Strategies for the transfer of container transport from land to rivers and inland waterways in Europe

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To cite this article:
Iordănoaia, F. (2026) Strategies for the transfer of container transport from land to rivers and inland waterways in Europe. Romanian Journal of Economics, 62(1), 428-455.

Abstract. *One of the main problems of freight transport on roads and motorways in European countries is the very large number of container trucks, which carry out this transport, over short, medium, long and very long distances. These have a number of advantages, but also disadvantages, which have created numerous problems, from heavy traffic, to serious accidents or destruction of the road surface on roads and motorways. This paper analyzes the possibility of transferring container transport from land, on roads and railways, to rivers and inland waterways. The study in this paper represents the first part of the project that follows the situation and possibilities of transfer, from the port of Constanța to Vienna. The other parts of the project will be presented later.* ***Objective****: the first objective is represented by the search, study and proposal of ports, which offer a series of technical, logistical and economic solutions, for the realization of this transfer of container transport. These ports must offer the optimal connections with the main, current routes, on which containers are transported in European countries. The second objective is the creation of an information system model, which will facilitate the employment of river vessels, for the transport of containers. This system will also include road and rail transport operators, for the takeover of containers from ports and their transport, on optimal routes, to the final destination.* ***Method****: The research was organized to obtain information and data from official documents of the European Union; of the ministries of transport and naval authorities of the riparian states of the Danube and Rhine; from official documents of the Administrations of river ports; from other documents of river navigation, rail and road transport companies. Then we used the "concept transfer" method to transfer ideas in the field of research and we looked for solutions to achieve the established objectives.* ***Results****: I had determined the ports that can be used immediately for the transfer of containers from land to rivers, between Constanța and Vienna. I have created the model of the information system, which can be created and then implemented to connect all those interested in this field.* ***Originality****: The work is original, it was not taken from someone else, and there are no other works with the same objective.*

Keywords*: transport, containers, river, strategy.*
JEL classification: O19, R41.

1. Introduction

In the last 20 years, there have been many discussions and decisions taken at the level of the European Union administration regarding the transport of containers on motorways and roads, on the situations generated by the large number of trucks transporting containers, but also other goods. The solutions adopted, so far, have not solved the main problem, i.e. the reduction of road transport of containers and the use of other routes and means of transport. There is an intention, for the transport of containers on the Danube River, the Rhine, on other rivers and on inland canals, both at the level of the European Union leadership, but also of the member states and other countries in Europe, but the

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reality is that this problem has not yet been solved. In a previous paper, an analysis of strategies for the development of sustainable river transport in Europe was carried out, (Iordanoaia, 2016). In this paper, an analysis of the natural environment of some important hydrographic networks in Europe was carried out and then a series of aspects regarding the economic and social development of the riparian states, as well as of external areas interconnected to the system, were followed.

Another aspect concerned the protection of the natural environment of the hydrographic network. In the same work, possible forms of cooperation were pursued and analysed, within the European Union and with other European countries. Forms of collaboration can be those relating to international intermodal transport of containerized goods; passenger transport and tourist cruises; establishing connections with land transport infrastructure; development of river infrastructure, on inland waters and river ports; unification of the training of navigation personnel, but also for new investments, in new ships and new unconventional energy sources, etc. In 2006, the European Parliament adopted the NAIADES program, relating to inland waterway transport, as an integrated European program (European Parliament, 2006).

In 2012, the European Commission established the "Danube Strategy" within the framework of the "Rhine-Danube Corridor". This was followed by a meeting in Luxembourg of the European Union transport ministers, who reaffirmed "the existing obligations to maintain the waterway at a good standard" and committed themselves "to address hydrological problems (low water or ice levels) and to coordinate actions involving the Rhine-Danube Corridor Coordinator through the structures of the Danube Strategy".

In 2013, the European Commission adopted the NAIADES II Programme "Towards quality inland waterway transport", following the first programme adopted in 2006 (European Commission, 2013). In 2014, in Brussels, the transport ministers approved the "General Plan for the rehabilitation and maintenance of the river and its tributaries" (European Commission, 2014). From here, starting with 2015, a series of steps and actions followed, at the level of each signatory country of the Belgrade Treaty, regarding the Danube, but also cross-border collaboration to maintain optimal navigation conditions on the Danube (International Convention of Belgrade, 1948). In 2017, a paper on the strategies for transferring containerized transport from land to the Danube in the Romanian sector was studied, developed and published. In this paper, the situation of freight transport on the Danube, the infrastructure of the main Romanian ports, the economic agents operating in these ports and the transport links from the ports to the interior of the country were monitored (Iordanoaia, 2017).

Now, in this paper, the analysis only followed the technical, economic and IT aspects regarding the transfer of container transport from land to rivers and canals, not the legal ones. In particular, the paper was oriented to the study of river transport on the Danube-Black Sea Canal, on the Danube, on the Main German Canal and on the Rhine River, between the ports of Constanța and Rotterdam.

2. Literature review

Documents developed within the European Union were studied. From there, those parts of the documents that are relevant to this work were extracted and synthesized. It can be said that the number of these documents is large, that there is a well-developed legislation, from an ideological and programmatic point of view, but concrete measures, for each individual situation, are missing. Of the specialized works studied, published in volumes or at international conferences, only those referring to river transport in Europe and those in North America were studied, without taking into account those referring to situations on the continents of Asia and Africa, due to the small number of specialized works published on these continents and the limited access to them. The situations of private companies operating in this field, including river shipowners, port operators and logistics companies, were also studied and analysed. It was found that a number of economic units, among those targeted, have investment programs for the development and implementation of new, less polluting technologies, using alternative energy sources. The specialized literature was studied and structured as follows:

A. Technical aspects of river transport, on the Rhine and Danube rivers. These works refer specifically to the management of the navigable channel, environmental protection, areas with navigation hazards and others (Havinga, 2020).

B. Navigation accidents on rivers and in river ports. A recent study highlighted the situation and causes of naval accidents on rivers and inland waters (Maternová et al., 2022). The causes and the consequences of these accidents were analysed. The study confirmed that human factor, particularly the level of training of crews on board river vessels, plays a significant role and must be taken into account in any development strategy for river transport, whether for freight or passengers services.

C. Pollution and technical ways to reduce pollution from river vessels. Another aspect pursued by specialists was the one related to reducing pollution in river transport (Jonkeren et al., 2019). Some authors even studied the issue of electrifying river vessels, taking into account the CO2 emissions of current ones and the costs of using electricity, but also identifying the most cost-effective options for river vessels and calculated "an estimate of the impact of emission policies on the profitability of each option", (Perčić et al., 2021). In this technical-economic work, a series of calculations were made regarding pollution and ways to reduce pollution from river vessels, using different methods. Finally, the authors assessed that electrifying river vessels is possible and reliable. From the statistical data published by the European Parliament, following studies and analyses carried out by the European Environment Agency, it emerged that the polluting factors are the following (European Environment Agency, 2022):

- Road transport = 71.7%, of which: small cars = 60.6%, heavy trucks = 27.1%, light trucks = 11.0%, motorcycles = 1.3%;
- Water navigation = 14.0%;
- Civil aviation = 13.4%;
- Railways = 0.4%;
- Others = 0.5%.

As can be seen from these data, river and inland waterway navigation pollutes half as much as heavy trucks (which also transport containers).

D. The relationship between the sustainability of multimodal transport and pollution. Other analyses of the situation have been made mainly following the sustainability of multimodal transport, but also the pollution generated by it, the measures and technical solutions provided for decarbonization (Knapčíková et al., 2019; Calderon-Riveira et al., 2024).

E. River freight vessels, logistics and economic aspects. Most works refer to the technical aspects of river freight vessels, logistics and economics, or multimodal transport, which also includes river transport. In the United States of America there is a great interest in river freight transport, for reasons similar to those in Europe (Moshiashvili, 2025). In addition, a number of specialized institutions and organizations follow what is happening in Europe and Asia with this type of transport, perform analyses, make forecasts and proposals to the US administration (Tianlin et al., 2025). Other studies and analyses specifically follow the transport situations on some rivers, such as the Mississippi River (Freight Amigo Services, 2025). Another aspect analysed follows the role of river transport, included in the global (multimodal) freight transport market (Donahue, 2022). Domestic and foreign investments in river transport infrastructure, as well as competitiveness in this field, have been analysed and based on them, important conclusions have been obtained for this economic sector (Lewis et al., 2022). From this brief presentation it follows that the US administration is interested in this transport sector and is following what is happening in other areas of the world.

Regarding the situation in Europe, a first paper, in which a comparison is made of river transport on the Rhine with that on the Danube, highlighted a series of aspects, problems and differences, related to the amount of cargo transported, the types of ships used, port facilities, but also other important aspects for inland waterway transport (Mako et al., 2021a). In another paper, the cargo transport capacity on the Danube was analysed (Mako et al., 2021b). The analysis carried out resulted in approx. 30% of the transport capacity on the Danube, which is very little, compared to rail and road transport. In another analysis of the same paper, a series of calculations are presented regarding pollution due to road transport and how much this would be reduced by transferring transport from land to the river. This work shows that the pollution caused by a river freight ship is much lower than that caused by freight trucks.

