READER – LOGISTICS IN THE CONTEXT OF INLAND NAVIGATION – GENERAL CONDITIONS AND CHARGES

Extract of relevant passages from the „Manual of Danube Navigation", viadonau (2019).

Pictures: viadonau in Manual on Danube Navigation, p. 79, 106.

Strengths and weaknesses of Danube navigation

The principal **strengths** of Danube navigation are the ability to transport large quantities of goods per vessel unit, its low transport costs and its environmental friendliness. Furthermore, it is available around the clock, with no prohibition on driving at weekends or during the night and can provide a high degree of safety and low infrastructure costs.

The **weaknesses** lie in its dependence on fluctuating fairway conditions and the consequent, varying degree of the vessel load factor, the low transport speed and network density, which often necessitate pre- and end-haulage by road or rail.

The **opportunities** of Danube navigation are the high free capacities of the waterway, international development initiatives such as the Strategy for the Danube Region, the internalisation of external costs at European level, cooperation with road and rail, as well as the use of modern and harmonised River Information Services (RIS).

The **threats** to Danube navigation are found in the different political and hence budgetary importance assigned to this transport mode in the individual Danube states, as well as in the need to modernise many Danube ports and parts of the Danube fleet.

STRENGTHS

- Low transport costs
- Bulk freight capacity
- Environmental friendliness
- Safety
- Availability around the clock
- Low infrastructure costs

WEAKNESSES

- Dependence on variable fairway conditions
- Low transport speed
- Low network density, often requiring pre-/end-haulage

OPPORTUNITIES

- Free capacities of the waterway
- Rising demand for green transport modes
- Modern and internationally harmonised information services (RIS)
- Cooperation with road and rail
- International development initiatives (e.g. Strategy for the Danube Region)

THREATS

- Inadequate maintenance of the waterway in some Danube riparian countries
- Administrative barriers lead to competitive disadvantages (e.g. time-consuming/expensive checks)
- High requirement to modernise the ports and fleets

Source: viadonau

SWOT analysis of Danube navigation

Classification of inland waterways

@ Working Party on Inland Water Transport of the UNECE's Inland Transport Committee: www.unece.org/trans/main/sc3/sc3.html

A **waterway** is a body of surface water serving as a route of transport for goods and/or passengers by means of vessels. Navigable inland transport routes are called inland waterways. Natural inland waterways are provided by **rivers** and **lakes**, whereas **canals** are artificial waterways.

In order to create the most uniform conditions possible for the development, maintenance and commercial use of Europe's inland waterways, in 1996 the Inland Transport Committee of the United Nations Economic Commission for Europe (UNECE) adopted the **European Agreement on Main Inland Waterways of International Importance** (AGN) (United Nations Economic Commission for Europe, 2010). The Agreement, which came into force in 1999, constitutes an international legal framework for the planning of the development and maintenance of the European inland waterway network and for ports of international importance, and is based on technical and operational parameters.

By ratifying the Agreement, the contracting parties express their intention to implement the coordinated plan for the development and construction of the so-called E waterway network. The **E waterway network** consists of European inland waterways and coastal routes which are of importance for international freight transport, including the ports situated on these waterways.

E waterways are designated by the letter 'E' followed by a number or a combination of numbers, whereby main inland waterways are identified by two-digit numbers and branches by four- or six-digit numbers (for branches of branches). The **international waterway of the Danube** is designated as **E 80**, and its navigable tributary the **Sava**, for example, as **E 80-12**.

Waterway classes are identified by Roman numbers from I to VII. **Waterways of class IV or higher** are of economic importance to international freight transport. Classes I to III identify waterways of regional or national importance.

The class of an inland waterway is determined by the **maximum dimensions of the vessels** which are able to operate on this waterway. Decisive factors in this respect are the **width** and **length** of inland vessels and convoys, as they constitute fixed reference parameters. Restrictions regarding the **minimum draught loaded** of vessels, which is set at 2.50 metres for an international waterway, as well as the **minimum height under bridges** (5.25 metres in relation to the highest navigable water level) can be made only as an exception for existing waterways.

The following table shows the parameters of international **waterway classes based on type of vessels and convoys** which can navigate the waterway of the respective class.

