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Design and Development of a New Web Platform for the Management of Physical Flows and Customs Documents at Port Terminals

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Abstract: *Background*: Telematization is essential for improving port efficiency by reducing dwell times and simplifying document management. Currently, only a few ports use informatic document management tools like the Port Community System (PCS), and customs documents are produced and shared in paper format. This results in long port dwell times. *Methods*: A platform was developed to allow sharing of documents among port actors. The platform shares export documents of each given shipment between export and import port actors; moreover, it serves as a document management platform for ports lacking PCS. In addition, the platform helps in reorganizing the shipment in case of disruptions. *Results*: The platform has global validity as it allows users to share documents among all port actors worldwide. The platform is formed by the following menus: "Path", which provides the intermodal freight path; "Shipment", which allows one to create or change shipment data; "Send notify" to send notifies in case of disruptions; "PMIS and PCS", which redirects to these platforms of ports involved in the project; and "Documents", which allows one to upload and share customs documents at the global level. *Conclusions*: The app contributes to speeding up port operations by reducing dwell times, assists in managing shipment disruptions, and enhances intermodality in freight transportation.

Keywords: web platform; customs documents; physical flows; physical flows management; customs documents management

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1. Introduction

In this paper, the main features of a web platform, which manages physical and documental flows, particularly customs documents at port terminals, are described.

The proposed platform tries to fill several gaps currently existing in logistics, especially for documental flows. The development of some customs documents, especially in import, is very long and requires several interactions among several port actors, and between these port actors and customs offices. For example, the redaction of customs declarations and cargo manifests is carried out in parallel by the customs agents (who are in charge of producing customs declarations) and the ship agent (who produces the cargo manifest); indeed, the cargo manifest reports a synthesis of all customs declarations of all batches of goods loaded or unloaded on a ship, while the redaction of customs declarations requires some codes that can be retrieved only from the cargo manifest.

When documents are produced only in paper format, this results in long dwell times of over 6 days, while when documents are produced and exchanged in electronic format,

dwell times are more than halved (reducing to 2 or 3 days), because, for example, several fields of cargo manifests are completed automatically from the information reported in the electronic customs declarations.

In order to improve port telematization, in several countries, single-window platforms have been developed; however, they are of service to customs and other public administrations, and therefore they allow the documents to be presented to customs in xml format, but do not help port actors in sharing the documents among each other. On the other hand, in several ports, PCS have been developed that also allow users to upload and share customs documents but are limited to a specific port.

The proposed platform was developed with a specific role in the field of port telematization; indeed, it is able to grant the exchange of documents relating to the shipments among all port actors. This feature of the platform is valid at the global level; that is, it is not limited to a specific port or scenario but is applicable to all ports worldwide. Also, a small port that is not telematized could share documents in xml format by means of the proposed platform.

In addition, all port operators have their own management software that is not capable of directly interacting with single-window platforms. As a result, documents are produced by means of management software, and then they must be uploaded a second time on single-window platforms. Moreover, the responses of the customs must be downloaded from single-window platforms and then uploaded on the management software of each port operator involved. The proposed platform was equipped with API that allows the platform to directly interact on one side with management software, and on the other side, with single windows. In this way, the problem of "double insertion" of documents and information is addressed.

Regarding physical flows, the platform addresses some drawbacks of information systems commonly used by operators as regards data on maritime and rail services and the possibility to easily reorganize the shipment in case of disruption. The case of disruption is especially crucial because the shipment must be quickly reorganized, while reservations must be canceled or modified as soon as possible in order to avoid incurring penalties. The proposed platform, in particular, allows one to easily cancel or modify reservations by providing either the link to the reservation page or all the contact information of operators; in addition, it allows them to send notifications to all actors involved in the shipment in case of disruptions.

This platform was designed for some main French and Italian ports of the Ligurian Sea. In particular, Toulon, Bastia, Genoa, Savona, Livorno and Olbia. This study is part of the European projects CIRCUMVECTIO [1] and CIRCUMVECTIO Plus [2], developed within the 'Italy–France Maritime' program. Therefore, for the sake of clarity, the proposed platform will be addressed as the CIRCUMVECTIO Plus platform in the rest of this paper.

The choice of ports of the Ligurian Sea was 'obliged' because of the project funding program. Although the platform was designed for these ports, it could have a general application, especially as regards the management of documental flows, applicable to all ports of the world.

In this paper, the layout of the online platform, which integrates and manages physical flows and customs documents, is illustrated. In Section 2, a literature review is provided about port digitalization and the main customs documents. In Section 3, the criteria adopted for the platform development are described. In Section 4, the platform's main functionalities as to the management of physical flows are described. In Section 5, the management of the documental flows by the platform is reported. Conclusions follow.

2. Literature Review

2.1. Port Digitalization

The importance of port digitalization is remarkable, especially as regards the efficiency of port operations, while an indicator of port performance is the dwell time. Before digitalization's development, dwell times at Italian ports ranged from 5 to 12 days for import and from 4 to 5 days for export [3], while after the digitalization development, they ranged from 3 to 6 days for import and were equal to about 2–3 days in export [4]. In northern European ports, before the digitalization, dwell times ranged from 3 to 7 days in import and from 2 to 4 days in export [3], while after the digitalization, they ranged from 1 to 3 days in import and were equal to about 1 day in export.

In Rodrigue and Notteboom [5], it is described that the largest part of dwell times is related to the production and the exchange of customs documents. Documental flows are particularly massive in import. The transmission of xml (electronic) documents as a substitute for paper-only customs documents and pre-clearance are solutions to reduce this problem.

However, as reported by Qian et al. [6], nowadays there is a lack of standardized documents in multimodal transport, leading to additional time and costs for carrying out document exchange operations. In addition, as reported by Heikkilä et al. [7], about 80% of port operations are still managed with paper documents.

2.1.1. Port Community Systems

In Kilańska et al. [8], it is stated that the use of an IT system shortens the time required for the preparation of documentation and minimizes errors. Almeida [9] explores the challenges of digital transformation in port operations, emphasizing how optimizing document flows between the various stakeholders involved can enhance overall efficiency. Cerin [10] provides insights into how digital platforms, such as Port Community Systems (PCS) or other platforms for document management, contribute to the sustainability of port operations by optimizing both physical and documental flows.

However, as reported by Caldeirinha et al. [11], not all PCSs manage documents. Indeed, PCS was developed especially with the aim of providing the following features:

- notifications of ship and goods arrivals;
- authorization of port/terminal operations and online payment of port and terminal fees;
- information about the supply chain; in particular, real-time information about the availabilities of inland services to transport containers between the port and the initial origin or final destination of the shipment;
- real-time monitoring of cargo locations, and integration of port information with other logistic facilities, such as airports and freight villages.

Among PCS, in Italy, those of Livorno, Genoa, Savona and Venice are currently in operation; however, the PCS with the widest functionalities, in terms of document management, is that of Livorno [12]. In Europe, the most remarkable PCSs are those of Rotterdam [13], Hamburg [14], Antwerp [15], and the Cargo Community System of Marseilles [16], which is at the service of the port, the airport and the major logistic platforms in operation in the area. Outside Europe, important PCSs are those of Los Angeles [17], New York [18], Shanghai [19], Singapore [20] and Alexandria, Egypt [21]. The PCSs of U.S. ports rarely manage customs documents, as port operators are reluctant to share information about documents, while PCSs with the widest functionalities are those of Shanghai, Singapore and Alexandria, Egypt.

In Table 1, a synthesis of the functionalities of the PCS mentioned above is reported, as well as the types of documents shared by means of each PCS. The first five rows of the table

refer to documents shared by means of the PCS, and the rows from 6 to 11 refer to the PCS functionalities. VGM stands for the Verified Gross Mass of the container. The documents mentioned in the table are described in detail in Section 2.2.

Table 1. Synthesis of the features provided by the main PCS in operation at the global level.

Documents Shared by the PCS and Other Functionalities	Livorno	Genoa	Savona	Venice	Rotterdam	Antwerp	Hamburg	Marseilles	New York	Los Angeles	Shanghai	Singapore	Alexandria
Customs declaration	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	YES
Cargo manifest	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	YES
Document of origin	YES	YES	YES	NO	YES	YES	YES	YES	NO	NO	YES	YES	YES
Bill of lading	YES	YES	YES	NO	YES	YES	YES	YES	NO	NO	YES	YES	YES
Others (e.g., VGM)	YES	YES	YES	NO	YES	YES	YES	YES	NO	NO	YES	YES	YES
Vessel Schedule	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Tracking and trace	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Booking	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dangerous freight	NO	YES	YES	NO	YES	YES	YES	YES	NO	NO	YES	YES	YES
Empty container	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
Payments	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES

2.1.2. Terminal Operating Systems

Besides Port Community Systems, other platforms have been developed to deal with port terminals and document management, especially Terminal Operating Systems (TOSs), Port Management Information Systems (PMISs) and single-window platforms.

TOS platforms have been developed with the aim of managing and optimizing the activities of port terminals; in particular, vessel information in real time, management and real-time monitoring of terminal operations, tracking and tracing of containers, reservation of terminal facilities, and payment.

The main TOSs operating worldwide are the following: ContPark (Cyprus) [22], TOPS Expert (Australia) [23], MarineBerth (New Zealand) [24], Octopi (USA) [25], Steizar (UAE) [26], Kalaris (USA) [27], iPortman (USA) [28], Mainsail (USA) [29], CommTrac Terminal (The Netherlands) [30], OPUS Terminal (Singapore) [31], Hogia Terminal Operating System (Sweden) [32], Solvo.TOS (The Netherlands) [33], TerminalControl (Sweden) [34], U& Terminal Control (South Korea) [35], Logstar TOS (UAE) [36], Intermodal Manager (UK) [37], Envision Container Terminal Operating System (India) [38], OSCAR TOS (France) [39], GullsEye (Turkey) [40], Infyz Dry Bulk Terminal Operations Management (India) [41], Autostore (The Netherlands) [42].

The TOS main functionalities are as follows:

- Container and Terminal Management: management of container operations and overall terminal activities, including both landside and seaside operations. This functionality is provided by ContPark, TOPS Expert, Octopi, MT, iPortman, Kaleris, CommTrac TOS, OPUS Terminal, Hogia Terminal Operating System (with edifact), Solvo.TOS, TerminalControl, U& Terminal Container, Logstar TOS, Intermodal Manager, Envision Container Terminal Operating System, OSCAR TOS, GullsEye, Infyz Dry Bulk Terminal Operations Management, Autostore, Kaleris.