F. Legal, social aspects and associated risks. In addition to the technical, economic and ecological aspects, regarding inland waterway and river transport, there have also been works of legal analysis of the situation in riparian countries, of the laws and regulations of inland navigation and port operations. In this regard, a work is highlighted that analyses the regulations of the 10 countries through which the Danube passes and found a large number of "administrative barriers", which "limit the economic and environmental potential of inland waterway transport, as a sustainable mode of transport" (Pfoser et al., 2018). This paper identified a series of "non-value-added activities", also called "waste", which are not justified and which negatively influence transport on the Danube River.

Social aspects. Regarding social aspects, currently, in Europe there is a crisis of truck drivers for transporting goods over long and very long distances. The transfer of transport from roads to rivers and canals will shorten road transport distances, which will make the profession of truck driver more attractive. In river transport there is a need for navigation personnel, which can be brought from among maritime navigators (sailors and officers), who with a short-term schooling (integration courses of 2-3 weeks), can be employed on river vessels. In terms of life on board river vessels, the activity is easier, the voyages are much shorter, compared to those at sea, and crew changes are made at 5 weeks, compared to those on seagoing vessels which are between 16-20 weeks. Salaries are lower on river vessels for officers, but for sailors they are of similar values. Some of the officers can participate in courses to become pilots on the Danube and Rhine, a profession in which much higher salaries are offered.

Technological risks. For the transport of containers, their storage, loading and unloading, there are no technological risks, apart from those involving work accidents or car or ship accidents. The only risk is that a group of hackers will break the database, copy the information and data about the partners registered in the computer system, possibly delete this information. When organizing the tender for choosing the company that will make the program, the tasks will be established and among these, those relating to the possibility of breaking the codes will represent a separate chapter.

Legal risks. Considering that the draft law will go through the stages established at the European Commission and the European Parliament, the risk of the law not being adopted is reduced. This is due to the fact that the law will provide for and include all the Member States of the European Union and others from Europe, even if for some, such as the Nordic countries, there are no direct river connections, but maritime connections, nevertheless, the Producers, Exporters and Importers (PEI) from these states will also benefit from the transport of goods from Eastern, Central and Western Europe, depending on their transport needs. The risk of the law not being adopted and not being financed is reduced, because the leadership of the European Union is looking for solutions that will solve the problems presented.

G. Easements of river transport. River transport has a series of easements and problems, which must be brought to the attention of state and European authorities, who respond through international laws and conventions, to ensure navigation conditions as follows:

-Ensuring permanent navigation conditions on the Danube, for a minimum draft of 2.5 m, on the channel and at the port berths or pontoons, in river ports. During the summer season, when the water flow decreases, the channel ensures the maintenance of river transport. This results in the fact that the dredging of the channel must be permanent, but also with the anticipation of difficult situations. Seasonal variations in the water level do not significantly influence transport on the Danube and the Rhine, and on the channels the levels remain constant throughout the year. Practically only a long-term drought can cause traffic to be reduced in certain sectors, which were not dredged in time, for ships with a draft greater than 2.5 m or problems to arise when entering some ports that use mooring pontoons and do not have built quays, with depths over 2.5 m.

- Provision of icebreakers during winter. For certain sectors, these can ensure a navigable channel if the river water freezes.

- Provision and maintenance of means of signaling the navigable channel and from the shore.

Other important economic aspects are the following:

- Reduction of transit fees on the Danube-Black Sea canal, the Sulina canal and locks, as an incentive for the development of river transport.

- Stimulation of shipowners for investments in new, non-polluting ships with large cargo transport capacities.

- Reducing the bureaucracy of naval authorities and port administrations, using at European level a single system for documenting the activity of river shipowners for river transport and access to ports.

3. Methodology and data

Given that the transfer of containerized transport from land to rivers has not been achieved, as expected by the leadership of the European Union and the riparian states, as well as other institutions and bodies (Keating, 2015), a series of questions have been asked in this paper, and the answers to them can be used to achieve this particularly important objective for river transport in Europe. Thus, the following questions were selected:

- Why can't the transfer of container transport from land to rivers be practically achieved? Why hasn't European legislation been created to favor this transfer?
- What is the strategy, objectives and stages that must be completed in order to achieve the objective?
- What are the influencing factors of the strategy for achieving the objective? What is the most important and easily achievable factor that will lead to the achievement of the main objective? What are the next stages to be completed?
- What are the costs of achieving this transfer and what can be the sources of financing?

The following answers were reached to these questions, as follows:

1. The transfer cannot be achieved due to the fact that there is no unified concept. A unified concept of a management structure at the level of the European Commission or a central, specialized structure that would adopt a decision, which would transform it into a law, with an implementing regulation, which would become mandatory for all land carriers and which would be permanently monitored.

In the "Strategic Plan 2020-2024, Mobility and Transport", very few references are made to river transport and these are the following: "we will focus in particular on increasing the adoption of sustainable alternative fuels for land transport, on water"; "As a priority, railways and inland waterways should carry a larger share of land freight transport, and greenhouse gas emissions from the transport sector should be reduced by 90% by 2050"; "we will promote the greening of ports"; "better integration of different modes of transport and facilitation of multimodal transport and mobility"; "DG MOVE will work to facilitate state aid for multimodal transport and EU co-financing of national operational support schemes", (European Commission, Directorate-General, 2020). The current legislation is incomplete! Such centralization of decision-making and control at the European Union level is important to start this transfer, otherwise "letting demand create supply" will be long-term and very difficult to achieve.

2. The strategy is "Transfer of container transport from land, rivers and inland waterways in Europe". The main objectives of this strategy are the following:

- Transport of containers on rivers and inland waterways;
- Decongestion of traffic on roads and motorways in Europe;
- Reduction of pollution;
- Creation of new jobs;
- Development of scientific research, development of modern, non-polluting river vessels and equipment, using alternative energy.

3. Factors of influence for achieving the strategy objective. The factors are the following:

- The decision of the European Union leadership and the collaboration between European states;
- The creation of a unique, European information system of the "e-Container" type, which would bring together in a database all those interested in this field, facilitate the exchange of information and the choice of transport routes that would include transport on rivers and inland waters in Europe;
- Making investments in ports, operating equipment, storage spaces and river vessels, with European, national and private funds;

- Transport costs. A river ship can transport a large number of containers or trucks over medium and long distances, which leads to a significant reduction in costs, if we compare them with road transport, but also with rail transport.

4. Research orientation in this paper. The research for this paper was organized as shown in Table 1. The information and data were obtained from official European Union documents; from official documents of the ministries of transport and naval authorities of the riparian states of the Danube and Rhine; from official documents of the river administrations of the riparian states, from other documents of river navigation, port operation and logistics, rail and road transport companies.

Table 1. Objectives, orientation and stages of the research

The objective	Research direction and stages	Observations
1. Technical study of the main river arteries, canals, inland waters, river and river-sea ports, on which containers can be transported.	- Technical and economic study of the Danube, in the Lower Danube area (Romania, Moldova and Ukraine).	- Study of the Danube tributaries: Prut, Olt, Tisa rivers, to determine the possibility of transporting containers on these rivers.
	- Technical and economic study of the Danube in Bulgaria (right bank), Hungary and Slovakia.	
	- Technical and economic study of the Danube-Black Sea Canal.	
	- Technical and economic study of the Danube-Black Sea Canal.	- Study of tributaries: Sava, Drava rivers
	- Technical and economic study of the Danube, Upper Danube area (left bank), in Serbia, Croatia and Austria.	
	- Technical and economic study of the Danube in Germany.	-
	- Technical and economic study of the Danube-Main-Rhine Canal.	
	- Technical and economic study of the Rhine, in the area of Germany and the Netherlands.	
	-Technical and economic study of the Rhine, in the area of France and Switzerland.	-
2. Technical study of the road situation: motorways, national roads, expressways and county roads, which have direct connections to river ports.	- The situation of roads in Moldova, Ukraine, Bulgaria and Romania.	-
	- Road conditions in Serbia, Croatia, Hungary, Slovakia and Austria.	-
	- Road conditions in France, Switzerland, Belgium and Luxembourg.	-
	- The situation of roads in Germany and the Netherlands.	-
3. Technical study of the situation of European railways, which are connected to river ports.	- The situation of railways in Moldova, Ukraine, Bulgaria and Romania.	-
	- The situation of railways in Serbia, Croatia, Hungary, Slovakia and Austria.	-
	- The situation of the railways in France, Switzerland, Belgium and Luxembourg.	-
	- The situation of the railways in Germany and the Netherlands.	-
4. Creation of a Database of European road, rail and river carriers.	- Database of transport operators from Moldova, Ukraine, Bulgaria and Romania.	-
	- Database of transport operators from Serbia, Croatia, Hungary, Slovakia and Austria.	-
	- Database of transport operators from France, Switzerland, Belgium and Luxembourg.	-
	- Database of transport operators from Germany and the Netherlands.	-

The objective	Research direction and stages	Observations
5. Technical study on river vessels that can transport containers. Creation of a ship project adapted to container transport requirements.	- Technical study on the types of river vessels that currently transport containers. - Technical study on the types of river vessels that can be adapted to the transport of containers. - Development of a project for a river vessel adapted to the transport of containers.	-
6. Creation of a single European IT system for the transfer of container transport from land to rivers and inland waterways, acronym "EU-e-Container". Application for computer, tablet and phone.	- Design of the information system. - Realization of the information system. - Promoting the system. - Implementing it to users and obtaining feedback.	-
7. Study of economic efficiency on river navigation routes for container transport.	- Study of economic efficiency and costs on routes in Moldova, Ukraine, Bulgaria and Romania. - Study of economic efficiency and costs on routes in Serbia, Hungary, Croatia, Slovakia and Austria. - Study of economic efficiency and costs on routes in France, Switzerland, Belgium and Luxembourg. - Study of economic efficiency and costs on routes in Germany and the Netherlands.	- Determining the transport price/distance ratio for each individual state.

