ANALYSIS OF THE ROLE OF WATER TRANSPORT IN COMBINED, INTERMODAL AND MULTI-MODAL TRANSPORT

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Abstract

This article examines the role and importance of water transport in the context of combined, intermodal, and multimodal freight transport. It presents the definitions, principles, and basic technical and legal aspects of these transport concepts. Special attention is paid to intermodal transport units and their application in combining sea transport with various types of specialized vessels, such as container ships, train ferries, Ro-Ro ships, lighters, and pallet carriers. The organization of multimodal transport is analyzed, in which the multimodal transport operator (MTO) is responsible for the entire transport chain, including the participation of subcontractors such as sea and inland waterway carriers. The article also explores **combined transport,** where water transport—particularly sea and inland waterways—constitutes the main segment of the route, while road transport is limited to short initial or final legs. The regulatory framework related to multimodal and combined transport is discussed, emphasizing its importance for the development of international trade and logistics. In conclusion, the article highlights the key role of water transport in effectively implementing sustainable and integrated international transport chains.

Keywords: combined transport (CT); intermodal transport; multimodal transport; water transport; intermodal transport units (**ITU/ILU);** multimodal transport operators (MTO)**;** combined maritime transport**;** container ships**;** Ro-Ro ships**; train** ferries**;** lighterage ships (LASH)**;** legal framework

1. Introduction

In the current conditions of globalization and expanding international trade, the efficiency of transport systems is crucial for ensuring sustainable economic growth and competitiveness. Intermodal and multimodal transport are increasingly emerging as dominant approaches, integrating different modes of transport—such as road, rail, and water—to achieve higher efficiency, flexibility, and reduced environmental impact. In this framework, water transport plays a key role as a sustainable and cost-effective component of the logistics chain. Its contribution is especially important in efforts to optimize freight movement across national and international corridors.

A central aspect of modern logistics strategies is the balanced use of different modes of transport. As noted by Koritarov and Dimitrakiev (2024), "the modal distribution is defined as the allocation of freight transport among various transportation modes, including road, rail, and inland waterways. The evaluation of this distribution offers insights into the efficiency of the transport network and the environmental impact of hinterland activities. Achieving a well-balanced modal distribution is imperative for enhancing logistics performance and reducing transport expenses."[1] This highlights the growing importance of inland and maritime transport within intermodal and multimodal systems.

This article aims to analyze the role and significance of water transport in the context of intermodal and multimodal freight systems, by examining its advantages, limitations, and future development opportunities.

2. Theoretical aspects of intermodal and multimodal transport

Intermodal transport is the transport of goods using more than one mode of transport, but within the same loading unit (e.g., container), without interruption of the load itself. Multimodal transport also involves the use of different modes of transport, but under the management of a single operator and using a single transport document. The main difference between the two types is in the coordination and responsibility along the supply chain. In both cases, the aim is to use the advantages of each mode of transport to achieve greater efficiency, sustainability, and economy.

2.1. Intermodality: Meaning and Application

When transporting goods over long distances, geographical conditions do not always allow for the same means of transport. Depending on the cargo quantity and the transportation distance, the effectiveness of each individual mode of transport varies. Additionally, due to certain technical limitations, it is not always feasible to provide the most suitable mode of transport at the goods' place of origin, necessitating the use of a different transport method at the start of the journey. Changing the means of transport requires the transshipment of the goods from one means of transport to another. Transshipment is accompanied by at least five negative consequences:

- additional costs
- delay in delivery
- losses of goods due to spillage, loss, theft, etc.
- mechanical damage to the goods during reloading
- damage to the goods when exposed to less favorable weather conditions