- Vessel Management: management of vessel-specific operations, often focusing on berthing, ship scheduling, and coordination of maritime activities. This functionality is provided by MarineBerth, TerminalControl, and Envision Container Terminal Operating System.
- Container management and tracking. This functionality is provided by ContPark, TOPS Expert, Steizar, Kaleris, Mainsail, OPUS Terminal, and Hogia Terminal Operating System.

Port Management Information Systems (PMISs) allow the real-time monitoring of port areas, such as arrival, berthing and departure of ships in real time, information on the amount of freight and passengers boarded and unboarded, and real-time occupancy of parking spaces in the port.

2.1.3. Single-Window Platforms

In several countries, single-window platforms have been developed. However, they are, at most, of service to customs and other public administrations. Examples of operating single windows are:

- The Italian AIDA (Automated Integrated Customs and Excise System) platform manages customs and operates through a fully digital and integrated approach. The platform enables the submission, processing, and monitoring of customs declarations, excise duties, and other mandatory requirements and connects with other public administration systems to allow data exchange. It centralizes communication between customs, terminal operators, shipping lines and public authorities, and simplifies the submission of customs declarations, certificates, and other required documentation [43].
- The Pro.Douane [44] is the French customs' electronic single-window system designed to streamline and centralize customs and logistics procedures related to international trade. It enables businesses, importers, exporters, and logistics operators to carry out their customs declarations and formalities online, in compliance with national and European regulations.
- The Swedish Single-window system, known as "The Virtual Customs Office" (VCO), allows for electronic customs declarations and applications for import and export licenses and licenses for strategic products [45].
- Recently, the European Maritime Single-window Environment (EMSWe) [46,47] was created. It is a comprehensive digital initiative introduced by the European Union to standardize and streamline reporting formalities for ships arriving in and departing from EU ports. It aims to enhance efficiency, reduce administrative burdens, and promote interoperability across EU member states. While the EMSWe operates as an EU-wide framework, it interfaces with National Single Windows (NSWs) that member states maintain. Data submitted through the EMSWe are automatically shared with relevant authorities, such as customs, border control, and port authorities.

Four phases of development of a single window were identified:

1. paperless customs, electronic payment of customs duties, container loading list, simple exchange of electronic documents of the customs with the port authority and terminal operators;
2. connection of other governmental informatics systems to the customs single window, for document controlling purposes;
3. exchange of electronic documents with all stakeholders of a given port;
4. integrated national logistic platforms devoted to document exchange with all logistic operators.

The fourth stage is the national or regional single window [48]. In Italy, the customs single-window platform, AIDA, has been developed. In Europe, after the Regulation of 23 November 2022 [49], a single customs platform has been established, valid for the entire European Union. However, as reported in [46], many single-window platforms are under development in several developing countries.

The majority of the single window is focused on simplifying customs declarations, automating compliance with import/export regulations and standardizing document formats (like XML) to facilitate digital submission. This can reduce paperwork and manual errors, fasten clearance of goods due to enhanced communication with customs and improve traceability and accountability in regulatory processes. However, while these platforms improve interactions with customs, they often neglect the operational and logistical needs of other stakeholders, such as terminal operators, freight forwarders, shipping lines, and hinterland transport providers (trucking, rail, etc.) [50].

This is a significant limitation in the single windows' current implementation; their focus often emphasizes compliance with regulatory requirements rather than fostering collaboration among port actors in the broader logistics ecosystem. Each actor, in any case, has to operate within his own managing software, leading to duplication of effort as the same data (e.g., cargo details, vessel schedules) must be entered multiple times in different platforms. Different actors use different formats, making interoperability challenging even when electronic documents are in XML. There is no unified platform for sharing operational data such as real-time vessel status, container locations, or truck scheduling and actors must resort to emails, phone calls, or proprietary systems to exchange critical information, increasing the risk of delays and miscommunication (Koh Tat Sen [51]).

Considering this, to achieve true digitalization and competitiveness, ports must adopt systems that support collaboration among all the different stakeholders, integrating customs and port actors into a cohesive ecosystem.

2.1.4. Limitations of Existing Document Management Platforms and the Gap Covered by the Proposed One

Single-window platforms show a significant gap: they were developed for direct interaction with the customs agencies, but do not allow the production and sharing of digital documents among the various port actors. This last feature is important, as the production of some documents, especially cargo manifests, requires numerous interactions among port actors.

A platform that allows this is the PCS of the port of Livorno [12]; however, it operates at the local level. At the national level, the Spanish USYNCRO [52] is remarkable, allowing one to share the customs documents among logistic operators across the whole Spanish territory.

The proposed CIRCUMVECTIO Plus platform is very similar to USYNCRO, for the management of documental flows, but it has been developed in order to be able to share all documents at a global level, that is, it aims to be applied worldwide.

The CIRCUMVECTIO Plus platform is based on some previous experiences. Among these, the most remarkable is Smart Tunnel [53], which was meant to develop a platform for the integration of documental flows. As regards the management of physical flows, some previous experiences concern the following projects: OPTIMED [54] concerned the development of a platform for information about the main motorways of the sea in the Mediterranean, and FUTUREMED [55] regarded the development of several infomobility systems of support for passengers and freight.

Finally, all port operators have their own management software; however, management software is not capable of interacting directly with single-window platforms. That is, documents produced by management software have to be downloaded and then uploaded to single-window platforms, and vice versa. The proposed platform will also try to solve

this problem, which is particularly felt by port operators and is commonly addressed as the "double insertion" problem.

2.2. Overview of the Main Customs Documents: In Europe, in the U.S., in the Far East and in the Non-EU Mediterranean

The documents related to the following countries were studied: Italy (however, the customs documents are the same in the entire EU), the U.S., China and Egypt. These countries were chosen because, from the experience of the authors, they could be representative at the global level, as they represent Europe, North America, the Far East and the non-EU Mediterranean.

The main customs documents are relative to a batch of goods. In general, a shipment consists of several batches of goods and also a container may transport several batches. A batch of goods is composed of freight all with the same characteristics, and especially with the same origin and the same destination.

The documents recognized at a global level are bill of lading, delivery order and packing list. The bill of lading is not related to only a batch of goods but to an entire shipment. It is produced by the freight forwarder and is destined to the ship captain. It reports the shipment data, the shipment value, and information on the freight composing the shipment [56]. The delivery order integrates the bill of lading, because the bill of lading is related to an entire shipment, and not to a simple batch of goods. The delivery order reports the specific information on a batch of goods not reported in the bill of lading [57]. Finally, the packing list reports the list of the packages and items composing the batch of goods [58].

All these documents are produced and exchanged only in paper format; however, some initiatives were carried out aimed at digitalizing the bill of lading.

Other documents are specific for each country but have homologous ones in the other countries. These documents in Europe are the customs declaration, the inward and outward cargo manifest, the commercial invoice, and the documents of origin, which are EUR1, EUR-Med, Form A and A-Tr.

The customs declaration is produced by the customs agent and sent to customs offices, which complete it with the clearance code. Each customs declaration refers to a batch of goods. A shipment is composed of several batches; therefore, several customs declarations are needed for a shipment.

A customs declaration of export contains the description of the batch and the clearance code, assigned from the customs offices after the batch of goods has been released. A customs declaration of import contains the description of the batch, the clearance code, and the 'A3' code. The 'A3' code is the identifier of the batch of goods the customs declaration is related to, and it is assigned from the customs before the customs control. The clearance code is instead assigned by the customs only when the freight has been released.

The inward and outward cargo manifests are produced by the ship agent and sent to the customs offices. These documents are related to an entire ship.

The cargo manifest is produced by the ship agent from the 'electronic' (that is, xml) customs declarations. Two cargo manifests are produced: the outward one in export and the inward one in import.

The outward cargo manifest is composed of several rows, each one related to a batch of goods, and to each row of the cargo manifest, the related customs declaration is attached. In each row of the cargo manifest, there is a field called 'irisp'. The outward cargo manifest is produced with all 'irisp' fields empty. Then, the ship agent uploads the cargo manifest on the AIDA platform, and the customs offices answer refilling the 'irisp' fields. If the 'irisp' is green, the freight can be released. If the 'irisp' is in yellow, all documents related to the batch of goods must be provided to the customs, including the invoice, bill of lading,

delivery order, transport document, packing list, and, if needed, EUR-1 or A.TR. If the 'irisp' field is red, the customs agent must bring physically the batch of goods to customs. Further details are provided in [59].

In the inward cargo manifest, each row refers to a batch of goods, and for each batch, the 'A3' code, the number of bill of lading, the data about the freight, and the 'irisp' field are reported. While no customs fees must be paid in export, in import, the customs agents must pay the import taxes, the excise duties and/or the value-added tax. After the customs agents have paid all fees, the customs offices complete the 'irisp' field. The 'irisp' can be completed with the same three colors as in export (green, yellow and red), with the same meaning [59]. Further details are provided in [60].

The documents of origin allow a reduction in customs taxes and are distinguished as follows:

- EUR1 certificate: produced only in export; produced by the freight forwarder for only some specific destination countries, with which a special customs agreement is in operation. It is related to export to non-Mediterranean countries.
- EUR-Med certificate: produced only in export; it is the same as EUR1 but it is specific to Mediterranean non-European countries.
- A-Tr certificate: produced both in import and in export; it is used for batches of goods incoming or directed to Turkey.
- Form A certificate: produced only in import; produced by the freight forwarder for only some specific destination countries, with which a special customs agreement is in operation. Normally, Form A is used to allow a reduction in customs taxes for freight with an origin in developing countries, in order to help their economy.

The customs declaration, the inward/outward cargo manifests and the commercial invoice are produced and exchanged both in 'electronic' (that is, xml) format, while the documents of origin (EUR1, EUR-Med, Form A and A.Tr) are produced and exchanged exclusively in paper format.

In the United States, the customs declarations are distinguished in the Entry and Export Declaration. In addition, only in import, a further document must be produced for freight that needs to be released in a short time: the Entry Immediate Delivery. The Inward and Outward Cargo Manifests and the commercial invoice are the same as in the EU. The certificate of origin also is used, but the customs agreement regards different countries from those in force in Europe.

In China, the customs declarations are the same as in the EU. As for cargo manifests, they are called Import and Export China Customs Advanced Manifest but have the same characteristics as in Europe. Similarly, the Chinese commercial invoice is called Fapiao but it is almost the same as the European commercial invoice. As for the certificate of origin, the same applies as reported for the U.S.

Finally, in Egypt, the customs declarations are the same as in the EU. The cargo manifests are called Import/Export general manifests. The commercial invoice is the same as in the EU. As for the certificate of origin, the same applies as reported for the U.S.

The documents specific to the various countries are:

- In the U.S.: the Duty Paid Warehouse Withdrawal for Consumption and the Certificate of Disposition of imported merchandise.
- In China: the Inspection certificate of the AQSIQ (the Chinese general administration for the supervision, the inspection and the quarantine for the quality); the Sales contract; the Import/Export license.
- In Egypt: the Inspection report and the Letter of credit.