Source: developed by the author.

4. Research results and comments

The research results will be presented within a much larger project. This paper will present aspects related only to:

- Connection points for container transfer on the Danube-Black Sea Canal and the Danube River, from Constanța to Vienna. For the Main and Rhine Canal, another paper will be prepared;
- Brief presentation of some river vessels that currently transport containers or can be easily adapted to transport containers;
- Design of the model for the "EU-e-Container" IT System, for the transfer of container transport from land to rivers and inland waters.

4.1. Container transport between Constanța - Vienna and river ports

The logic of carrying out this study is related to the current situation of container transport in the riparian countries, between the two major ports, Constanța and Rotterdam, located in eastern and western Europe. Next, the model for transport initiated from the port of Constanța, towards the Danube riparian countries, up to Vienna, will be presented. Thus, we followed the main situations:

- Containers arrive at the port of Constanța, are unloaded in the terminal, then loaded into wagons or trucks, and with these they are transported to their destination, over short, medium, long and very long distances. This real, current situation has generated and generates major problems regarding congestion, accidents, pollution, destruction of infrastructure, etc.;
- The main proposal within this work is to take over containers on board river ships, which are transported to the ports closest to the final destinations. From river ports, containers can be picked up on wagons or trucks and taken to their final destination. Transport costs, congestion, accidents, pollution and destruction of infrastructure are reduced.

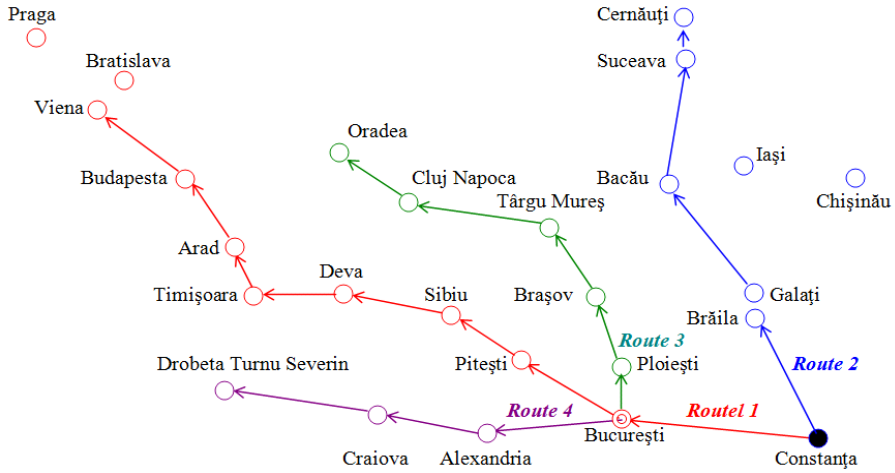
- From producers located in the interior of the riparian countries, containers will be transported by wagons or trucks to the nearest river port. From the river port, ships transport the containers to the port of Constanța, to the loading terminal on sea vessels.

Following the current container transport routes, it was found that from the port of Constanta, there are the main road transport connections, namely:

- Route 1: Constanța, Bucharest, Pitești, Râmnicu Vâlcea, Sibiu, Deva, Timișoara, Arad, Szeged, Budapest, Vienna. With a derivation to Bratislava and Prague;
- Route 2: Constanța, Măcin, Brăila, Galați, Bacău, Suceava, Cernăuți. With a derivation from Galați to Reni and Ismail and another from Bacău to Iași and Chișinău;
- Route 3: Constanta, Bucharest, Ploiești, Brașov, Târgu Mureș, Cluj Napoca, Oradea. With a derivation to Baia Mare and Satu Mare;
- Route 4: Constanța, Bucharest, Alexandria, Craiova, Drobeta-Turnu Severin.

Figure 1 shows a schematic representation of these road transport routes.

Figure 1. Main container road transport routes



Source: developed by the author.

The same transport routes are also used by rail within Romania, with certain differences. This means that all technical, infrastructure and logistical aspects of the river transport route between the ports of Constanța and Rotterdam must be known in detail. On this route, the following have been identified:

A. Map of the hydrographic basin of the canals and rivers. Figure 2 shows the hydrographic basin, as established by the European Union's "TEN-T" Project (European Commission, 2005). On this, we know:

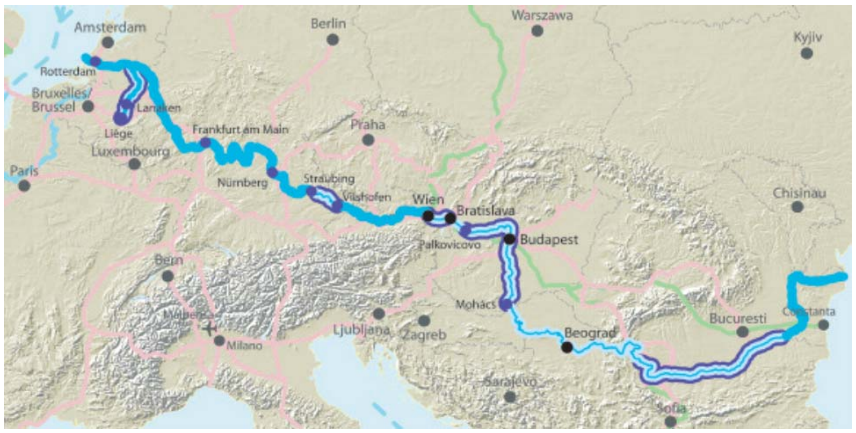
-The Danube-Black Sea Canal and the Main Canal from Germany;

-The Danube River and the Rhine River.

It is very important to know the river basin, on which river navigation takes place, then the navigable port areas, the places where ships are parked and especially, the depths that allow access for cargo ships.

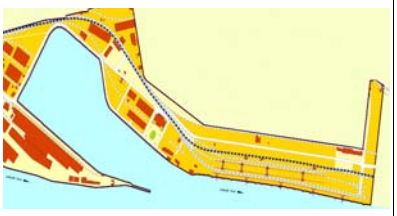
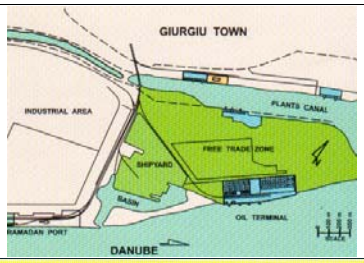
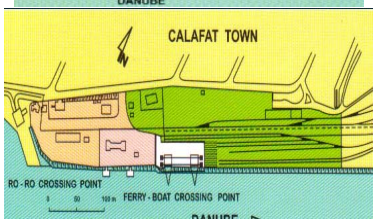
B. Ports, connection points and infrastructure leading to river ports. River ports were analysed and selected that have connections to railways and main roads leading to the interior of the riparian countries and further, to other countries. Table 2 presents the main ports between Constanta and Vienna, which offer conditions for the transfer of containers, do not require investments, and have the necessary equipment for the operation of containers.

Figure 2. The river connection between the ports of Constanta and Rotterdam



Source: European Commission (2005).

Table 2. Main ports offering container transfer possibilities

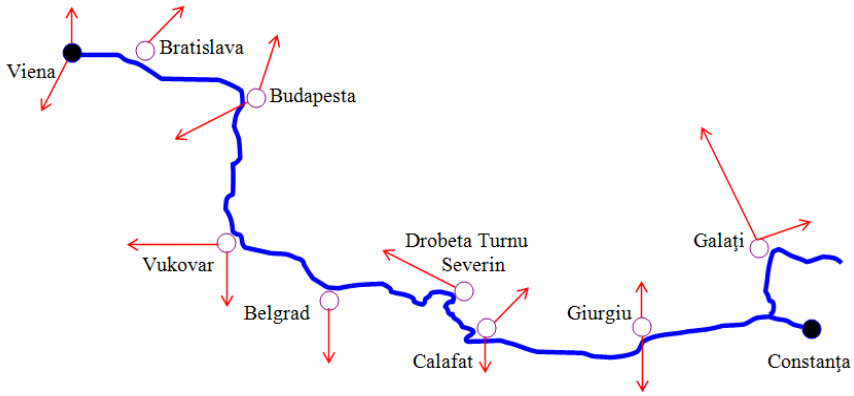
No	Ports	Logistics and infrastructure connections	Image of the port container area
1.	Constanța	- Port railway, connected to the national network. - Access roads to the A2 motorway. - 2 specialized berths for container operations. - Container depots. - Direct access to the Danube-Black Sea Canal, through the Agigea lock (National Company "Administration of Maritime Ports", 2025).	
2.	Galați	- Port railway, connected to the national network. - Access road to the northeast of the country, the Republic of Moldova and southern Ukraine. It has a Container Warehouse. - Specialized berth for container operations (National Company "Administration of Danube Maritime Ports", 2025).	
3.	Giurgiu	- Port railway, connected to the national network. - Access road to Bucharest and Bulgaria. - General cargo berth, which can handle containers (Plant Basin). - Available areas for container storage (National Company "Administration of Danube River Ports", 2025).	
4.	Calafat	- Port railway, connected to the national network. - Access road to Craiova and Bulgaria. - General cargo berth, which can handle containers. - Available areas for container storage (National Company "Administration of Danube River Ports", 2025).	