In form, goods can be in bulk or in bulk. When they are in bulk and in large batches, also if the nature of the goods themselves allows, the same can be transported in bulk to the end user. In other cases, the goods must be appropriately packaged. The packaging can be

boxes, bags, crates, etc. facilitate reloading and transportation, it is necessary to consolidate the packaging. In this regard, transport engineering has created pallets. Pallets serve as a simplified load unit, facilitating the arrangement and strengthening of bulk loads in bags, boxes, and other containers. This activity is called palletization and allows it to be carried out at the place of production of the goods, after which it can be easily and reliably stored, loaded, unloaded, reloaded onto a truck, from a truck to a wagon, etc. During transportation and when reloading pallets from one mode of transport to another, the goods are sufficiently protected for short distances, and the pallets also allow them to be reloaded mechanically and relatively quickly. This is the meaning of intermodalism. The main element of this theoretical concept is the consolidated loading unit, also referred to as a transport unit, which serves to reduce the negative consequences associated with transshipment activities. The phrase "intermodal transport unit" or "Intermodal Transportation Unit" (ITU) is also referred to as "intermodal loading unit" or "Intermodal Loading Unit (ILU).

This technique for transportation and transshipment is not new. Various techniques have been applied over the years, in simpler forms and technically possible for their time.

UNICE 's definition of intermodal transport is "a transport system in which goods are transported in the same transport unit (ITU) or vehicle using at least two transport modules (types) without handling the load."

(Working Party on Intermodal Transport and Logistics [WP.24], 2014). In addition, the term intermodality is used to describe a transport system in which two or more modes of transport are used for the same transport unit in an integrated manner, without manipulating the cargo during transport— "door-to-door transit". [2]

❖ **Intermodal transport units (ITU or ILU):**

The European Commission directives specify that intermodal units include containers, swap bodies, and truck trailers. According to a more extended understanding, intermodal units are:

- **Containers**—used as intermodal units transported by road, rail, and water transport
- **Trucks and trailers with and without tractors** are used as intermodal units transported by rail cars and water transport.
- **Railway wagons**—used as intermodal units transported by sea ferries (train ferries).
- **Lighters** are unmanned, non-self-propelled vessels used as intermodal units; they are moved by pushers in rivers and then reloaded at their mouths onto lighter-type ships for transport along the sea route.
- **Pallets** are used as intermodal units transported in aviation, road transport, and water transport.

The above five intermodal units are also transported by specialized water transport vessels.

2.2. Multimodality—Necessity and Application

(United Nations, 2004). The basic feature of multimodal transport is that at least two modes of transport are used. The definition jointly given by the United Nations Economic Commission for Europe (ECE), the European Conference of Ministers of Transport (ECMT) and the European Commission (EC) is "Multimodal transport: carriage of goods by two or more modes of transport".[3]

The implementation of international transport of goods is carried out using more than one type of transport. In addition to the transshipment of goods, which is a problem solved with the intermodal concept, another problem is their organization. The task of organizing the entire transport of goods, from the place of origin to the place of its realization, is beyond the capabilities of individual traders. The use of individual modes of transport and the corresponding transshipment is accompanied by the conclusion of numerous contracts and coordination of the entire transport with individual carriers. As a result of the development of international trade in transport services, transport companies with international representation were created, which are technically capable of organizing complete international transport of goods. In this regard, the need arose for the legal regulation of these services. Users of transport services, in addition to a good price, also seek reliability of transport in all its dimensions. On the other hand, international trade, which is closely related to and dependent on transport, also has its requirements regarding the legal side of transport and especially regarding transport documents (bills of lading, waybills, etc.), which are necessary for payments in commercial transactions. As a result of all this, the need arose to negotiate the entire transport with only one carrier company, under one transport contract for the entire section of the transport, including the use of at least two modes of transport. In addition, the goods must be transported with only one transport document. The solution to this need is the concept of multimodality.

Related to this concept is the United Nations Conference on a Convention on International Multimodal Transport, Geneva, 1980.

According to the Convention, "International multimodal transport (international multimodal "transport " means the carriage of goods by at least two different transport modules (means) based on a multimodal contract from a place in one country where the goods are accepted by the responsible multimodal transport operator to a specified place of delivery located in another country. The carriage and delivery of goods carried out under a contract involving only one transport module, if so specified, shall not be considered international multimodal transport."

By convention, the carrier is responsible for the entire carriage, even if it is performed by several modes of transport (e.g., rail, road, and sea). The carrier is not required to own all the means of transport, and in practice, it typically does not. Sub-carriers, also referred to as "actual carriers," typically perform the carriage. The carrier who is responsible for the entire transport is also called a multimodal transport operator, or MTO.[4]

According to the Convention, a "multimodal transport operator" (MTO) means any person who, in his name and on his account or through another person acting on his behalf, concludes a multimodal transport contract and who, as principal (entrepreneur), not as agent or on behalf of the consignee of the goods or the carriers involved in the multimodal transport operations, assumes responsibility for the performance of the contract.