In Table 2, a synthesis of all customs documents is provided. In the plain text, the documents produced and exchanged only in paper format are reported; in italics, the documents that could be (in a telematized port) produced and exchanged also in electronic (xml) format are reported.

Table 2. Synthesis of customs documents in Italy, the US, China and Egypt. In the plain text, the documents produced and exchanged only in paper format are reported; in italics, the documents that could be (in a telematized port) produced and exchanged also in electronic (xml) format are reported.

	Common Documents	Similar Documents	Specific Documents
Italy	Bill of lading; Delivery order; Packing list	(1) *Customs declaration* (2) *Inward/Outward cargo manifest* (3) *Commercial Invoice* (4) Documents of Origin	• Documents of origin are differentiated in EUR1, EUR-MED (both in export), Form A (in import) and A.Tr (limited to Turkey)
US	Bill of lading; Delivery order; Packing list	(1) *Export declaration (in export)* (2) *Entry summary/Entry-Immediate delivery (in import)* (3) *Inward/Outward cargo manifest* (4) *Commercial Invoice* (5) Documents of Origin	• Duty Paid Warehouse Withdrawal for Consumption; • Certificate of disposition of imported merchandise
China	Bill of lading; Delivery order; Packing list	(1) *Customs declaration* (2) *Import/Export China Customs Advanced Manifest* (3) *Fapiao* (4) Documents of Origin	• Inspection certificate of the AQSIQ (General administration for the supervision, the inspection and the quality); • Insurance Police; • Sales Contract; • Import/Export License
Egypt	Bill of lading; Delivery order; Packing list	(1) *Customs declaration* (2) *Import/Export General Manifest* (3) *Commercial Invoice* (4) Documents of Origin	• Inspection report; • Letter of credit

3. Materials and Methods

The CIRCUMVECTIO Plus platform provides two main services: the management of customs documents, which is the most important, and the management of physical freight flows, which is the organization of the intermodal path followed by the shipments, together with the reservations of all carriers involved.

3.1. Platform Design for the Management of Customs Documents

As regards the management of customs documents, the CIRCUMVECTIO Plus platform was developed based on the experiences of those PCSs that manage documents and it aims at covering the gap between single-window platforms of the various countries, which are at most of service to customs offices and other public bodies, and the TOS and PCS platforms of the different ports.

The CIRCUMVECTIO Plus platform was studied and designed in such a way that it allows the efficient share of customs documents among port actors. The platform is capable of managing documents from all countries worldwide. Indeed, as shown in the previous Section 2.2, the most important documents are either valid at the global level, such as the bill of lading, or similar from one country to another; for example, the customs declaration or cargo manifests.

In addition, the platform was equipped with a versatile API, designed in order to be compatible with the largest number of management software currently sold on the market. This API is an interface designed for transferring the results of the elaborations

from any possible ICT system to the CIRCUMVECTIO Plus platform, and vice versa. For example, through this API, the information is transferred from any management software to the CIRCUMVECTIO Plus platform, and vice versa, and from the CIRCUMVECTIO Plus platform to a customs single window and vice versa. This API was developed with similar purposes to that developed for the app by Lupi et al. [61]. This aspect is important as the main difficulty faced by port operators consists of the necessity to upload the same documents many times on different platforms. Thanks to this API, the CIRCUMVECTIO Plus platform allows one to transfer of the document from one platform to another.

The importance of the interaction of the platform with management software is fundamental as the development of customs declarations and especially of cargo manifest, especially in import, requires several interactions between the main port actors, such as the customs agents, the freight agent and the customs offices. In addition, the cargo manifest is an enormous document, as it reports a synthesis of all customs declarations of all batches of goods loaded or unloaded on a ship. These documents are very often produced and exchanged in paper format, and this requires a severely long time, especially because every single row of cargo manifest (a cargo manifest is generally composed of millions of rows) concerns a batch of goods; therefore, it requires the interaction between the ship agent (that is, producing the cargo manifest), and the customs agent (that is, producing the customs declaration).

In export, the situation is simpler because cargo manifests are produced from customs declarations, and then they are sent to the customs office for release. In import, instead, the development of these documents requires several mutual interactions between the customs offices, the ship agent, and the customs agents.

Sometimes, customs declarations and cargo manifests are produced and exchanged in 'electronic', that is, xml, format. This allows the production of cargo manifests, which are very large documents, automatically from customs declaration, by means of the management software of the ship agents.

As a result, the CIRCUMVECTIO Plus platform was designed in order to be able to share customs documents both in pdf (or image) format (that is a scan of paper documents) and in xml version. In this way, customs declarations and cargo manifests could be produced and shared both in xml or scanned paper format, while if customs declarations are uploaded in xml format, it is much easier to produce the cargo manifests.

The other customs documents, such as bills of lading and documents of origin, are currently exchanged in paper format, but they can be scanned and uploaded on the platform in pdf (or image) format. In this way, port operators have at their disposal all documents directly from the platform, thus avoiding several phone calls and emails to retrieve the missing information.

The CIRCUMVECTIO Plus platform allows the exchange of documents in two specific cases:

- In the ports not equipped with PCS, the platform allows the sharing of documents among the various subjects operating in the port: ship agents, customs agents, freight forwarders, but also terminal operators and maritime carriers. In this case, the platform plays the role of a PCS, but is applicable to any port of the world.
- In all cases, the platform allows to transfer of documents generated in the export port, from the export port to the import port. This allows freight forwarders, customs agents and ship agents established in the port of import to produce in an easier way their own documents. At present, the PCS of the different ports do not communicate with each other. In addition, the customs single windows of the different countries do not communicate, with the only exception of the European Union.

A flowchart of the functioning of the management of documental flows is reported in Figures 1 and 2.

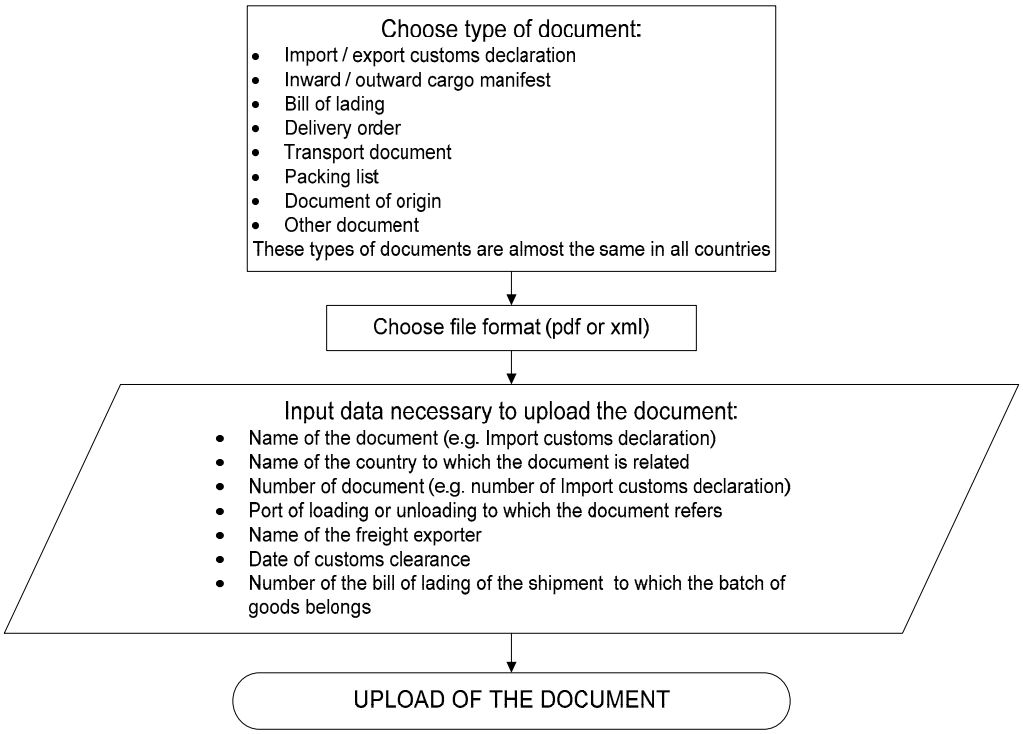

Figure 1. Flowchart of the use of the menu "Documents" for the document upload. Source: own elaboration.

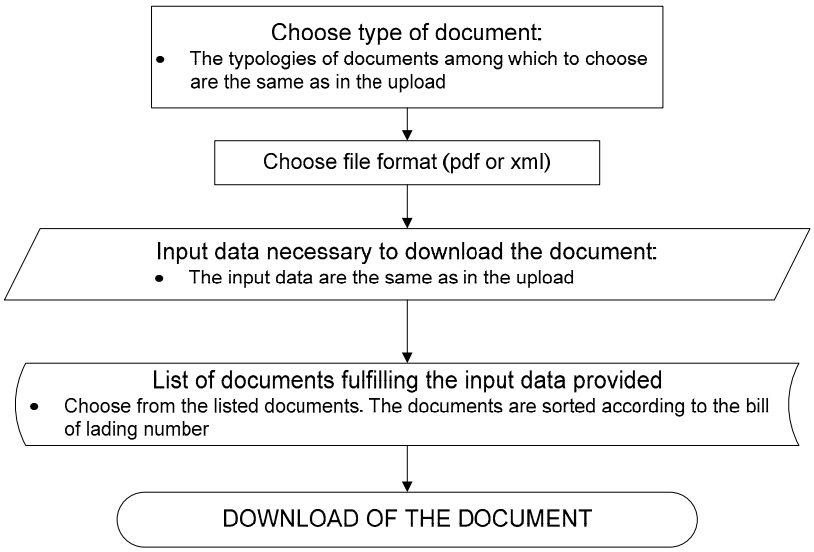

Figure 2. Flowchart of the use of the menu "Documents" for the document download. Source: own elaboration.

The CIRCUMVECTIO Plus platform allows the uploading of all customs documents, reported in the rectangular box of the flowchart of Figure 1. At the moment of document upload, it is necessary to refill the input data reported in the rhomboidal box. These fields are completed automatically if the document is uploaded as xml file and allow easy retrieval of the document at the download moment. It is not necessary to provide all input data; however, the more input data provided, the easier it is to find the document to download.

The main documents exchanged in export are outward cargo manifest, customs declaration, bill of lading, invoice, transport document, delivery order, packing list, and, when applicable, (depending on the country with which the product exchange is carried out) EUR-1 or A.TR. The main documents exchanged in import are inward cargo manifest, customs declaration, bill of lading, invoice, transport document, delivery order, packing list, and, when applicable (depending on the country with which the goods are exchanged), Form A or A.TR. Outward and inward cargo manifests concern an entire ship. The other documents refer to a batch of goods, except the bill of lading which refers to a whole shipment (which in general consists of several batches of goods).