No	Ports	Logistics and infrastructure connections	Image of the port container area
5.	Drobeta-Turnu Severin	- Access road to Craiova and Timisoara. - National railway passes near the port, but has no connection to the port berths. - General cargo berth, which can handle containers. - Available areas for container storage (National Company "Administration of Danube River Ports", 2025).	
6.	Belgrade	- It has an access road to highways. - It does not have access to the railway, which is located approx. 500 m away from the port front. - It has commercial berths for general cargo, a container terminal and storage areas (Luka Belgrade, 2025).	
7.	Vukovar	- Port railway, connected to the Croatian national network. - Access road to Zagreb and Sarajevo. - General cargo berth, which can handle containers. - Available areas for container storage (Vukovar Port Authority, 2025).	
8.	Budapest	- Port railway, connected to the Hungarian national network. - Highways to all main directions in Hungary. - Container terminal, with warehouses and available areas for container storage, in the Csepel Freeport area (Danube Logistics Portal, 2025).	
9.	Bratislava	- Port railway, connected to the national network of Slovakia. - Highway to Prague and other main directions in Slovakia. - Container terminal, with large storage capacity and large areas available for container storage (Slovak Shipping and Ports, 2025).	
10.	Vienna	- Port railway, connected to the Austrian national network. - Highways to all main directions in Austria, to Prague and Slovakia. - Container terminal, with warehouses and available areas for storing containers (Danube Logistics Portal, 2025).	

Source: developed by the author.

In addition to the ports presented in Table 2, there are a number of river ports, between Constanța and Vienna, in Romania and in other riparian countries, which offer the possibility, through investment, to be introduced into this multimodal container transport circuit. This is, for example, the situation of the port of Ruse, the largest river port in Bulgaria. Figure 3 schematically presents the main container transport circuits, departing from the ports presented in Table 2.

Figure 3. Main container transport routes from river ports



Source: developed by the author.

4.2. River vessels that can transport containers

On the Danube, Rhine and the two canals, approximately 9750 river vessels carry out freight transport, of which 6940 for dry goods, 1435 for liquid goods and over 1350 tugboats (Buzinkay, 2024). A river container ship can carry a large number of containers, up to approximately 500 TEU (containers) or 280 trucks, which it carries depending on its size and load capacity.

However, regarding river vessels that carry containers, this type of transport takes place more on the Rhine, between Rotterdam and the ports inland in western and central Europe, much less on the Danube and the Danube-Black Sea Canal. The following problems were identified:

- *The first problem* related to this low number of containers transported on the Danube is the lack of container-port type river vessels;

- *The second* is that shipowners in Romania, Bulgaria, Ukraine, Serbia, Hungary and Slovakia do not have specialized vessels for transporting containers, they have barges on which containers can be transported, but the demand for this type of transport is low. For example, a specialized terminal for operating containers was built in the port of Galati, but it is not used at its operating capacity, there is no container line transport (Autonomous Administration "Lower Danube River Administration", 2025);

- *The third problem* is related to the way river vessels are operated. Currently, ships are operated by crews, but already, throughout Europe, there is a lack of qualified personnel to work on board them. Under these conditions, projects have been carried out for the construction of autonomous river vessels, which can be operated by Artificial Intelligence. Given the complexity of river navigation and the problems that may arise on rivers, it will be a long, step-by-step process until such autonomous ships are reached, which are electrically powered, based on alternative, renewable energy, in order to reduce pollution (Blenkey, 2022).

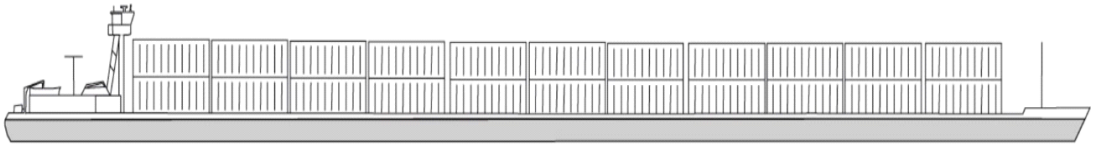
Currently, several types of container river ships are operated, from barges (Buzinkay, 2024) to container ships (Identec Solutions, 2025) and river container ship (Viadonau, 2024) (Figure 4a and Figure 4b). A model of a container river ship is shown in Figure 5. This type of ship has a length of 135 m, a width of 17 m, and a draft of 3.7 m. It has a loading capacity of 470 containers (TEU) or 235 trucks. Since 2012, studies have appeared on new types of river vessels, for container transport, based on LNG or alternative fuels (Figure 6). There are several shipyards in Romania that, based on a modern ship design, could build container river ships.

Figure 4. River container ships

a) Container barge b) River container ship

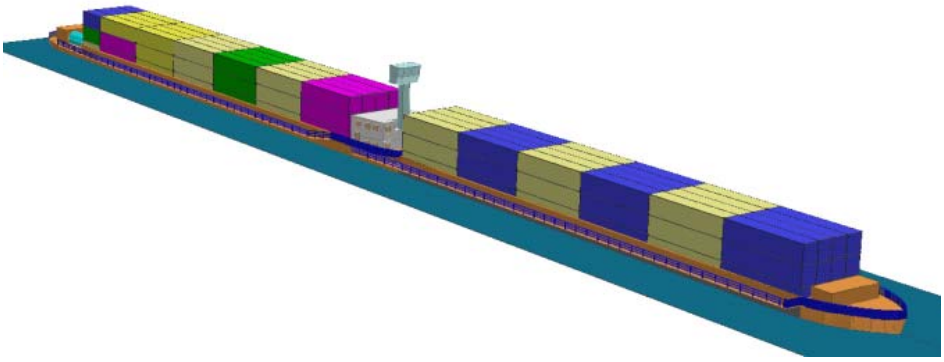
Source: Identec Solutions (2025); Viadonau (2025).

Figure 5. Container river ship



Source: Viadonau (2025).

Figure 6. Model of a container river ship



Source: Austrian Institute for Regional Studies and Spatial Planning (2012).

4.3. EU-e-Container. Information system for the transfer of container transport

After studying the programmatic documents of the European Union and other institutions, it is clear that solving the problems generated by the transport of containers on roads and highways can be stimulated and concretely solved, with the help of a specialized computer program. This information program, called "EU-e-Container", can include all those interested in this type of transport, from authorities and carriers, to producers. Based on the studies carried out, it can be appreciated that the "EU-e-Container" information system must contain the following main elements:

- Database, which includes all interested institutions and companies;
- The program that puts all interested parties in contact in real time. Through this program, "demand and supply" meet, naval and port authorities, port operators, road and rail carriers are informed;
- Information infrastructure. This will include electronic computers, tablets and mobile phones. The program can be installed very easily on all equipment and has an interface that is easy to understand and work with, facilitating connections between commercial partners, between partners and authorities. A database model is presented in Table 3.

Table 3. Content of the "EU-e-Container" Information System

No	Institutions and companies	Role, tasks and main duties	Observations
1.	European Union (EU)	- Development of a law and an implementing regulation to regulate the transfer of container transport. - Monitoring the implementation of the legislation.	Decision-making institution.
2.	EU-e-Container Program Implementation and Management Information Center (ICe-C)	- Development of the e-Container software. - Implementation, monitoring and maintenance of the system.	It can be a specialized company, chosen based on an international tender.
3.	Ministries of Transport of the riparian countries (MT)	- Application of legislation in each country.	-
4.	Naval Authorities (NA)	- Implementation and monitoring of the application of legislation regarding container transfers. - Resolving issues regarding transport licenses, operation, traffic surveillance, etc.	Institution with direct responsibilities in river transport.
5.	River Port Administrations (RPA)	- Implementation and monitoring of legislation, authorization of port operators, pollution control, etc.	The companies that own the ports
6.	Port Operators (PO)	- Presentation of information regarding container operation facilities, ships under operation, operating times, free spaces for container storage, etc. - Can establish operating rates/container or negotiable.	-
7.	River Vessel Owners (RVO)	- Presentation of ships that can transport containers, availability or engagement in contracts, travel time, problems that occur during transport (delays due to low water levels, presence of ice in certain sectors, etc.). - I can establish transport rates per container/km or negotiable directly with the transport beneficiary.	Ships can be hired on a line or tramp basis
8.	Logistics Operators (LO)	- Presentation of facilities, installations and operating equipment, warehouses and available areas, etc.	-
9.	International Road Transporters (TIR)	- Presentation of transport offers available means and locations. - Transport duration from the river port and route to the final destination of the containers. - Transport duration and route from the manufacturer's headquarters (warehouse) to the nearest river port that operates containers.	-
10.	Rail Carriers (RC)	- Presentation of transport offers available trains and wagons, and their locations. - Transport duration from the river port to the closest train station to the final destination of the containers. - Establishment of transport rates per container/km or negotiable.	
11.	Producers, Exporters, Importers (PEI)	- Presenting offers for transportation, final destination, packaging method, deadlines.	The computer program will choose the optimal river, road or rail transport routes.