According to the Convention, a "multimodal transport contract" refers to an agreement in which a multimodal transport operator commits, in exchange

for freight payment, to carry out or guarantee the execution of international intermodal transport.

According to the Convention, a "multimodal transport document (multimodal transportation document) means a document that is evidence that a contract for multimodal transport has been concluded, the assumption of responsibility for the goods by the multimodal transport operator, and his guarantee that he will deliver the goods in accordance with the terms of the contract."

According to the Convention, "Consignor of the goods (Consignor) means any person by whom or on whose behalf the contract of multimodal transport is concluded with the multimodal transport operator, or any person by whom or on whose behalf the goods are made available to the multimodal transport operator in connection with the multimodal transport contract."

The Convention defines "Consignee" as the legal recipient of the goods. According to the Convention, "Goods" include containers, pallets, or similar articles used for transport or packaging that are supplied by the consignor.

The concept of multimodal transport is not new. There are examples of popular science literature.

According to the United Nations (2004). "In the 17th century, a French writer described how his cart was loaded onto a barge and traveled 400 km down the Rhine River to avoid poor travel on the undeveloped road network at the time. This example is given as Ro-Ro transport." - This example can be argued to what extent it is multimodal transport, since it is not stated that it was carried out on the transport of foreign cargo for freight.

A contemporary writer asserts that the invention of modern multimodal transport occurred in the context of railway transport. On the first railway in 1830, the coach body was removed from the chassis and loaded onto a flatbed wagon to save passengers from the inconvenience of changing coaches for wagons. This approach may have been a strategy to gain acceptance for this new mode of transport. Some cities strongly opposed this system.[5]

Not enough countries have ratified the Convention on Multimodal Transport to achieve international recognition. However, it is successfully applied in transport using intermodal units such as containers, trailers, and semi-trailers, as well as railway wagons. In connection with the convention, Ordinance No. 53 of February 10, 2003, on combined transport of goods of the Republic of Bulgaria was promulgated in the State Gazette, No. 18 of February 25, 2003.

❖ **Application of intermodal and multimodal transportation in water transport**:

The concept of intermodality is associated with intermodal transport units, with which the goods loaded in them are transported by two or more modules (types) of transport, with the transshipment being carried out without manipulating the goods. Multimodality refers to contracts for the international transport of goods involving two or more modules of transport, which are concluded between the shipper and the multimodal transport operator (MTO) responsible for the entire transport. In addition, on these means of transport, only one transport document, Bill of Lading or Waybill, valid for the entire transport, is issued.

The principle of negotiation is based on the convention on multimodal transport. Multimodal transport operators (MTOs) operate the intermodal transport units that they use to transport the goods. The intermodal units can be owned by the MTO or be rented. MTOs conclude contracts with shippers for the carriage of goods along the entire multimodal transport chain. In addition to shippers, MTOs conclude contracts for the carriage of intermodal transport units with the relevant actual carriers for each section of the transport chain. Actual carriers are companies that own and operate road transport, rail transport, air transport, or water transport with any of the types of specialized container ships, Ro-Ro, ferries, lighters, or pallet carriers. In relation to multimodal transport contracts, actual carriers appear as subcontractors (subcarriers). Actual carriers do not have direct contractual relations with shippers. The MTO issues the appropriate multimodal transport document on its behalf after the goods are loaded, and this document is valid for the duration of the goods' transportation.

2.3. Combined sea transport

Sea transport of intermodal transport units is carried out with specialized seagoing vessels used in liner shipping. Liner shipping has undergone an evolution because of which traditional liner transport of general cargo continues today, but liner transport with intermodal transport units has also developed. These transports in Bulgarian terminology are also called combined sea transports. In these transports, sea carriers, as noted above, act as subcontractors of the MTO. We can divide combined sea transport into separate sectors:

- Transportation of containers with container ships.
- Transportation of trucks and trailers by Ro-Ro ships.
- Transportation of railway wagons with ships, such as railway wagon ferries.
- Transportation of lighters with lighter-type ships; pallet cargo transportation with pallet trucks.