The development of the platform functionality for the management of customs documents was carried out after several meetings carried out with operators in the field, in order to understand their logistic needs. The interviewed operators are terminal operators, ro-ro and container operators, customs offices, shippers and freight forwarders.

3.2. Platform Design for the Management of Physical Flows

As for the management of physical flows, several interviews were carried out with about 50 operators in the sector, established in the area of the port of Livorno, concerning the following two aspects:

- the reason why intermodal transport is less attractive than an all-road mode to freight forwarders, although remarkably less expensive;
- which services are most important in order to quickly reorganize the shipment in case of disruption.
    - The respondents provided that the weak point of intermodal transport concerns the need to book several operators, while in the case of all-road mode, it is sufficient to book only one carrier. This aspect becomes problematic in case of a disruption that causes excessive delay to the shipment, which consequently misses the ship where the freight was supposed to be loaded. In this case, it is necessary to reorganize the transport in the shortest possible time, and change reservations as soon as possible to avoid or at least reduce cancellation penalties.

Following these findings, the CIRCUMVECTIO Plus platform provides specific functionalities to redirect to the reservation pages of maritime and rail operators and reports the contacts of operators concerning the change of booking.

The platform also provides the best intermodal path for a shipment from an origin to a destination. The path calculation is based on the Dijkstra algorithm, applied to an intermodal network (road + maritime + rail) with costs updated in real time.

A flowchart for the management of physical flows is reported in Figure 3. The CIRCUMVECTIO Plus platform is organized in the following menus:

- Path: it allows the calculation of the optimal intermodal path from an origin to a destination, that is followed by the shipment. This menu allows not only to determine the optimal path before the shipment begins to be transported, but also to recalculate the path in case of disruption.
- Shipment: it allows the insertion of the shipment details, and also provides the contacts of the operators for the reservation before the shipment departs or for reservation changes in case of disruption.
- Send notification: it allows us to easily send notifications in case of disruptions to all actors involved in the shipment.

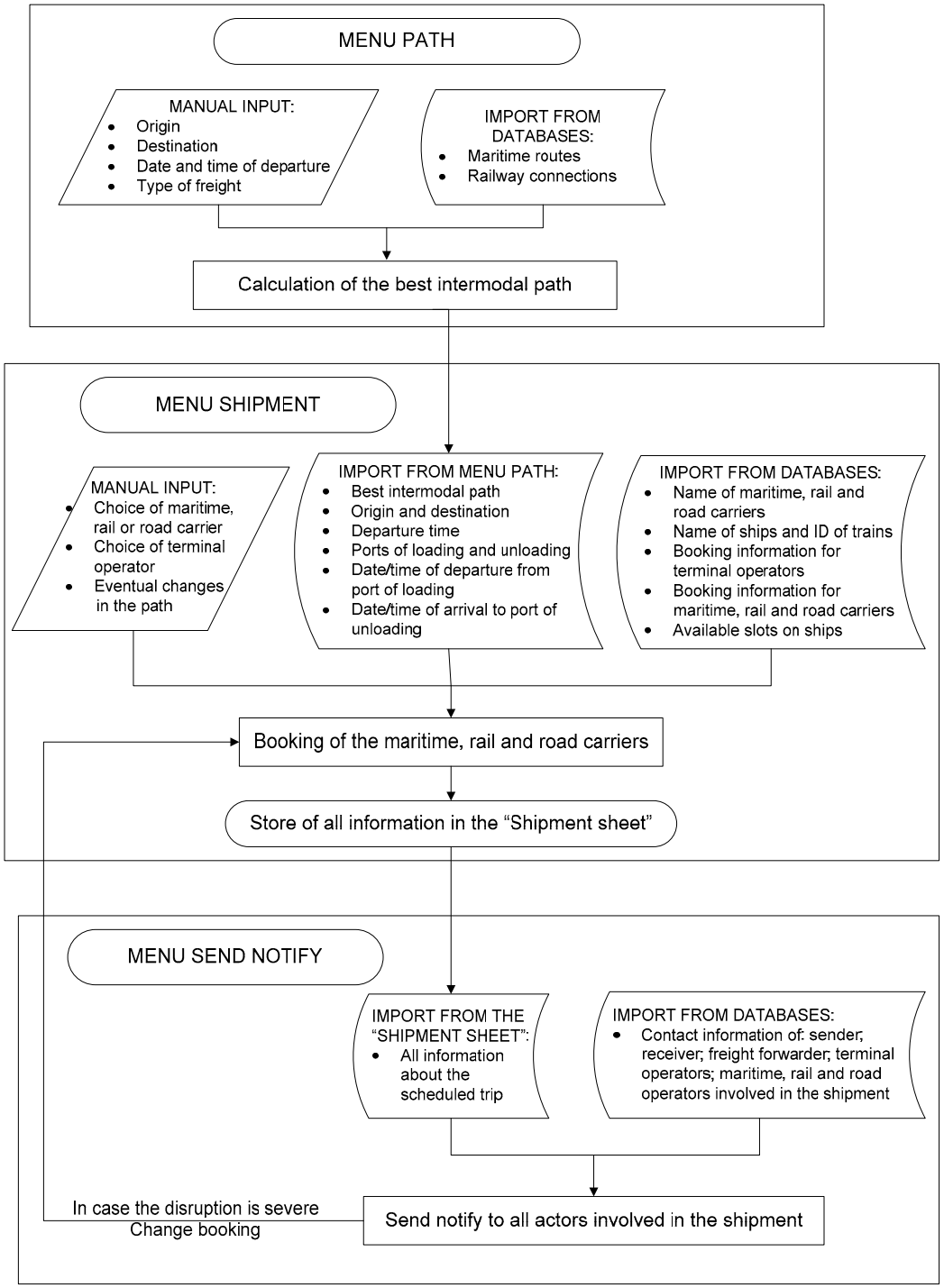

Figure 3. Flowchart of the use of the platform for the management of physical flows: menu "Path", "Shipment", "Send notify". Source: own elaboration.

3.3. The Platform Architecture

The proposed platform is composed of a main back end that connects together all the following modules:

- A GUI, which allows the user to navigate among the platform menus.
- A repository, which allows to upload and download the customs documents.
- An API, which allows direct interaction between the platform and other software. It allows the automatic upload of the documents created by management software of port operators on the repository of the CIRCUMVECTIO Plus platform; it also allows the automatic upload of the documents, or the information sent by the customs

offices by means of their single windows. This API also allows the CIRCUMVECTIO Plus platform to interact with PCSs as regards the transmission of documents and information.

- Other APIs, which allow the platform to receive real-time information about road traffic from Infoblu [62] and about ship positions from Marinetraffic [63]; to connect to the PCS and PMIS [64] platforms in operation in the Italian and French ports of northern Tyrrhenian and Ligurian Seas. Real-time ship positions are retrieved not only from Marinetraffic but also from PMIS, and transmitted directly to the CIRCUMVECTIO Plus platform by dedicated APIs. The ports involved are Livorno, Piombino, Civitavecchia, La Spezia, Marina di Carrara, Genoa, Savona-Vado, Nice, Toulon, Marseilles, Olbia, Porto Torres, Arbatax, Cagliari, Bastia, Porto Vecchio, Propriano and Ajaccio.
- The databases of freight forwarders, terminal operators, maritime and rail operators, and trucking firms. These databases store all operator data, but especially the information for change booking in case of disruption. They were created by the authors of this paper by collecting all data of operators based on the ports mentioned in the previous point, or operating in the regions of Tuscany, Liguria, Sardinia, Corsica and PACA (Provence-Alpes-Cote d'Azur).
- The databases of maritime routes and rail connections. They were created after a data collection, carried out by the authors of this paper, about all maritime ro-ro, container and general cargo scheduled maritime routes in operation among the above-mentioned Italian and French ports of the Ligurian and northern Tyrrhenian Seas; all rail services, carried out by rail operators, in the regions of Liguria, Tuscany, Sardinia, Corsica and PACA.
- Finally, a routing module, which allows the calculation of the optimal intermodal route for freight transport, involving not only road transport but also maritime services, such as motorways of the sea and container routes, and rail freight connections, in the regions and among ports mentioned above.

A general scheme of the CIRCUMVECIO Plus platform, as well as its interaction with the other platforms and websites, is represented in Figure 4.

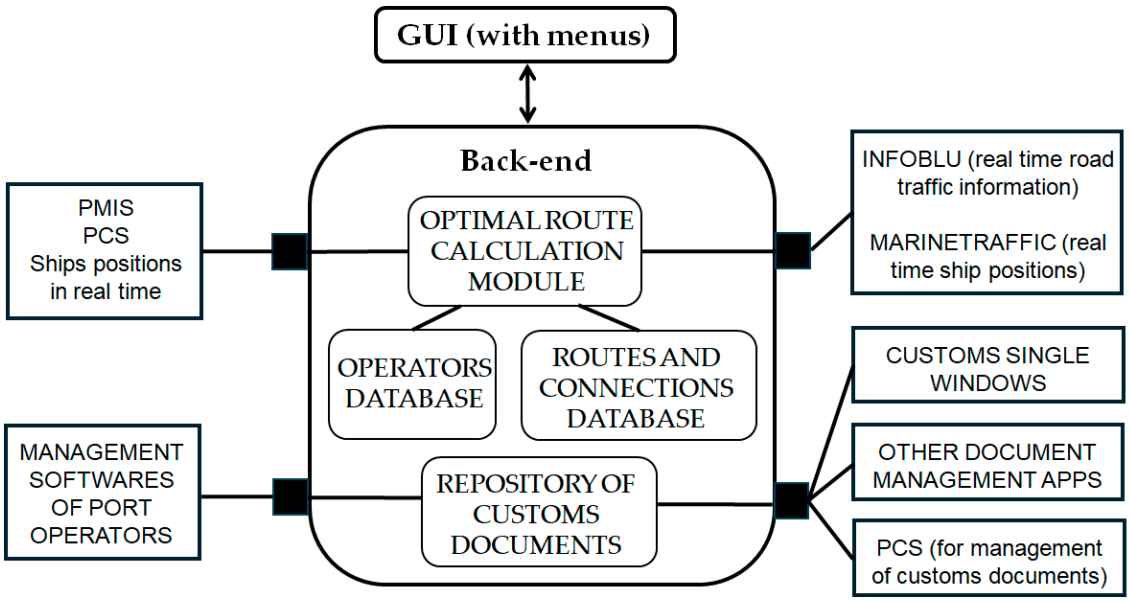

Figure 4. General scheme of the CIRCUMVECIO Plus platform, as well as its interaction with the other platforms and websites. Source: own elaboration.