No	Institutions and companies	Role, tasks and main duties	Observations
12.	Environmental protection organizations (NGOs)	- They can have access to observing and monitoring container traffic on rivers and canals, they can follow the status of their operation and whether the environment is being polluted.	They must register in the database and receive an access agreement from the transport ministries.

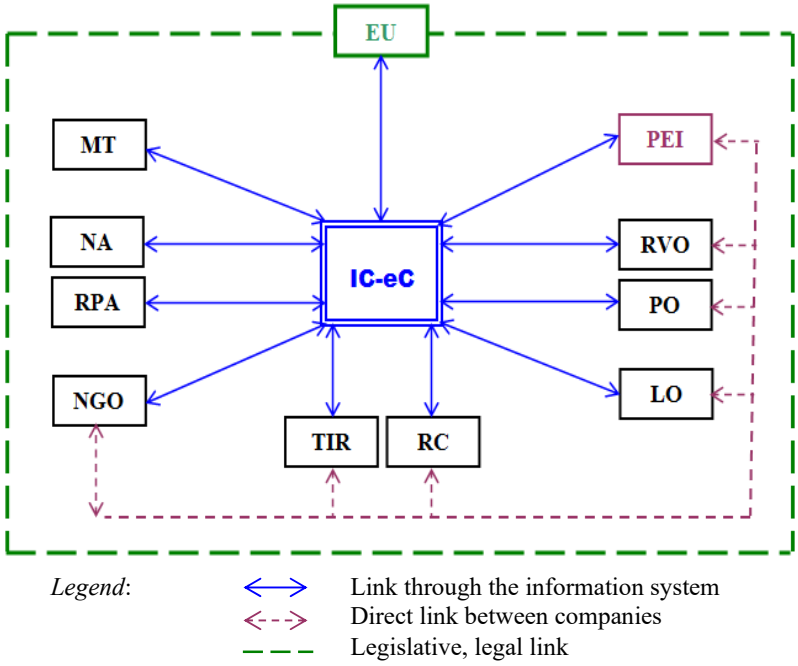
Source: developed by the author.

The working mode of the "EU-e-Container" information system is schematically presented in Figure 7. The "EU-e-Container" information system may include the following elements:

A. Database. The database, for its implementation, will require a team of specialists, who will make the program, based on which it will be possible to work to achieve the main objective of the program. Using a specialized company, chosen through an international tender, will generate a series of high costs, along with investments in the necessary servers and equipment.

The database can contain the information presented in Table 4.

Figure 7. The "EU-e-Container" information system



Source: developed by the author.

Table 4. Database template

No	Database content	Observations
1.	Institutions responsible for financing and implementing the "e-Container" project. The information will include: address, contact details.	- EU, - Ministry of Transport, - Naval Authorities. - River port administrations.
2.	Manufacturing companies in Europe and the European Union. The information will include: address, contact details, products they sell, their storage locations. -Companies outside Europe, which sell products in Europe.	- China, - USA, - Japan, etc.
3.	River navigation companies. The information will include: address, contact details, ships available for container transport.	-
4.	Road freight transport companies. The information will include: address, contact details, means of transport containers and other goods.	-

No	Database content	Observations
5.	Railway transport companies. The information will include: address, contact details, number of wagons and locomotives available.	-
6.	Port operators. The information will include: address, contact details, operating facilities and equipment, warehouses and available areas.	-
7.	Logistics operators. The information will include: address, contact details, operating facilities and equipment, warehouses and available open areas.	-

Source: developed by the author.

B. Website (Portal). The proposed name for the website is "Container and general cargo transport by river in Europe". The website will contain all the information on all interested parties (Figure 8). In addition to information on manufacturers, importers, exporters, carriers and authorities, it will also contain information on "Transport requests" and "Transport offers". In these places on the main page, the latest information on transport requests, goods and necessary transport means will be found, from where interested parties, carriers, can get their information and then directly access those they are interested in. The design and launch of the website (portal), www.EU-e-Container.eu (or another available, meaningful name), will constitute the basis for launching and developing the project. The model presented in Figure 8 may include the following main and secondary sections:

1. General presentation. In this section, the general data of the Project will be presented, as follows:

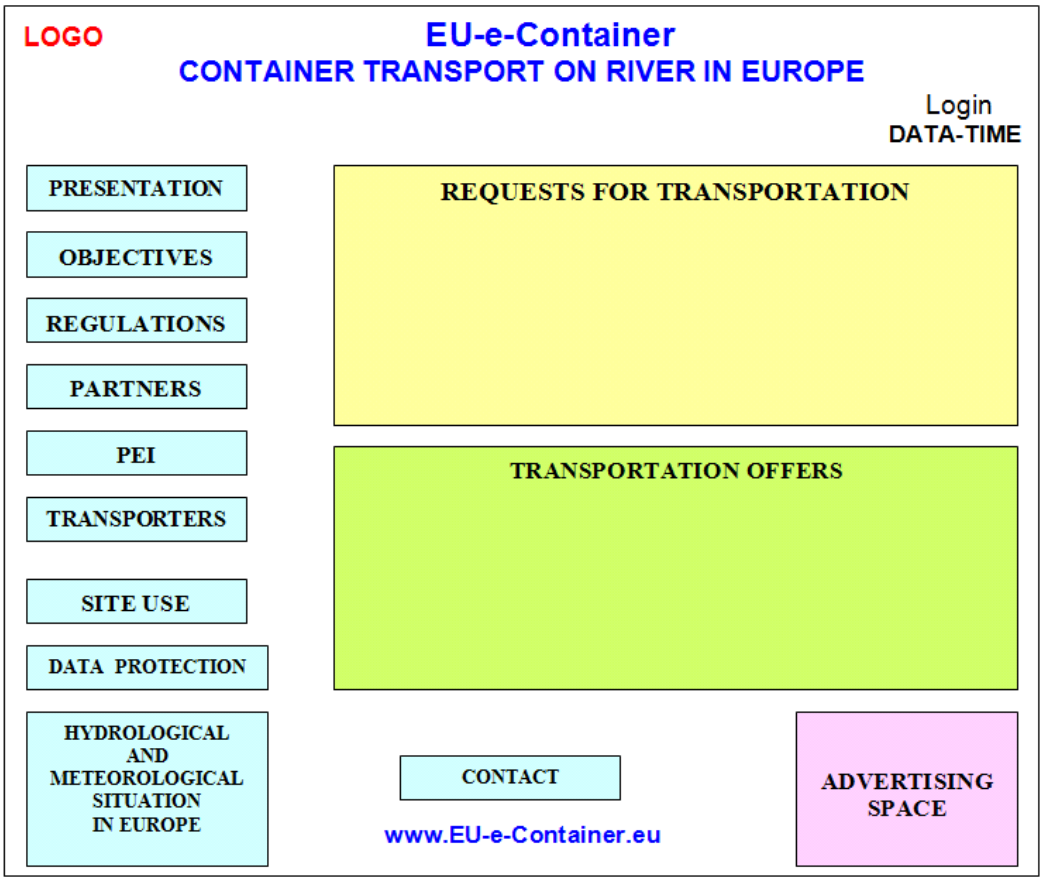
- ***The project***. It begins with a general presentation of the project regarding the transfer of container transport (general goods), from land, on rivers and inland waters.
- ***Objectives***. The main objectives of the project will be presented.
- ***Regulation***. In this section, the following information will be found:
  -Law and Regulation. Presentation of the legislation underlying the project.
  -General principles of the Project.
  -Who can become a member?
- ***Partners***. The official partners of the project will be listed: European Union, Ministries of Transport, Naval Authorities, and Port Administrations (with links to websites).
- ***PEI***. Producers, exporters and importers.
- ***Transporters***. River, road and rail transport companies
- ***Use*** (instructions for accessing information). This section will present for commercial companies, the method of registration on the site, the minimum data and information that must be registered: official registration data at the Trade Register; Unique registration code; Address and contact details; Information about the means of transport, installations and equipment provided for the operation of containers; Photos of the means of transport, equipment and installations available.

Presentation of the method of accessing information and entering new information and data. In this section, information and data about commercial companies interested in the transport of containers will be registered and found as follows.

- ***Data protection***. Protection of data entered on the site.
- ***Hydrological and meteorological situation***. This section will contain links to the pages of professional institutions in Europe, which publish hydrological and meteorological information. By directly accessing the profile institutions, it will be possible to obtain the hydro-meteorological situations for the transport routes.
- ***Login***. Through this option, directly from the main page, a partner can enter the site and perform the operations he wants. He can update information about his situation, his means of transportation.
- ***Date-time***. The main page will display the date of the day and the time, with minute precision.
- ***Requests for transport***. In this section, all those who need means of transport, over medium and long distances, will post requests with details regarding their goods.
- ***Transportation Offers***. In this section there will be three spaces for ships, trucks and wagons. All carriers will present their ships, trains and trucks.

- ***Contact***. The contact section includes the contact details of the system administrator, who can be contacted in case of problems with the system.
- ***Space for advertising.*** In this section, the logos and names of companies that buy advertising space on the "e-Container" page will be presented. With a simple click on the logo or image of the company (product), you can go directly to the company page or the product it offers through this site. The number of accesses will be recorded. You can also advertise to other companies that have a different object of activity.

Figure 8. Website template



Source: developed by the author.