In combined sea transport, the operator of the intermodal transport unit, as the MTO, concludes a multimodal transport contract with the shipper. Sea carriers are subcontractors (subcarriers) of the MTO who are responsible to the shipper for the entire transport. The responsibility for the goods to their recipient is borne by the MTO, which to a counterclaim against the sea carrier in cases where damage to the goods occurred during sea transport.

❖ **Analysis of the EU Combined Transport (CT):**

(European Commission, 2015). The CT market has been defined by various definitions, including Maritime CT and Continental CT. The CT Directive refers to the transport of goods between Member States, involving the movement of CT load units on CT services between MS. However, available data on freight traffic flows does not provide sufficient detail on these criteria to verify which traffic flows qualify as CT.

The CT market has traditionally been split into two broad segments: Maritime CT, primarily related to the movement of ISO-standard shipping containers between seaports and inland terminals, and Continental CT, primarily related to movement of CEN-standard European swap bodies between inland terminals in European countries. However, recent developments have

blurred the distinction between the two definitions due to increasing liberalization of the railway industry.

To provide clear and distinct definitions, further segmentation is necessary, such as by CT modal combination (CT RR), geographic coverage (intra-MS), and type of service (UCT) or accompanied (ACT). These definitions are used in a consistent format, with CT rail/road > Intra-EU > Unaccompanied. This helps to provide a more transparent analysis of the CT market and ensures that the industry can better understand and understand the CT market.[6]

2.3.1.Combined sea transport with container ships

Multimodal container transport occupies the largest share of all multimodal and combined sea transport. They are very flexible and meet the requirements of the largest number of users. Additionally, regarding load capacity and cargo capacity, containers are comparable to both road transport and rail transport. Containers can transport nearly 90% of the cargo that rail wagons carry. The door-to-door system (door this door) is very convenient and efficient.

❖ **Combined sea transport of containers is carried out with two types of ports:**

- Feeder or power ports (feeder ports) serve to collect and redirect containers from and to the final points of the transport chain served by land transport and rail transport.
- A hub port is a type of port that consolidates and distributes containers. Each hub port is fed with containers from its feeder ports, and vice versa, containers are directed from the hub ports to the corresponding feeder ports.

Combined sea transport of containers is carried out with two types of container ships:

- Feeder container ships (feeder ships)—these are small-capacity ships and are used to transport containers between feeder ports and consolidating ports.
- Mainline container ships (mega ships)—these are large-capacity ships and are used to transport containers only between consolidating ports (hub ports).

In combined maritime transport with container ships, the concept of "**hub**" is applied and "**spoke**" which is also applied in aviation. The basis of this model is the economic concept of economies of scale. In this model, containers are first transported from the place where they are loaded with goods to the nearest port, which acts as a feeder port of the respective line. The feeder ports are served by feeder container ships (feeder ships) that transport containers to hub ports (hub ports), where ships are transshipped onto large container ships (megaships). Each hub port has a certain number of feeder ports from which they provide goods for container transport. Large container ships (mega ships) transport containers to the hub port that serves the feeder port, which is closest to the final point on land where the container is to be delivered. Feeder line transport is short, usually within a single sea basin and over less than 1000 nautical miles. Trunk line transports are long-distance, oceanic, and usually between hub ports located on different continents.

2.3.2.Combined transport with Ro-Ro ships

Christodoulou, Raza, and Woxenius (2019) examine the integration of Ro-Ro shipping in sustainable intermodal transport chains. Ro-Ro shipping services, a maritime segment, can easily integrate into intermodal transport systems as they do not require port lifting.[7]

Users of Ro-Ro ships are car carriers. In these transports, the intermodal transport unit is the truck with a trailer and a driver, or the trailer without a driver. There is a transport scheme in which the trailers are towed along the land sections by different tractors on both sides of the sea line, with the Ro-Ro ship transporting only the trailer with the goods.