Detail on the Routing Module and on the Combination of Real-Time Data

The intermodal network was modelized by means of a graph, where links represent road sections, rail connections and maritime routes of scheduled services, while nodes represent road intersections, motorway exits, port terminals, and rail terminals.

Costs on the links are a combination of real-time and scheduled ones.

As regards road transport, real-time data are retrieved from Infoblu, as data from Google Maps are not feasible, as they are available only in specific motorway sections. As a result, for the rest of the network, a large work of data collection was carried out. In particular, travel times were collected at different hours of the day, on different days of the week and in different periods of the year, in order to have reliable scheduled traffic information. Scheduled traffic data were used as a departure point to calculate an initial demand origin–destination (O-D) matrix of displacements. Then, the demand O-D matrix was updated in real time by the platform using real-time traffic counts. Then, traffic data in all the other road sections were recalculated by means of a stochastic equilibrium assignment algorithm.

As regards maritime transport, all data about maritime routes were collected and stored in the database. In particular, also the identifiers of the ships that carry out the route services were collected. The Marinetraffic website provides real-time positions of all ships. As a result, real-time data about maritime routes are retrieved by interrogating the Marinetraffic website with the identifiers of the ships.

As regards rail transport, these data are of propriety of Mercitalia Rail; therefore, the platform redirects to this website.

4. Results: The Main Features of the Platform for Physical Flow Management

The CIRCUMVECTIO Plus platform is formed by a Graphical User Interface (GUI) and by modules and databases. The databases embedded in the platform are maritime transport operators, maritime routes, Multimodal Transport Operators (MTOs), rail freight connections, terminal operators, freight forwarders, and trucking firms.

The platform is available only to registered users. The GUI of the platform is composed of five menus, which is described in this paper, and an interactive map showing the user the best path from a given origin to a destination. The menus of the platform are Path; Shipment; Send notify; PCS–PMIS–ERIS Liner; Documents.

The menu '**Path**' opens an interactive map; the itinerary can be set by choosing origin, destination, type of goods transported and travel preferences. In particular, the user can choose between the cheapest path and the fastest path and can also decide which transport modes to use road + sea + rail, road + sea, road + railway, road + railway only, rail only, sea only. See Figure 5.

The main sources about the best path, which could be either intermodal or single mode, are the following:

- For road transport: the platforms 'Infoblu' for Italy and 'Autoroutes.fr' for France. Originally, 'Via Michelin' was chosen, but it does not provide real-time information on traffic and road closures. Infoblu instead provides real-time information on the Italian motorway network and Autoroutes.fr on the French one. The choice of Google Maps was not feasible, because its managers do not allow other apps to import quantitative data from Google Maps. It is only possible to import the entire map, for example of a city, as described in [61].
- For the maritime transport in the intermodal path:

- from the websites of maritime operators, which provide the departure and arrival date and time of maritime services, the name of the ships which perform each service;
- from the website www.marinetraffic.com, which gives the position of each ship in real time;
- directly from operators, as regards the prices of tickets and the number of slots available on a certain ship. This information is private, since maritime operators make preferential prices and reserve slots for the main clients. However, operators are usually reluctant to expose this information on a website. Therefore, in the platform, it is shown only in demo mode.

- For the rail transport in the intermodal path:
  - from MTO websites which provide the time of cargo closure, time of cargo availability upon arrival, and the number of the train;
  - directly from MTOs, as regards prices and availability of train slots. However, also in this case, operators are usually reluctant to display this information. Therefore, as in the case of the maritime part of the path, in the platform, it is shown only in demo mode.

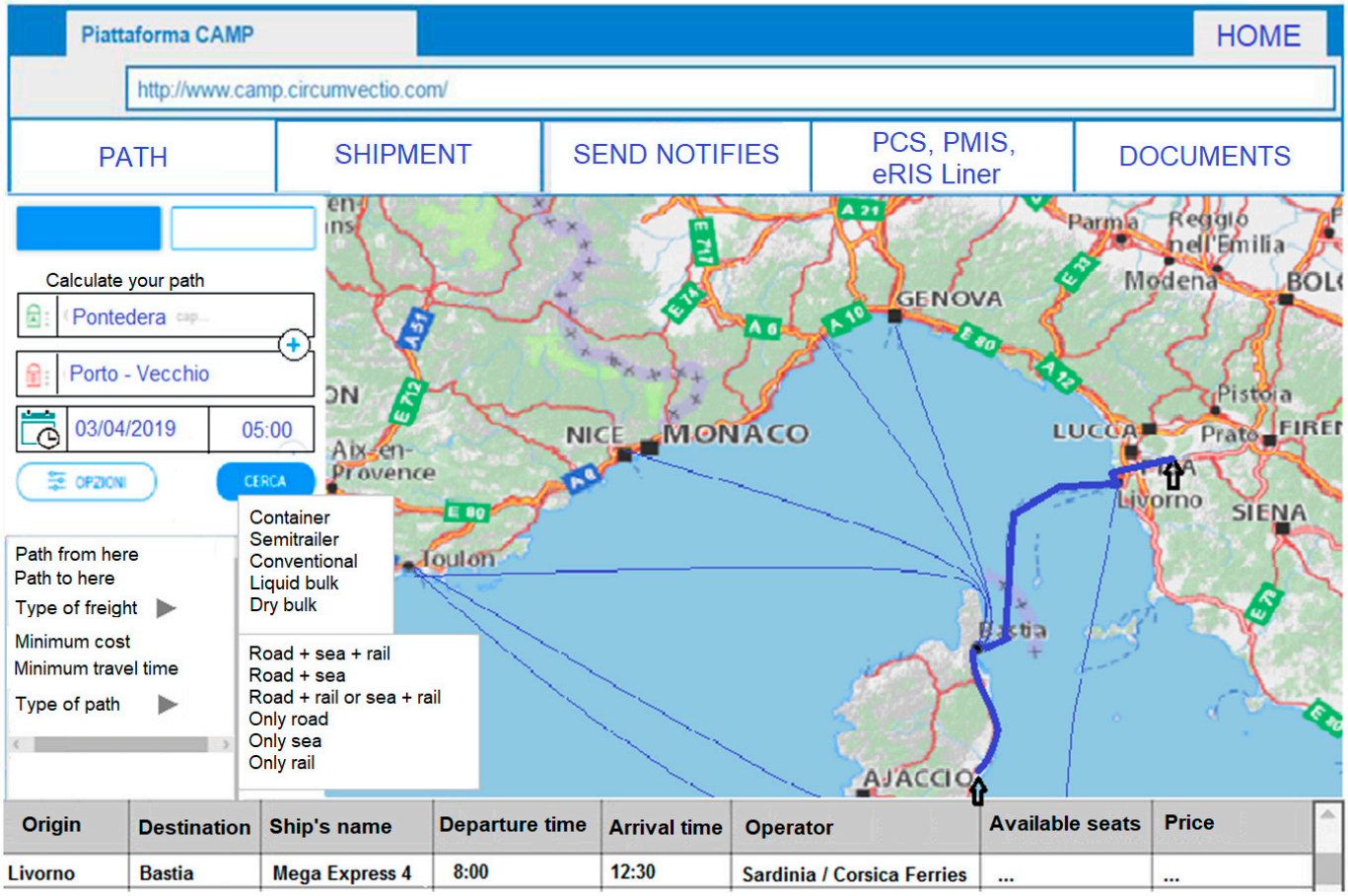

Figure 5. Example of using the 'Path' menu: determination of the intermodal route (road + sea) Pontedera–Porto-Vecchio. Source: own elaboration.

The '**Shipment**' menu is composed of four sub-menus, which redirect to precise actions on the 'Shipment sheet' (see Figure 6), described in the following:

- Create shipment: it contains all the instructions necessary for the creation of the 'Shipment sheet'. It allows the insertion of travel details and the choice of the carriers (maritime, railway, and road) and the terminal operators (maritime and railway).
- Change shipment data: this allows us to modify an existing 'Shipment sheet'.
- View shipment data: this allows us to visualize a 'Shipment sheet', but without the possibility of modifying.
- Cancel shipment data: this allows us to cancel a 'Shipment sheet' once the shipment is consigned to the receiver. This sub-menu is necessary as the platform does not cancel automatically the 'Shipment sheet'.

The shipment sheet for the itinerary from Pontedera (Italy, Tuscany region) to Porto-Vecchio (France, Corsica region) is shown in Figure 6.

Some information of the 'Shipment sheet' is imported from the menu 'Path'; for example, the address of the origin of the shipment, address of destination, dates and times of departure, arrival at the loading terminal, ship departure from the loading terminal, arrival at the unloading terminal, and arrival at the destination.

However, this information is automatically modified after the user has booked the road, maritime and, possibly, rail carriers, and the terminal operators. In addition, all the fields of the 'Shipment sheet' can be also manually modified by the user.

In the 'Shipment sheet', we can also observe (see Figure 6):

- a map that displays the itinerary; this is gradually updated by the reservations of road, maritime and rail carriers and terminal operators;
- the buttons that redirect to the booking pages of carriers (maritime, road and rail ones) and terminal operators.

Carriers, at present, are not very inclined to share sensitive data through the platform, such as, for example, prices charged. The platform, however, supplies the contacts (telephone and e-mail) of vectors or terminal operators, so that the users can quickly contact them and establish a private negotiation.

The menu '**Send notify**' allows one to send notices to all actors involved in a given shipment in the following situations:

- in case of a serious disruption (for example engine failure or an accident) that results in such a high delay in the shipment that makes it impossible to reach the rail or the maritime terminal in time for the departure of the booked train or ship.
- in the event of a small disruption (for instance the shipment is stuck in a traffic jam), that results in a little delay of arrival at the rail or maritime terminal; however, in time to board the train or the ship booked.

In the case of disruptions, the notification is sent by the carrier (road, maritime or rail) that is transporting the shipment at the moment the disruption occurs. Instead, departure or arrival notifications are sent by the sender or the receiver of the shipment, or by the freight forwarder.

The menu '**PMIS, PCS and eRIS Liner**' reports the updated links to the PCS (where it is available), PMISs, and eRIS (electronique Réseau Informatif Service). Liner web platforms of ports included in the project CIRCUMVECTIO Plus: Genova, Livorno, Olbia, Savona-Vado Ligure, Toulon, Bastia. The eRIS Liner platform is the PMIS of the French ports.