2. Producers, Exporters, Importers (PEI). These are commercial companies that produce, sell, export or import finished products, raw materials, materials, etc. and that need means of transport in Europe, over medium or long distances. All of them, after registering on the site, will be able to enter this section and submit the "Transport Request", which will include:

- The quantity of goods they wish to transport, the number of containers, packages, etc.;
- The form of packaging (containers, packages, barrels, boxes, etc.);
- The number of means of transport they need (trucks, wagons, ships);
- Loading point, transit point, and final unloading point;
- Date of start of loading, period of transport, final date of transport (when the goods must arrive at the final destination or at the seaport, for loading onto sea vessels).

These companies can enter several requests for transport, on the same route or on different routes. After concluding the transport contracts, he can delete the request and enter another one. If he deletes a request, the information about it will no longer appear on the page of the respective company. The other transport requests will remain on the pages of other manufacturers, exporters or importers, each of whom can proceed in the same way. The producer, exporter or importer (PEI) can

choose their river or sea port operator, port logistics operator or can accept the one agreed by the carriers. The loading of the products will be done based on the contract, between the PEI and its client, depending on:

- The technical means and product loading capacities of the PEI;
- The date and time of the start of the loading, the estimated duration for the loading.

Transport, port operations, insurance and all related taxes will be borne by the party listed in the sales contract concluded between PEI and the client.

- If additional costs arise for the operation of loading and stacking the goods on board the means of transport, they will be borne by the party listed in the contract.

3. Transporters. This section includes all commercial companies that fall into the category of transporters, port operators and logistics operators.

***Transporters*.** These are the owners of means of transport, which they can make available to customers (PEI), for the transport of purchased goods. On the site they can present: the means of transport, maximum and minimum loading capacities, average travel speeds (for river vessels, empty, loaded, downstream and upstream), the locations of the vessels, trucks or wagons. The section can be divided as follows:

- *Road*. This category includes owners of means of transport such as trucks of various sizes and capacities, special transport vehicles, which are used for medium and long-distance transport.
- *Railway*. This category includes owners of railway transport vehicles, which are equipped with locomotives and container transport wagons.
- *Rivers*. This category includes the owners of river vessels such as container ships, container barges, cargo ships that have warehouses that allow the loading of containers. They can register and permanently update the position of the ships, in port or on voyage, empty or under loading-unloading operations. To find out the position of ships, you can also use the specialized website "Marine Vessel Traffic", (Marine Vessel Traffic, 2025).

Port operators. This section includes commercial companies that have port operating activities, which load and unload goods in river ports. The website will provide all the information and data necessary for those who wish to use a port operator in a particular port. These refer to: the berths they operate on, the depths at the berth, cranes, road or rail access roads, means of transport within the port, on the berth and in their own warehouses, the types of goods they can store and open spaces.

Logistics operators. This section includes commercial companies, owners of storage and operating spaces in ports or nearby areas, which have spaces available for storing containers until they are all brought or until the ship on which they will be loaded arrives. Likewise, after the ship arrives at the port, it is unloaded and the containers are stored until they are taken over by other carriers, who will take them to their final destination. The site will contain all the information and data necessary for those who wish to use their warehouses and equipment. These refer to: refrigerated warehouses (for refrigerated containers), packaged product warehouses (packaged or containerized), special warehouses (which allow the storage and preservation of goods that require special conditions and open spaces, usually uncovered, but located in a perimeter that is secured or allows the securing of vehicles, installations and goods.

C. System applications. The system can be installed on electronic computers (desktops), laptops, tablets and mobile phones. For this, the site will contain information about the "EU-e-Container" system, which can be automatically downloaded to one or more devices. When downloading the application, the system will request the identification data of the commercial company, email, phone number and then automatically generate a unique registration number, after which it will request a password, based on which they will be able to log in to the system later. These will be kept by the applicant and will not be public.

D. How to work in the system. A PEI, who has registered in the database, if he has to transport a large quantity of containerized cargo or in trucks, proceeds as follows:

1. Choosing the transport route. The program allows the choice of means of transport and port operators. PEI proceeds as follows:

-Choose the transport route from the container storage location, with the most appropriate means of transport, i.e. road or rail, to the nearest river port, depending on the number of containers or

the quantity of cargo. The system will graphically present the route on roads and motorways or by rail, the road and rail distances, the nearest river port, port operators, warehouses and storage spaces.

-Choose the navigation route, from the nearest river port, to the river port (or sea river) for unloading the containers. The system will graphically present the navigation route and information about the river vessels available in the loading port or nearby, and if there is no vessel available nearby, it will present the list of navigation companies that can be contacted and hired. At the unloading port, the system will present the container port operators, warehouses and available spaces.

-The system will provide information about: the value of car vignettes; bridge tolls; other transport conditions, etc.

-The system can also be designed with a series of restrictions, which refer to the choice of the transport route, by rail or by road, that is, to choose between the two the one that is considered the cheapest, compared to the number of trucks or containers. This option, through which the system chooses the route and proposes the means of transport, is very important for reducing costs for PEI, but it does not ignore road carriers, in favour of those on the railway. In this way, the system is designed to be impartial, but in making the calculations it will be based on the transport prices, entered in the database by each individual carrier.

2. Conclusion of transport, storage and port operation contracts. After choosing the routes, means of transport and port operators, PEI contacts them all, sends them the request for transport and port operation and requests: the prices for the services they offer, the dates when they can perform the transport and port operation, the payment terms, etc.

3. Carrying out the transport and port operation. After concluding the contracts, PEI cancels the request from the system, and shipowners and other carriers can post information on the page about the hiring of transport means, routes and ports of operation.

This basically informs the system about the status of the ships, the routes they will travel, the ports in which they will operate and the ports where they will be available for a new load. In this way, through this update, the system can respond quickly with the optimal transport solutions when new requests are made by other PEI. Upon termination of the transport contract, all carriers and port operators will transmit information on availability for other contracts, in the form of "empty ship"; "train with 00 wagons available"; "00 trucks available". Registration in this IT System does not exclude the direct conclusion of line contracts between PEI and carriers for the transport of river and land containers, but will require the transmission of the availability of the means of transport when they become free from the contract. The "EU-e-Container" IT System will not have any direct involvement between PEI, carriers and port operators regarding the negotiation and value of contracts, and will not request such information. If carriers and port operators decide to inform publicly about the transport price Euro/km/container, etc., this information will be visible to all those registered in the system.

4.4. Mode of carrying out the proposed activities

The activities are divided as follows:

A. The main activity. This will be carried out on the website (site or portal), which will be called "EU-e-Container. Transport of Containers on Rivers in Europe", acronym "EU-e-Container". This page will be accessed by all those who are interested in the transport of goods in containers or trucks in Europe.

1. The working method of a PEI. The activity involves:

-Simple way of accessing the page, obtaining information by those registered in the database and authorities.

-Those who access the page for the first time must become members, based on real information about the companies they represent, that is, they register in the database, with all their identification data.

The flow of transactions, with the help of the portal, is simplified and follows the online development of all aspects, as follows:

-PEI accesses the page.

-Searches for suitable means of transport for its goods.

-When he has found the nearest means of transportation, he contacts the transport company by sending a standard request through which he reserves the means of transportation and requests data on availability, price, and transportation deadlines.

2. The working method of a transporter. The activity involves:

-The carrier responds to the request, blocks the means of transport so that it is not requested by another PEI, sends details about the price and delivery times.

-If the two companies agree and the contract is concluded, then the carrier sends to the database about the transport with the respective means.

-PEI, in the same way, contacts the other transport companies, port or logistics operators.

-After completing these steps, the carrier sends the means of transport to the established place (PEI warehouse), loads the goods or containers and carries out the transport to the established destination. There, the containers are transferred or trucks are loaded aboard the river ship, which takes them to the port of destination, from where their operation continues, they are loaded aboard sea vessels or they arrive at the buyer's warehouse.

B. Support activities. In order to transfer container transport from land to rivers and inland waters, the support activities of the "e-Container" information system are as follows:

-The system has its own database storage space, on a server that operates permanently and securely, offering protection against password cracking, information theft and portal blocking.

-It offers a large capacity for storing information and data and has high operating speed.

-It has terminals with which all transactions are tracked and monitored. The system management receives all information in real time.

-The system offers all the necessary information to members and partners.

4.5. Initial conditions necessary to start the proposed activity

In order for this transfer of container transport from land to inland waterways and rivers in Europe, the following steps must be taken:

-Adoption of the "Transfer Law" and the "Implementing Regulation" by the European Union.

-A public institution (Ministry of Transport, a specialized university) or a non-governmental organization or a public-private consortium can initiate a project with European funds to study in detail all the legal, technical and economic aspects regarding this transfer.

-Organization by the European Union of an international tender through which a commercial company with activity in the IT field will create the "EU-e-Container" Information System and then administer it for a certain period of time.

-Promotion of the project and the information system by organizing conferences, symposia.

The Law and Regulation that will regulate this transfer must take into account the following very important aspects:

1. What is the minimum distance by road and rail over which containers and trucks with goods can be transported?

2. What is the minimum number of containers or trucks, above which they may be required to be transferred to water transport?

1. Minimum distance. Beyond this minimum distance, by road or rail, a combination of land and river transport may be required. In order to understand the current and expected situation with the help of the "EU-e-Container" IT system, the following case study will be presented.

Case study

Consider a producer who exports products in containers from Oradea to Alexandria in Egypt, in 400 containers by 40' (containers that can load cargo with a total weight of 26.7 t, and the total weight of the container is 38 t). The total weight of the cargo is 8,000 tons.

