	F
Requirement Class	Market
Title	Demand Forecasting
Description	Predict demand
Priority	Should
Dependency	MLP_2, MLP_3, MLP_4, MPL_5

User Requirement ID	MLP_10
Requirement Type	F
Requirement Class	Technical
Title	Messaging
Description	Allow the users to communicate within the platform about an order
Priority	Should
Dependency	MLP_2, MLP_3, MLP_4, MPL_5

User Requirement ID	MLP_11
Requirement Type	F
Requirement Class	Technical
Title	Show the transport network on a map
Description	Show the transport network on a map including hubs, roads, rail tracks, sea routes and inland waterways.
Priority	Should
Dependency	-

Annex 3: MOSES Matchmaking Platform Specifications

Req. ID	Requirement Description	Specification
RQ-MLP-1	Web-Platform Administration	The platform shall have an administrator and all users will be assigned roles and corresponding access rights to the information available on the platform.
RQ-MLP-2	Transport Network Information	The platform shall host the framework of transport networks (roads, rail, sea routes, inland waterways). Transport service providers or terminals shall be able to provide information about the services that operate along the network, including type, modality, capacity, origin and destinations, scheduled departure and arrival date and time.
RQ-MLP-3	Transport Request Management	The platform shall receive transport requests from authorised users who shall provide all the related information (type, volume, size, pick-up and drop-off time and location), communicate with potential collaborators and confirm transport orders.
RQ-MLP-4	Demand Aggregation	The platform shall aggregate orders at container level according to capacity, availability, user-defined criteria, legal and practical constraints.
RQ-MLP-5	Network Flow Optimisation	The platform shall optimise the transport flow within a wide local network. While considering the best option for a specific order at a particular point in time, demand and supply of the wider network will be taken into account.
RQ-MLP-6	Status Reporting	The user shall receive on-demand reports about the status of an order or historical data about a service or their interactions.
RQ-MLP-7	User Interface	The platform shall offer a combined tabular and web-mapping interface.