At the beginning of the CIRCUMVECTIO project, a direct interaction was also previewed between the CIRCUMVECTIO Plus platform and the PMIS and eRIS Liner ones; in particular, it was previewed that PMIS and eRIS Liner platforms could transmit to the CIRCUMVECTIO Plus platform position of ships in real time. However, this turned out to be not feasible because the PMIS and eRIS Liner managers were reluctant to share and display this information.

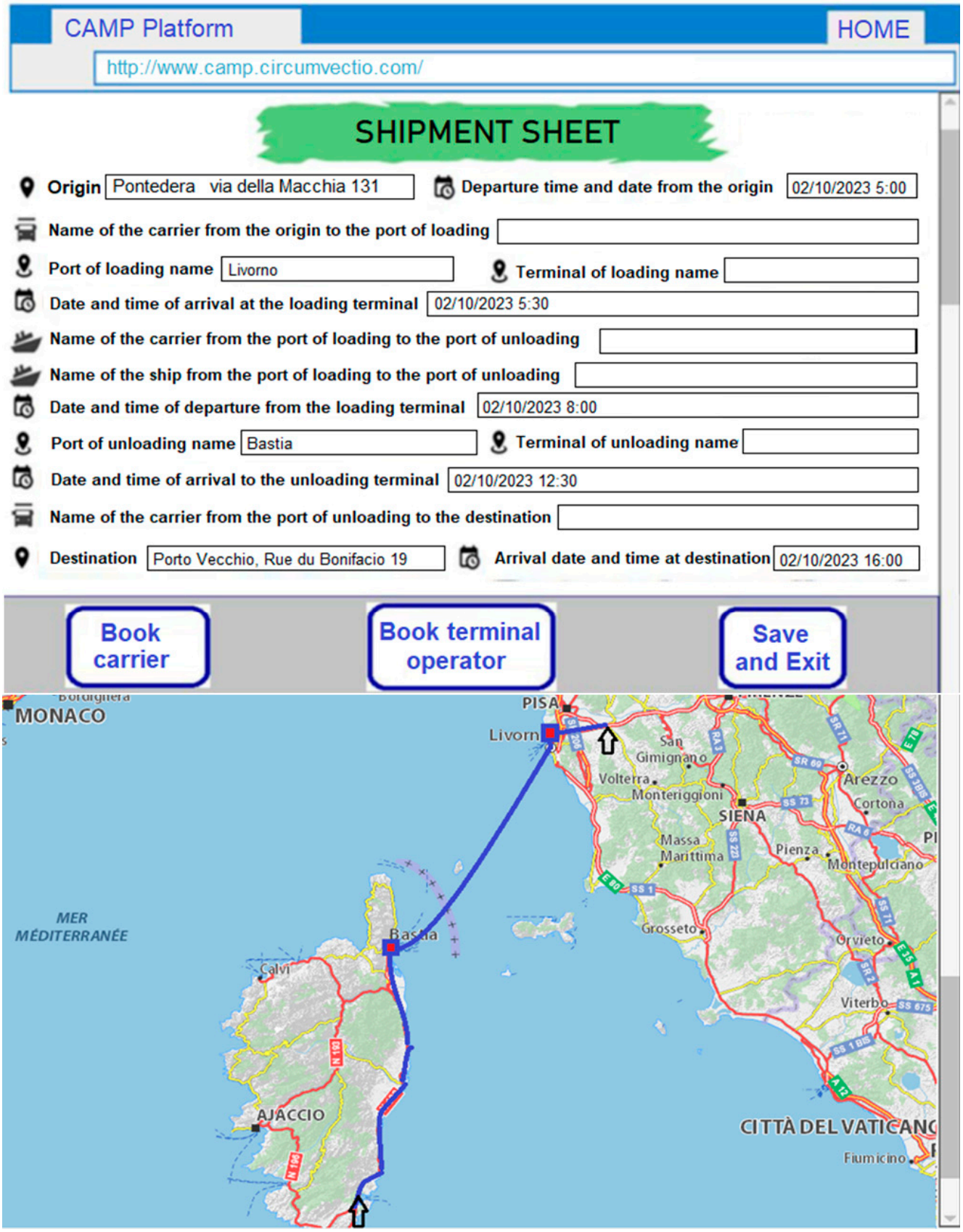

Figure 6. Example of 'Shipment sheet' for an itinerary from Pontedera to Porto-Vecchio. Source: own elaboration.

5. Results: The Documental Flow Management by Means of the CIRCUMVECTIO Plus Platform

The menu 'Documents' is the most important one of the CIRCUMVECTIO Plus platform, as it allows the management and integration of customs documents.

The menu Documents is connected to a repository, where customs documents may be uploaded and downloaded.

An overview of the principal documents required by customs offices, and their exchange among the port actors, is provided in Lupi et al. [65].

The customs agencies, in Italy AIDA [43] and in France Pro.douane [44], have their own single-window platform. The Italian and French cases were studied in the CIRCUMVECTIO and CIRCUMVECTIO Plus projects, as these projects were financed by the Italy–France Maritime Programme; however, also, in several other countries, the single-window customs platform is also in operation.

The menu 'Documents' of the CIRCUMVECTIO Plus platform provides the following functionalities:

- Transfer documents generated in the export port, from the export port to the import port. This allows freight forwarders, customs agents and ship agents established in the port of import to produce in an easier way their own documents. At present, in fact, the PCS of the different ports do not communicate with each other.
- To allow, in the ports not equipped with PCS, the sharing of documents between the various subjects operating in the port: ship agents, customs agents, freight forwarders, but also terminal operators and maritime carriers.

These possible situations were taken into account:

- Trade between Italy and another country belonging to the EU: intra-community transfer.
- Export from an EU country to a non-EU country.
- Import from a non-EU country to an EU country.

In the case of intra-community transfer, the documents exchanged are only invoices, transport document and packing lists. These do not involve the use of PCS.

Documents in non-EU countries vary from one country to another. In this paper, as a non-EU country, the United States was considered as an example.

5.1. Use of the Platform in the Case of Intra-Community Transfer

In the case of intra-community transfer, there are no customs. The freight forwarder produces invoices, transport documents and packing lists in paper format. They are loaded on the platform as pdf or image files. These documents 'accompany' the goods in paper format and must be shown in case of eventual control of the police and at the entrance and the exit from port terminals.

The use of the platform in the case of intra-community transfer is shown in Figure 7.

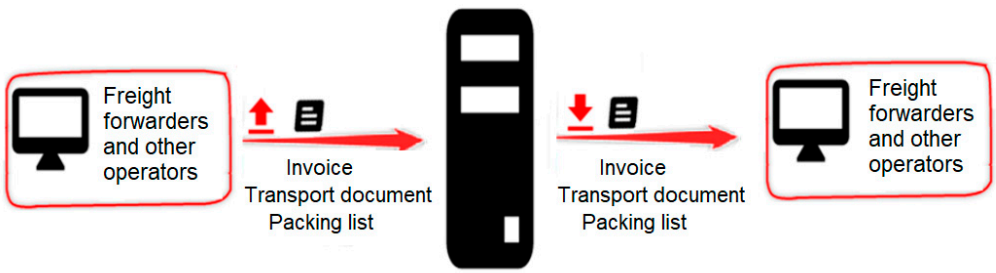

Figure 7. Exchange of documents between the export port, platform and import port in the case of intra-community transfer. Source: own elaboration.

5.2. Use of the Platform for Exchange of Customs Documents Outside the European Union

Initially, it was planned that documents could be directly exchanged from the CIRCUMVECTIO Plus platform to the PCS by simply clicking on a button on the PCS or on the platform. However, this turned out to be not feasible, because:

- it would be necessary for the collaboration of a large number of PCS managers from several countries in the world;
- the PCSs of the U.S. ports do not manage customs documents, because port actors are reluctant to share the information about their freight, as shown also in [12].

As a result, only the case of uploading and downloading the customs documents on the platform was considered, while the possibility of sending the documentation between the PCS and the platform by pushing simply a button was neglected.

For the sake of example, in the following, the use of the platform for the exchange of documents between Italy/France and the United States is presented.

5.2.1. Export from EU Countries to the United States

As EU countries, the case of Italy and France is taken as an example. Italian or French customs agents create the export customs declarations, while the ship agents produce the outward cargo manifest. These documents are generated in xml format by means of the management software of ship and customs agents, and are loaded after by these port actors onto the CIRCUMVECTIO Plus platform.

The Italian or French outward cargo manifest, available on the platform, allows the U.S. ship agent to produce more easily the U.S. inward cargo manifest.

The export customs declaration, available on the platform, allows the U.S. customs agents to draft more easily the Entry summary and the Entry/immediate delivery; that is, the U.S. homologous of the European customs declaration of import. Bill of lading, invoice, delivery order and packing list are generated in the port of export, and are currently shipped by the freight forwarder (Italian or French) to freight forwarders and customs agents of import (US) only in paper format. Instead, using the CIRCUMVECTIO Plus platform, freight forwarders of the port of export (Italian or French) are able to scan and load these documents on the platform in pdf format, while the freight forwarders operating in the port of import (American) are able to download them. See Figure 8.

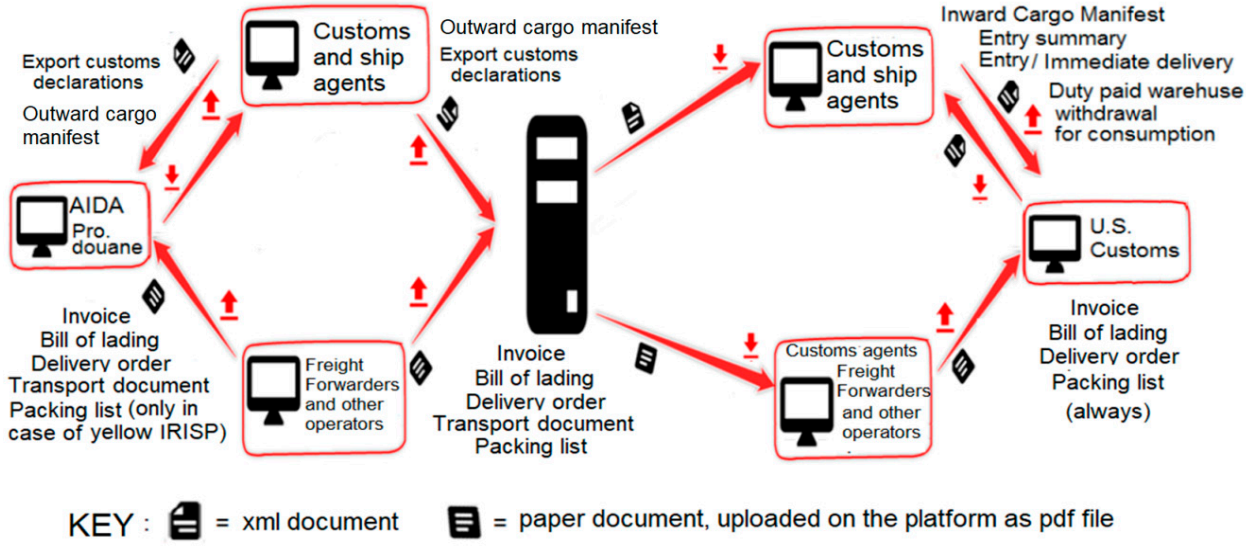

Figure 8. Transmission of export documents, from a European (specifically Italian or French) export port, to a U.S. import port, in case both ports are not furnished with PCS. Source: own elaboration.