1. Current situation. Currently, the producer can transport the containers by rail and road, as follows:

-By rail: Oradea, Sibiu, Pitesti, Bucharest, Constanta = 616 km.

-By road: Oradea, Cluj-Napoca, Sibiu, Pitesti, Bucharest, Constanta = 815 km.

The transport, loading and unloading time is as follows:

A. By rail. For a train composed of 20 wagons, the following values are given:

-Time to load containers from the warehouse onto the truck:

10 min x 1 container x 20 containers = 200 min = 3 hours 20 min.

-Travel time to the station: 15 min x 1 truck x 20 trucks = 300 min = 5 hours.

-Time to load a container from a truck to a wagon:

10 minutes x 20 containers = 200 minutes = 3 hours 20 min.

-Time to return the trucks to the depot: 15 min x 1 truck x 20 trucks = 300 min = 5 hours.

-Time to travel by rail: Oradea, Sibiu, Pitești, Bucharest, and Constanța:

616 km: 16.87 km/h = 30 hours (a train with 20 wagons needs a 250 kN locomotive, which can pull approx. 750 t of cargo), without taking into account the stops, for different situations (Cireasa, 2021). This means that 20 freight trains are needed. These can transport the 400 containers.

-Unloading time in the container terminal from the train and loading directly onto the sea vessel: 5 min x 1 container x 20 containers = 100 min = 1 hour 40 min.

-Return time of the train = 30 hours.

Total transport time of a train = 73 hours 20 min = 3 days 6 hours 20 min, without taking into account the delays that may occur at all times of the operations. Also, the productivity of labour and the efficiency of loading-unloading equipment are different, in the economic units in Romania. If the first train leaves the Oradea station on the first day, at 19.15, when the loading of the containers has finished, it will return to the same station on the fourth day and will start reloading at 20.00.

In this way, from the planning of rail transport, it results that:

11 trains x 20 wagons are required, of which 9 trains will make 2 trips, and 2 trains, only one trip.

(The ideal case is represented by the existence of 20 trains available, which load the 400 containers and make a single trip, but, in reality, the number of trains available for container transport is much smaller).

The total minimum transport time of containers, from the producer to the container terminal in the port of Constanta, is 275 hours, within a period of 12 days.

The situation was considered that for the 400 containers, based on a transport program, a constant flow of loading, transport and unloading is ensured, and the trains come to the station for loading, one after the other. The time can be reduced if:

-the manufacturer has the possibility to load the containers with 2-3 machines (cranes);

-at the station, if the operator has several loading machines on the wagons;

-the manufacturer has a railway line that reaches its warehouse, then the time for trucks to pass from the warehouse to the station is eliminated;

-a locomotive with higher power is used, then the train can be made up of a larger number of wagons, approx. 30-35 wagons.

In the same way, it can be appreciated that delays may occur in the following situations:

-a constant flow of loading is not ensured at the manufacturer's warehouse;

-transport by trucks takes longer due to traffic congestion;

-trains have delays in transport;

-unloading is not done at the seagoing ship, but at the terminal warehouse, then there will be a time for unloading at the terminal and then loading onto the ship, when it reaches the terminal.

All these situations can influence the transport time by rail, which can double, from 12 days, to over 20-25 days.

B. Road. On roads and highways, the road route is Oradea, Cluj-Napoca, Sibiu, Pitești, Bucharest, and Constanța. For a truck with a container, we have the following time values:

-Travel time of the truck from the garage to the manufacturer: = 15 min.

-Time of loading the containers from the warehouse onto the truck:

10 min x 1 container = 10 min.

-Travel time (at an average hourly speed of 70 km/h): 815 km: 70 km/h = 11 hours.

-Waiting time at the terminal to enter for unloading and formalities:

= 30 min (minimum value).

-Time of unloading the containers from the truck, directly onto the sea vessel:

10 min x 1 container = 10 min.

-Return time of the truck: = 11 hours.

-Legal break time for the driver to rest: = every 4 hours and 30 min = 45 min. After 22 hours of driving = 3 hours of break. After the end of the trip, the rest time is no longer calculated, but the driver must take a break of at least 8-10 hours to be able to resume the trip. If he makes several trips, then the minimum recovery period is 12 hours, (European Parliament, 2024).

-Total time, minimum estimated, for a round trip: 1 truck = 26 hours 05 min.

For 400 containers, considering that the road carrier provides a number of 20 trucks, which ensure continuous flow transport, a minimum of 40 days of transport will be required. This means that a truck can arrive at the loading point after 26 hours, but if the same driver is used, he will not be able to leave on the journey until after approx. 10 hours of rest, i.e. at the end of the second day. However, loading and departure of the vehicles on the journey is avoided at night, and this means that the first driver will make the second journey at the beginning of the third day.

The time can be reduced if:

-the transporter provides several trucks;

-the producer has the possibility to load the containers with 2-3 machines (cranes);

-the road carrier has a trailer and carries 2 containers at a time;

-several trucks are unloaded at the port terminal at the same time.

In road freight transport, delays may occur in the following situations:

-blockages on streets, roads and motorways,

-traffic accidents that stop road traffic;

-congestion at the port entrance, when the activities of several road carriers overlap.

2. With the "EU-e-Container" Information System. The producer may have the following options:

-Oradea, by rail or road, to Budapest.

-Budapest, on the Danube and the Danube-Black Sea Canal, to the port of Constanța, at the container terminal.

-Operation in the container terminal, unloading of the river ship, transport and storage in the terminal and/or direct loading onto the sea ship.

The distances are as follows:

-By rail: Oradea - Budapest = 218 km;

-By road: = Oradea - Budapest = 264 km;

-By river: Budapest - Constanța = 1400 km, (Danube Logistics Portal, 2025). A river container ship was taken into account, which can transport 400 containers (at an average speed of 17 km/hour, downstream).

A. By rail. For a train with 20 wagons, on the Oradea-Budapest route, the following values were obtained:

-Time to load containers from the depot onto the truck:

10 min x 1 container x 20 containers = 200 min = 3 hours 20 min.

-Time to travel to the station: 15 min x 1 truck x 20 trucks = 300 min = 5 hours.

-Time to load a container from the truck onto the wagon:

10 minutes x 20 containers = 200 minutes = 3 hours 20 min.

-Time to return the trucks to the depot: 15 min x 1 truck x 20 trucks = 300 min = 5 hours.

-Time to travel on the Oradea-Budapest railway: 218 km: 16.87 km/h = 13 hours.

-Time to unload from the train into the container terminal and load directly onto the river ship: 5 min x 1 container x 20 containers = 100 min = 1 hour 40 min.

-Time to return the train = 13 hours.

Total transport time of a train, round trip = 31 hours = 1 day 7 hours.

For 400 containers, the following are required:

10 trains x 2 trips/train = 95 hours = 4 days, until they all reach the river ship.

B. Road. On the roads and motorways between Oradea and Budapest we took into account the following time periods:

-Travel time of the truck from the garage to the manufacturer: = 15 min.

-Time of loading the containers from the warehouse onto the truck: 10 min x 1 container = 10 min.

-Travel time (at an average hourly speed of 70 km/h): 264 km: 70 km/h = 3 hours 45 min.

-Waiting time at the terminal to enter for unloading and formalities: = 30 min.
-Time of unloading the containers from the truck, directly onto the sea vessel:
10 min x 1 container = 10 min.
-Rest time of the driver: = 45 min.
-Return time of the truck: = 3 hours 45 min.
-Total time, minimum estimated, for a round trip: 1 truck = 9 hours 20 min.

For 400 containers, 25 trucks are needed, which if they make only one trip per day, it would take 16 days to take all the containers to the port of Budapest.

-Total minimum time = 16 days. If the drivers make 2 trips every 20 hours, then the time would be reduced by approx. 2-3 days.

C. River. On the Danube and the Danube-Black Sea Canal, between Budapest and Constanța, the estimated time is as follows:

-Ship travel time = 82 hours = 3 days and 10 hours, without stopping in ports, (Danube Logistics Portal, 2025).

-Locking time and passage through the locks Porțile de Fier I and II, Cernavodă and Agigea: = 4 hours.

Total minimum time = 86 hours = 3 days and 14 hours.

Centralizing the information and data in Table 5, the differences between the two types of transport strategies are observed.

Table 5. Time differences between container transport organization methods

No	Route and means of transport	Distance and average speed	Estimated minimum total time for loading, moving, unloading and return
1.	**Current situation**		
	a) By rail: Oradea, Sibiu, Pitești, Bucharest, Constanța	= 616 km =16,87 km/h	**=73 hours 20 min**, for a train with 20 containers, round trip. **Total time = 12 days, 11 trains, 9 with 2 trips.**
	b) Road: Oradea, Cluj-Napoca, Sibiu, Pitești, Bucharest, Constanța	= 815 km = 70 km/h	=**26 hours 5 min**, for a truck with 1 container **Total time = 40 days, for 20 trucks**.
2.	**With the "EU-e-Container" information system**		
	a) By rail: Oradea, Budapest.	= 218 km =16,87 km/h	=**31 hours**, for a train with 20 containers, round trip. **Total time = 4 days, with 10 trains x 2 trips**.
	b) Road: Oradea, Budapest.	= 264 km = 70 km/h	=**9 hours 20 min**, for a truck with 1 container **Total time = 16 days, for 25 trucks, with 1 trip/day**.
	c) River: Budapest, Constanța.	= 1400 km = 17 km/h	=**82 hours**, for a 400-container ship. **Total time = 3 days 16 hours**.
	Final result		**Total time Oradea-Budapest-Constanța, by rail and river:** **=182 hours = 7 days 14 hours.**

Source: developed by the author.