2.3.3.Combined transport with railway ferries

Combined transport with railway ferries Users of ferries are railway operators, which can be companies with railway rolling stock or wagon fleets. The intermodal unit is the railway wagon. In ferry transport, the railway operator, as the MTO, concludes a multimodal transport contract with the shipper. Sea carriers are subcontractors (subcarriers) of the railway operator, who is responsible for the entire transport.

(Fomin, Lovska, & Horban, 2021). The transport industry significantly benefits from combined transport systems such as train ferries, which integrate railway and maritime infrastructure to enhance the efficiency and sustainability of freight and passenger movement. These systems have been extensively analyzed to provide a comprehensive understanding of their historical development, operational features, and strategic importance. Train ferry routes—both sea-based and those crossing rivers and lakes—have played a crucial role in improving national economies and strengthening military logistics. A notable example is Ukraine's network of train ferries connecting with Bulgaria, Georgia, and Turkey, with specific emphasis on the structural and technological characteristics of modern ferries operating in the Black Sea, Caspian Sea, and Baltic Sea regions. These services facilitate the transportation of rail wagons and even passenger trains, requiring specialized vessels and infrastructure.[8]

In the Bulgarian context, ferry services have a well-established tradition. The first train ferry line was launched in 1978 between the ports of Varna and Illichevsk, followed by the Varna–Port Kavkaz route. The development of such lines is guided by intergovernmental agreements and cooperation between national railway carriers, which are crucial for establishing and operating the necessary ferry terminals and ensuring interoperability. These projects demand significant investment and are often preceded by detailed analyses of trade potential and strategic connectivity among the participating countries. The successful operation of train ferries thus depends not only on technical and infrastructural readiness but also on institutional coordination and long-term bilateral cooperation.

These shipments are largely like Ro-Ro shipments. Ferry ships for transporting railway wagons are technically also suitable for transporting trucks.

2.3.4.Combined transport with lighter carriers

In this transport system, the lighter is the intermodal cargo unit. Lighters are non-self-propelled vessels used for river transport. The means of transport is the lighter carrier, which carries out ocean transport connecting the mouths of rivers or canals to inland waterways. Usually the lighter and lighter carrier (LASH system) is owned and operated by a single commercial company. In this system, goods are loaded onto lighters at a river port, after which the lighters are taken on board by a lighter carrier, which transports them to the

mouth of another river and canal on an inland waterway, where they are towed as non-self-propelled vessels to the river port where the goods are to be unloaded. After unloading the lighters, they are loaded onto other goods and returned on the return journey. It is practically possible for lighter lines to also serve shallow water seaports.

The barge transport that connected the European countries along the Danube River with ports in the Far East has already been discontinued; they remain only of theoretical importance, although such lines are still maintained in other parts of the world. Given its environmental friendliness, we can anticipate its eventual restoration. This transport system can be developed between the mouths of the Danube and the Don Rivers. with those of central and western Europe.

2.3.5.Combined transport with pallet trucks

In these transports, the intermodal unit is the pallet, which is transported by a specialized ship-type pallet carrier. The characteristic of these ships is that they are multi-deck with low cargo spaces adapted for the transport of containers only. These ships were used in the 80s of the last centuries but gave way to container ships. Nowadays, similar ships are used for the transport of some fruits requiring constant temperatures.

2.3.6. Allocation of Carrier Responsibility in Combined Maritime Transport

In private marine law, the identification of maritime carriers is a critical issue, further complicated by the allocation of responsibility for both the transport process and the cargo itself. Carriers may act as maritime entrepreneurs without owning vessels, necessitating a distinction between carriers operating under charter agreements and those acting under a bill of lading. Several legal entities, such as shipowners, time charterers, and even sub-charterers, may distribute obligations and responsibilities in cases involving chains of charter parties.

(Dimitrakiev, Koritarov, & Velinov, 2025). This distinction is particularly important during cargo discharge, where inconsistencies in the quantity or condition of goods may arise. Determining which party holds liability is essential for assessing claims for damage or loss. The problem becomes even more complex in combined or multimodal transport chains, where the sea leg is integrated with inland or port operations. In such cases, identifying the contractual carrier — especially when multiple parties have overlapping roles — is crucial for enforcing liability under legal instruments such as the Hague-Visby Rules, Hamburg Rules, or Rotterdam Rules.[9]

Moreover, in door-to-door transport services, carriers may subcontract segments of the journey, making it difficult for cargo owners to pinpoint the responsible party when loss or damage occurs. Therefore, clear contractual arrangements and transparent documentation remain essential tools for assigning liability in combined sea transport.