5.2.2. Export from the United States to Europe

The U.S. export declarations and the U.S. outward cargo manifest are produced by means of the management software of the American customs agents and ship agents, in xml (electronic) format, and are loaded on the platform. These are unloaded by customs and ship agents of the Italian or French import port.

The American outward cargo manifest is much easier to produce, especially in electronic format, than the inward cargo manifest in the Italian or French import port. From the American export declaration, it is much easier than the Italian/French import customs declaration.

Bill of lading, invoice, delivery order and packing list are required in the port of import, Italian and French. These are currently transferred and shared as paper documents; however, with the CIRCUMVECTIO Plus platform, it is possible to scan and load them on the platform in pdf in the American port of export and to unload them at the (Italian or French) port of import.

The invoice, however, in the United States, is often exchanged also in xml format (instead of paper format); in this situation, it is loaded on the platform as xml file (instead of pdf file). In any case, the invoice is currently produced in electronic format in Italy and France also; however, at least for now, it must also be produced in paper format. In the case of police checks, in fact, it must be presented in paper format and not in electronic format. As mentioned above, the transport document is not required by US customs, and it is therefore produced exclusively in the import port. See Figure 9.

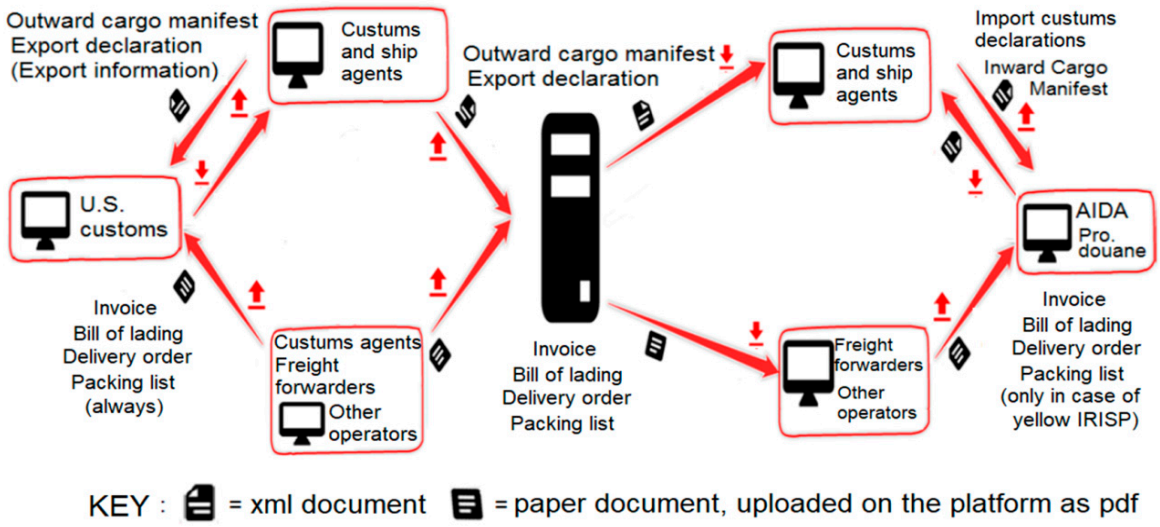

Figure 9. Transmission of export documents from a U.S. export port to an Italian or French import port, in case both ports are not furnished with PCS. Source: own elaboration.

5.3. Share of Documents Among the Actors of Export and Import Ports Not Equipped with PCS

5.3.1. Document Share in the Port of Export

At present, customs agents send (by e-mail) customs declarations, in xml (electronic) format, to the ship agent. The ship agent generates the outward cargo manifest through its management software from the customs declaration received.

Customs agents load the declarations, in electronic format, on the CIRCUMVECTIO Plus platform. The ship agent downloads them from the platform and generates the outward cargo manifest through their management software without the need to collect all customs declarations (for example, by e-mail) which can be thousands even for a single outward cargo manifest.

Port actors load on the platform the documents that they have produced; in addition, they can access all the documents of their own interest on the platform, as well as those produced by the other port actors. Each actor of the port does not have access to 'all' the documents present on the platform, but only to the documents of his own interest.

This procedure is schematized in Figure 10.

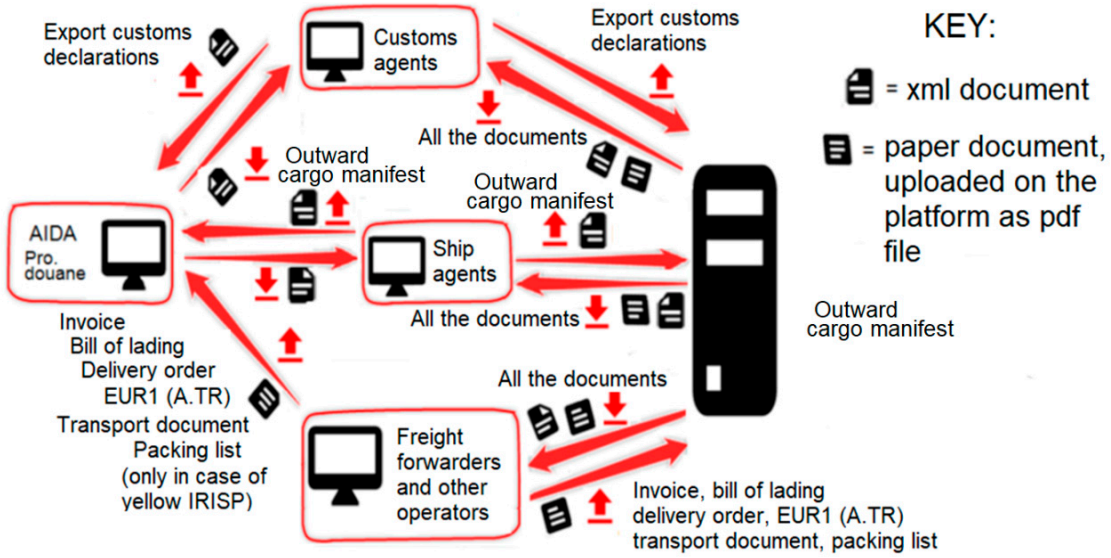

Figure 10. Sharing of documents between the actors of the export port not furnished with PCS. Source: own elaboration.

5.3.2. Document Share in the Port of Import

Customs agents send to the ship agent 'provisional' customs declarations; that is, without A3 codes. The 'A3' code identifies the batch of goods to which it is related to a given customs declaration. The customs offices assign each A3 code to each batch of goods before the customs control. The ship agent generates a 'temporary' inward cargo manifest, as it lacks A3 codes, starting from the customs declarations and uploads it to AIDA. Customs offices enter the A3 codes in the inward cargo manifest and send it back to the shipper.

In some ports, the ship agent must send, to the customs agents, the A3 codes relating to the batches of goods under their jurisdiction. In case the port is not furnished with PCS, the ship agent has to send (e.g., by email) to the different customs agents, one by one, the A3 codes. However, these A3 codes can be in the thousands, and this results in a serious inefficiency, and therefore in a slowdown of the document import procedures. In other ports, the customs office either enters A3 codes into the inward cargo manifest or sends them directly to the different customs agents, which can be in the thousands. This entails a high workload for customs offices.

Using the CIRCUMVECTIO Plus platform, the ship agent loads on the platform the inward cargo manifest, complete with the A3 codes received by customs offices. Therefore, the customs agents are capable of finding the codes A3 of their interest on the platform. This simplifies the document import procedures and therefore surely brings great benefits to the operators in terms of workload and time saved. This is already possible in ports equipped with PCS. Customs agents can access and download the inward cargo manifest loaded on the PCS by the ship agent.

This procedure is schematized in Figure 11.

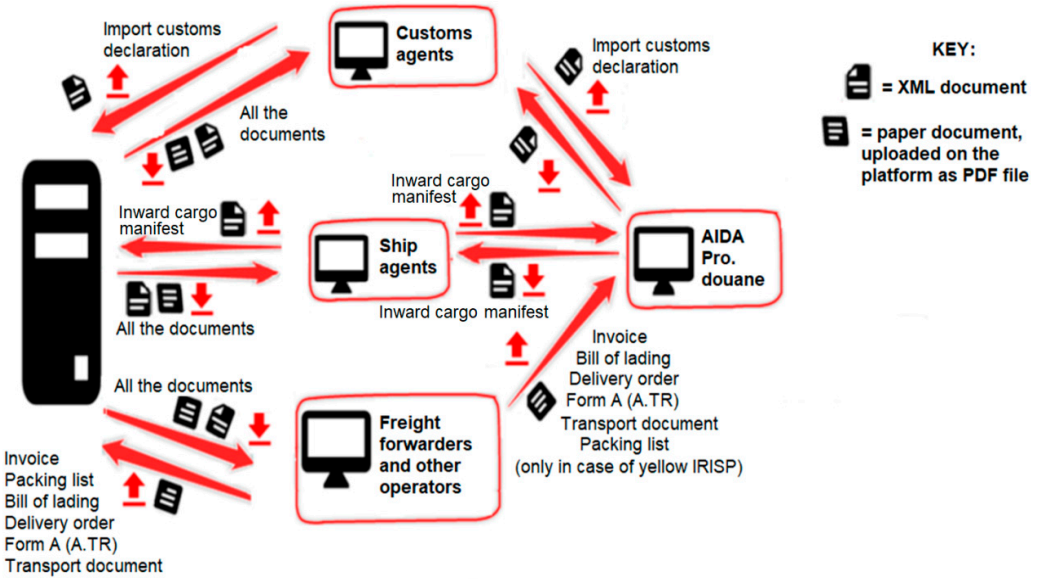

Figure 11. Sharing of documents between the actors of the import port not furnished with PCS. Source: own elaboration.

5.4. The Web Pages of the Platform for the Upload and the Download of Customs Documents

The CIRCUMVECTIO Plus platform allows one to upload and download the main customs documents, displayed in Figures 8–11.

The web page of the menu 'Documentation' for the upload of a customs document is displayed in Figure 12. The web page for the download of a customs document is shown in Figure 13.