This example results in the following:

-Advantages: the problem of road and railway congestion in Romania is solved, the total cost of transport between Oradea and Constanta is reduced.

-Disadvantages: the total transport route is lengthened, railway traffic is congested in Hungary, up to Budapest.

In addition, a European law for the transfer of container transport must also contain a set of rules, mandatory for all EU member states and riparian countries, which would eliminate the current administrative barriers, which hinder river traffic and mainly lead to a loss of time.

Regarding the calculation of the transport price, Table 6 presents the estimated transport costs for the 400 containers (8,000 tons of cargo), for the routes and means of transport presented

previously. Loading, unloading or parking operations in the terminal, as well as road taxes, have not been taken into account, also, the rates are negotiable, etc.

Table 6. Shipping prices for containers

No	Route and means of transport	Distance	Estimated total cost for 1 container / 400 containers
1.	**Current situation**		
	A. By railway: Oradea – Constanța (CFR Marfa, 2024).	= 616 km	1 train x 400 t x 480.5 lei/t = 192,200 lei 8 trains x 2 trips = 3,075,200 lei 4 trains x 1 trip = 768,800 lei **Total estimated price = 3,844,000 lei** (759,683 euros) (1 Euro = 5.06 lei)
	B. Road: Oradea – Constanța (Cargopedia, 2025).	= 815 km	1 truck x 1 trip = 4,920 lei 20 trucks x 4,920 lei x 20 trips = 1,716,000 lei **Total estimated price = 1,716,000 lei** (339,130 euros)
2.	**With the information system "EU-e-Container"**		
	A. By rail: Oradea – Budapest.	= 218 km	1 train x 400 t x 170 lei/t = 68,000 lei **Total estimated price =** 10 trains x 2 trips x 68,000 lei/t = 1,260,000 lei (249,011 euros)
	B. Road: Oradea – Budapest.	= 264 km	1 truck x 1 trip = 1,316 lei. **Total estimated price** = 25 trucks x 16 trips x 1,316 lei = 526,400 lei (104,031 euros)
	C. River: Budapest - Constanța (Danube FIS Portal, 2025).	= 1400 km	**Total estimated price** = 1 ship x 400 containers x 2,530 lei/container = 1,012,400 lei (200,000 euros)
	Final result Oradea-Budapest-Constanța (trucks + river ship)		Trucks = 526,400 lei (104,031 euros)' River vessel = 1,012,000 lei (200,000 euros). Total cost = 1,538,400 lei (304,031 euros).

Source: developed by the author.

A simple calculation regarding the costs/km/container, using the data in table 6, reveals the following results:

1. Current situation:

A. Railway transport Oradea-Constanța:

3,844,000 lei: 616 km: 400 containers = 15.6 lei/km/container (3.08 euro).

B. Road transport Oradea-Constanța:

1,716,000 lei: 815 km: 400 containers = 5.2 lei/km/container (1.02 euro).

2. Using the "EU-e-Container" IT system:

A. Railway transport Oradea-Budapest:

1,260,000 lei: 218 km: 400 containers = 14.4 lei/km/container (2.84 euro).

B. Road transport Oradea-Budapest:

526,400 lei: 264 km: 400 containers = 4.9 lei/km/container (0.96 euro).

C. River transport Budapest-Constanța:

1,012,400 lei: 1,400 km: 400 containers = 1.8 lei/km/container (0.35 euro).

As can be seen from table 6, we have the following values:

i). In the current situation of container transport. It is observed that:

-Transport of containers by truck is the cheapest, but from table 5 we have noticed that this means the longest duration of time.

-Transport by rail is much more expensive, but the duration of time is much shorter, compared to road transport, directly between Oradea and Constanța.

ii). With the help of an "e-Container" type information system. For transport through Budapest, the following is observed:

- The total cost, with trucks and river ship is the cheapest, but the shortest duration of time is with the train and river ship (table 5).

- The total cost, with trucks and river ship is lower, compared to direct transport by trucks between Oradea and Constanța (by 177,600 lei), and the duration of time is 19 days, compared to 40 on the direct road route. The operating costs of the containers in the two ports and the costs of passing through the locks were not taken into account.

A simple evaluation of the transport costs, for the three types of means used, proves that the most profitable is river transport, and the combination with the other two types leads to a reduction in costs and total transport time.

From the example presented and from the two tables, the following conclusions can be drawn regarding the current situation of freight transport in Romania and the countries of Central and Eastern Europe:

-Transport of containers and other goods by truck is much cheaper than by rail.

-The long duration of time for the transport of containers by truck is solved by concluding transport contracts in which time reserves are provided, so that the containers arrive at the sea port terminal on time, for loading sea vessels.

-River transport of containers and freight trucks is much more developed and cheaper in Western Europe, where a tariff of approx. 250 euros/container, compared to Central and Eastern Europe, where the cost rises to 500 euros/container.

2. Minimum number of containers. There may also be a situation where a PEI has to transport a small number of containers over a long distance. In this situation, the question arises whether the law and the implementing regulation can oblige the owners of the goods to resort to river transport or to carry out the activities as at present?

This situation, of the transport of a single container (or a small number of containers), can be solved with the help of the information system, which in the same way, will be able to offer the options of transport and transfer on the river. If we consider the previous example of transport between Oradea and Constanța, for a single container, the following situations will arise:

-After transporting the container to the river port, it will wait for the arrival of a river ship, which will offer the capacity of taking over and transporting on the river, to the destination.

-The waiting time in the port can be quite long, which can lead to the situation that this container does not arrive on time to be loaded onto a sea vessel, then will be stored in the sea port until the arrival of the next sea vessel.

In this way, the question arises whether or not this transfer is still sustainable, is it efficient for PEI? It follows that the future transfer law must offer economically correct solutions for all those interested in multimodal transport.

The program will have algorithms that will solve the transportation problem, with minimal costs, with the shortest duration and with the least pollution. From the analyses and calculations performed and taking into account the interest of the PEI, the following aspects resulted:

-The minimum number of containers that must be transferred from road transport to rail is 20 containers, which means one train.

-The minimum number of containers that must be transferred from road transport to river transport is 50-70 containers, which can cover the costs and ensure a minimum profit for the river ship owner.

One solution is that for the transport of a small number of containers, which is not cost-effective for a river ship, it is necessary to establish container and truck transport lines that respect a schedule for the arrival and departure of ships from ports. The river transport line is the one that can ensure a fair ratio between the PEI's profit and that of the river shipowners.

5. Conclusion

The transfer of container transport from land to rivers and inland waters can be achieved as follows:

-By adopting the Law on the “Transfer of Container Transport from Land to Rivers and Inland Waters” and the Regulation for the implementation of the law, which the European Parliament must adopt.

-Development of the "EU e-Container" IT System, which can be installed on a website named "www.EU-e-Container.eu".

-Informing and then implementing the information system, using it for the practical transfer of containers.

-Organizing international tenders for the establishment of river navigation lines for the transport of containers and trucks.

-Obtaining the information and data necessary for correcting and improving the system.

Without a law and this unifying information system, it will be very difficult and long-term to achieve this transfer of container and truck transport, only on the basis of "meeting demand with supply". Otherwise, it means that we will continue to have pollution, heavy traffic, road accidents and very high costs, which are found in the cost of the final product.

The ideas presented in this paper can be taken over and adapted in the river freight transport in North America and Asia, for those rivers, which have a significant length, depth that allows the navigation of river freight ships and which connect important port cities, in a country or continent. The information system and the computer program can be adapted and used in any area of the world, for example, a US Computer System "US-e-Container.gov".

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Annex 1. Definitions

Container = a modular construction in the form of a rectangle or a special casing for transporting goods, which allows stacking, lifting, vertical or horizontal transfer.
Downstream = on a river or stream, in the direction of water flow.
Drawn = the distance measured vertically from the lower plane of the ship's keel to the plane of the ship's waterline. It is measured in meters, decimeters or feet.
Easement = situation of dependence on other factors that influence the main activity.
Fairway = A navigable portion along a river, canal or lake, wide and deep, to ensure the navigation of ships and the entry into a port.
kN = kilonewton is a decimal multiple of the Newton (N), where 1 N = 1 kg•m/s² and 1 kN = 1000 N.
Line = liner shipping has as its main characteristic the fact that it places great emphasis on regular arrivals and departures to/from ports of loading or unloading and not on the use of a single ship.
LNG = Liquified Natural Gas.
PEI = producer, exporter or importer of containerized goods.
TEU = Twenty-foot Equivalent Unit, represents the equivalent unit in twenty feet, which is used to determine the capacity of cargo that can be loaded into a container or for loading containers on board ships.
TIR = is the acronym for “Transports Internationaux Routiers”, being synonymous with large road transport.
Tramp = “Tramp”, a type of navigation where ships depend on the ports where there is cargo, make different voyages, depending on the destination of the goods, and the voyages are not repeated.
Truck = truck, which has a platform for transporting containers or a tank for general cargo.
Upstream = on a river or stream, in the direction of the source.