2.4. Definitions of Multimodal, Intermodal, and Combined Transport

In the context of transport policy and regulation, unified terminology is essential for clarity and interoperability between transport modes. In 2001, three key institutions—the European Conference of Ministers of Transport (now the International Transport Forum), the **United** Nations Economic Commission for Europe (UNECE), and the European Commission—agreed on standardized definitions of the terms multimodal, intermodal, and combined transport (Reis et al., 2013). According to these definitions:

- **Multimodal Transport** is the "carriage of goods by two or more modes of transport";
- **Intermodal Transport** is the "movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes";
- **Combined Transport** is the "intermodal transport where a major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible".

Furthermore, the **European Commission** later introduced the concept of **co-modality**, defined as the "efficient use of different modes on their own and in combination" (European Commission, as cited in Reis et al., 2013, p. 18). This terminology plays a vital role in shaping transport strategies and integrating water transport into modern logistics chains.[10]

3. Importance and advantages of water transport

Water transport has advantages that make it preferred in many cases:

- **Economy:** It is one of the most cost-effective modes of transport when large volumes of cargo over long distances.
- **Environmental friendliness:** Compared to road and air transport, water transport emits fewer harmful emissions per unit of transported cargo.
- **Large capacity:** Sea and river vessels can carry large amounts of cargo at once, reducing the need for multiple trips.
- **Low infrastructure cost:** Unlike road and rail transport, water transport uses natural infrastructure—seas and rivers.

4. Role of water transport in intermodal and multimodal transport

Water transport is an essential component of intermodal and multimodal systems, especially in international transport. Seaports are often the starting or ending point of a freight chain connecting to rail and road transport. For example, containers arriving by sea are loaded onto trains or trucks for distribution inland. (Caris et al., 2014)**. Water transport, particularly inland navigation, plays a crucial role in enhancing the efficiency and sustainability of intermodal supply chains.** It provides a vital connection between the hinterland and seaports, especially in regions with well-developed river networks such as the Danube basin. **Integrating inland waterway transport (IWT) into the intermodal chain offers significant opportunities for improving supply chain service performance, reducing external costs, and supporting green logistics.** Future research efforts focus on developing system-wide models for IWT, integrating operational planning tools, and optimizing bundling networks. **Additionally, better alignment of intermodal transport decisions with broader supply chain strategies is essential for achieving seamless and sustainable freight movement.[11]**

5. Main problems and challenges

Despite its advantages, water transport faces challenges:

- **Dependence on natural conditions:** Navigation on rivers and seas depends on climatic and hydrological factors.
- **Limited speed:** Water transport is slower than others, which is a disadvantage when transporting goods with a short shelf life.
- **Infrastructure constraints:** Insufficiently modernized ports, lack of logistics terminals, and connectivity with other modes of transport hinder effective integration.
- **Regulatory barriers and administrative burdens:** In many countries, there is still a lack of sufficient coordination and synchronization of regulatory regimes between different modes of transport.

6. Development prospects and opportunities for improvement

In view of the increased focus on sustainable development and the "green transition," waterborne transport has significant potential for expansion. The EU, through strategies such as the "Green Deal," is promoting the use of environmentally friendly means of transport, including inland waterway transport. Necessary are:

- In port modernization and multimodal terminals.
- Development of digital systems for coordination and tracking cargo.
- Improving compatibility between different types of transport.
- We are fostering public-private collaborations to build a logistics network.

7. Conclusion

Water transport, with its economic and environmental efficiency, is unchanged apart from modern intermodal and multimodal transport systems. Despite some challenges, in the presence of strategic vision, adequate investments, and improvements in coordination between transport types, there is the potential to play a more important role in global logistics. Bulgaria, as a country with access to the Black Sea and an important participant by the River Danube, has significant potential for development in this direction.

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