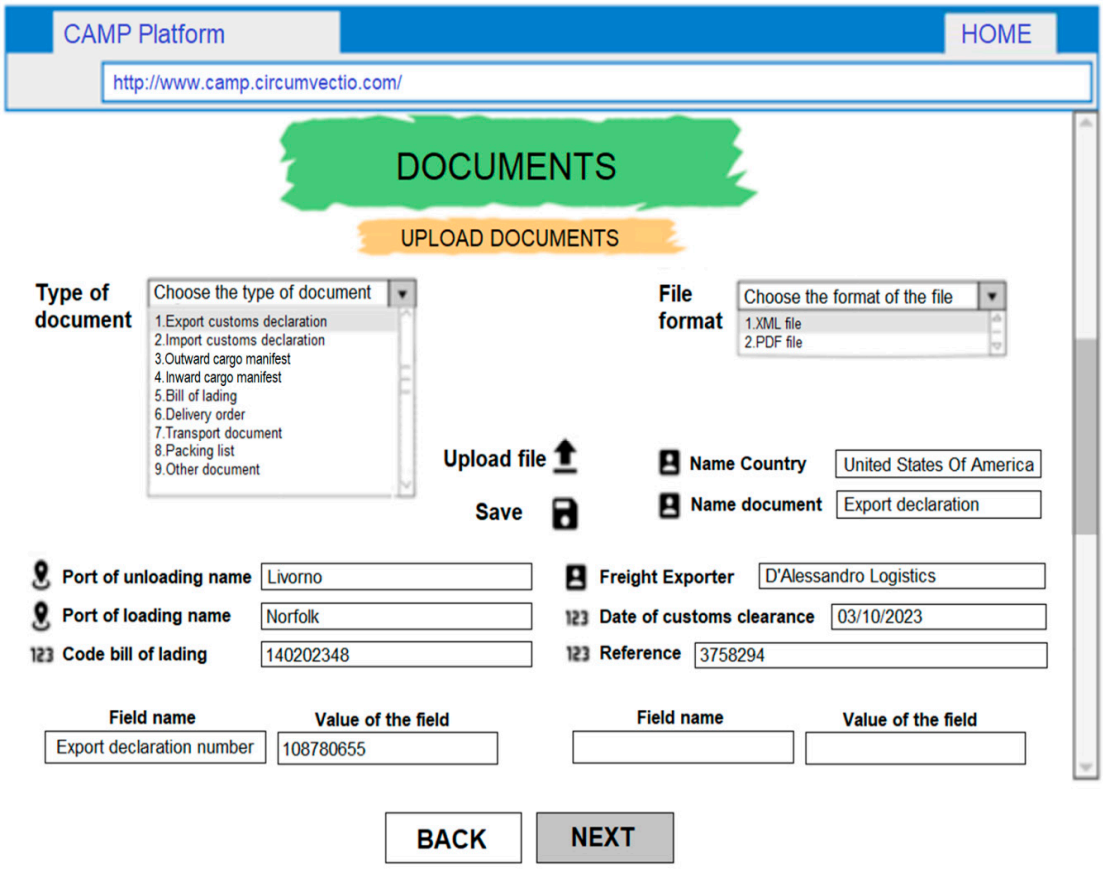

Figure 12. Menu Documents: upload. Source: own elaboration.

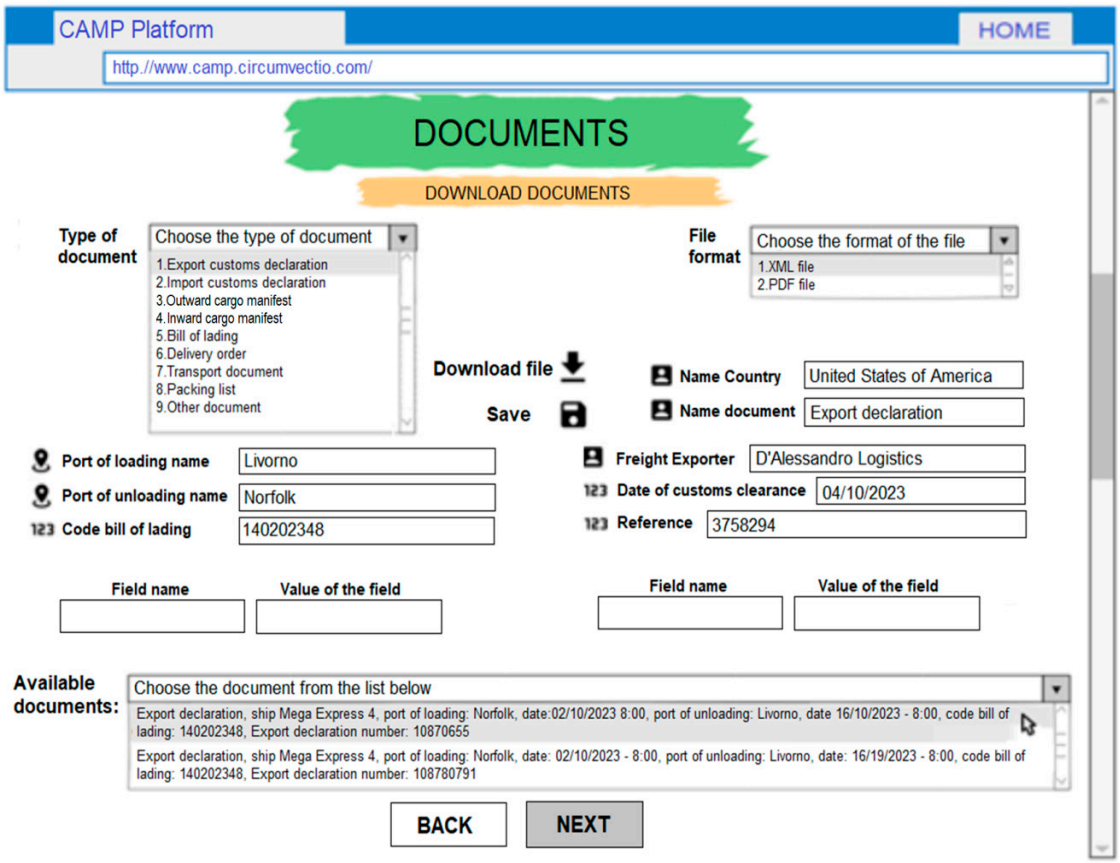

Figure 13. Menu Documents: download. Source: own elaboration.

As a result, when uploading a document on the platform, it is necessary to choose, as the type of document, the corresponding Italian document, and not the document type 'Other document'. For example, in the case of the Import China Customs Advanced Manifest, the document type to choose upon the upload is 'Inward Cargo Manifest'.

The document type 'Other document' should be chosen only for the documents specific to a given country; for example, the U.S. 'Duty paid warehouse withdrawal for consumption'; indeed, if in the group 'Other documents' a very large number of documents is stored, at the moment of download it could be difficult to find the wanted document.

Figure 12 reports, for example, the upload of a U.S. customs declaration of export, i.e., the 'Export declaration'. In the drop-down menu 'Type of document', upper left of Figure 12, it is necessary to choose the typology of the document, in this case, 'Export customs declaration'. In the drop-down menu 'File format', upper right of Figure 12, the voice 'XML file' must be chosen. Then, the remaining data must be manually inserted; the most important ones are the name of the country (In this case, United States of America) and the exact name of the document (in this case, 'Export declaration').

When downloading a document, at first, it is necessary to choose the type of document in the drop-down menu 'Type of document' (upper left of Figure 13); in this case, 'Export declaration'. After, it is necessary to choose the file format in the drop-down menu in the upper right of Figure 13. It is also necessary to insert the name of the country (United States of America) and the exact name of the document ('Export declaration').

However, it is suggested to compile all possible fields of Figure 13 in order to make it easier the search of the documents.

After, the platform shows, on the bottom of the page, a drop-down menu called 'Available Documents', where all documents fulfilling the data reported in the page fields, are displayed. The platform user chooses the correct document from the drop-down menu.

6. Conclusions

This paper describes the characteristics and features of a platform that manages documental and physical flows at ports. This platform was designed as part of the European project CIRCUMVECTIO and was developed in the CIRCUMVECTIO Plus project.

The platform was developed to address some drawbacks of port logistics, such as high dwell times connected to the reduced telematization and difficulty in reprogramming shipments in case of disruptions.

At first, the platform allows us to handle physical flows and, in particular, helps the logistic operators to reorganize the shipment in case of disruption, as it makes it easier to cancel or modify the booking and send notifications to the other operators involved in the shipment. The platform also embeds several databases.

However, the main objective of the platform is to aid in the management and integration of documental flows at ports, particularly of customs documents. The platform provides features valid worldwide; that is, the operators of any port of the world not equipped with telematization can use the platform for sharing customs documents, especially in electronic (xml) format.

The design of the platform was carried out after several meetings and interviews with freight forwarders, customs, terminal operators and maritime ro-ro and container operators based on the Italian and French Ligurian and Tyrrhenian ports. The management of physical freight flows carried out by the platform aims at increasing the modal shift to intermodal transport, while the management of documental flows is aimed at providing some degree of telematization also to those ports that are not equipped with PCS or any other customs document management platform.

As regards the management of physical flows, freight forwarders and port stakeholders are often unaware of some existing intermodal alternatives to all-road mode; for example, they do not have any updated information on maritime routes. In addition, they are often unaware of the real costs of the available transport alternatives, and, in particular, they tend to overestimate the costs of intermodal transport.

Secondly, freight forwarders and port stakeholders have clearly stated that the major drawback of intermodal transport concerns the difficulty in reprogramming the shipment in case of disruption. Indeed, in a short amount of time, it is necessary to find another path alternative, cancel the existing reservations and make new ones. The proposed platform features, as regards the physical flow management, were designed specially in order to provide a reliable tool to support the choice of the new intermodal path and the change of reservation in case of disruption.

As regards the management of documental flows, the platform supports achieving port telematization, and it could be used as a document management platform, such as a PCS, in non telematized ports at the global level. The benefits of port telematization are remarkable, especially as regards the reduction in dwell times, which are very large, especially in import, and could achieve significant reductions after the development of customs single-window platforms, which allows the sharing of the documents between the customs on one side and port operators on the other side. PCSs allow all port operators managing a given shipment to share all necessary documents among each other. However, only the largest ports are equipped with PCSs or other platforms capable of managing customs documents.

The reduction in dwell times in telematized ports was quantified as follows: in northern European ports, it was from 3–7 days to 1–3 days, while in Mediterranean European ports, it was from 4–10 days to 1–4 days. These savings are achieved also thanks to the pre-clearing, which is the possibility to begin customs operations before the ship's arrival.

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