Motor cargo vessels						
Type of vessel: general characteristics						
Waterway class	Designation	Max. length L (m)	Max. width B (m)	Draught d (m)	Deadweight T (t)	Min. height under bridges H (m)
IV	Johann Welker	80-85	9.5	2.5	1,000-1,500	5.25 / 7.00
Va	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	5.25 / 7.00 / 9.10
Vb	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	5.25 / 7.00 / 9.10
VIa	Large Rhine vessel	95-110	11.4	2.5-2.8	1,500-3,000	7.00 / 9.10
VIb	Large Rhine vessel	140	15.0	3.9	1,500-3,000	7.00 / 9.10
VIc	Large Rhine vessel	140	15.0	3.9	1,500-3,000	9.10
VII	Large Rhine vessel	140	15.0	3.9	1,500-3,000	9.10

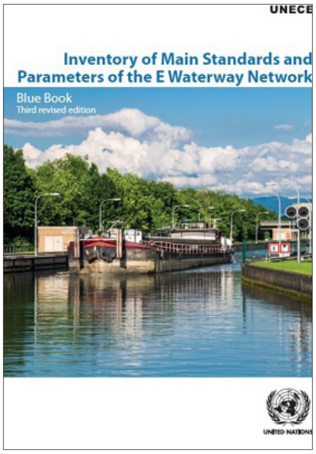
Pushed convoys						
Type of convoy: general characteristics						
Waterway class	Formation	Length L (m)	Width B (m)	Draught d (m)	Deadweight T (t)	Min. height under bridges H (m)
IV		85	9.5	2.5-2.8	1,250-1,450	5.25 / 7.00
Va		95-110	11.4	2.5-4.5	1,600-3,000	5.25 / 7.00 / 9.10
Vb		172-185	11.4	2.5-4.5	3,200-6,000	5.25 / 7.00 / 9.10
VIa		95-110	22.8	2.5-4.5	3,200-6,000	7.00 / 9.10
VIb		185-195	22.8	2.5-4.5	6,400-12,000	7.00 / 9.10
VIc		270-280	22.8	2.5-4.5	9,600-18,000	9.10
		195-200	33.0–34.2	2.5-4.5	9,600-18,000	9.10
VII		275-285	33.0–34.2	2.5-4.5	14,500-27,000	9.10

Source: United Nations Economic Commission for Europe, 2010

Waterway classes according to the AGN

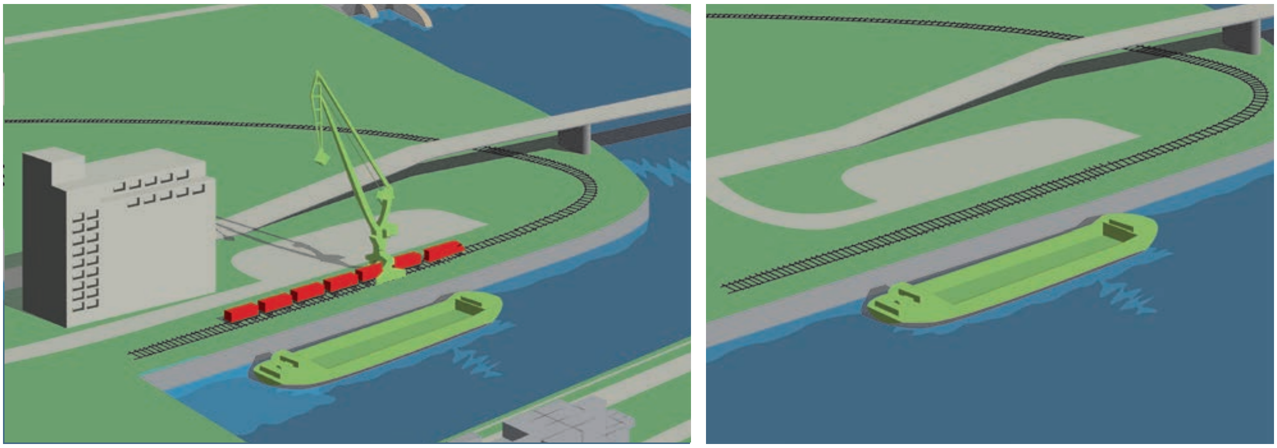
In 1998, the UNECE Inland Transport Committee first published an **Inventory of Main Standards and Parameters of the E Waterway Network**, the so-called 'Blue Book', as a supplement to the AGN (United Nations Economic Commission for Europe, 2012). The 'Blue Book' contains a list of the current and planned standards and parameters of the E waterway network (including ports and locks) as well as an overview of the existing infrastructural bottlenecks and missing links. This publication, which supplements the AGN, allows for the monitoring of the current state of implementation of the agreement on an international basis.

@ 'Blue Book' database: www.unece.org/trans/main/sc3/bluebook_database.html



Terminology

Ports are facilities for the transhipment of goods that have at least one port basin. Transhipment points without a port basin are known as **transhipment sites.**



Source: viadonau

Comparison of ports and transhipment sites

A port has many advantages compared to a transhipment site: Firstly it has longer quay walls and can therefore offer more possibilities for transhipment and logistics. Certain cargo groups are only allowed to be transhipped in a port basin in accordance with national laws. Secondly the port provides an important protective function: During flood water, ice formation or other extreme weather events ships can stay safe in the port.

A **terminal** is a facility of limited spatial extension for the transhipment, storage and logistics of a specific type of cargo (e.g. container terminals or high & heavy terminals). A port or a transhipment site may dispose of one or more terminals.

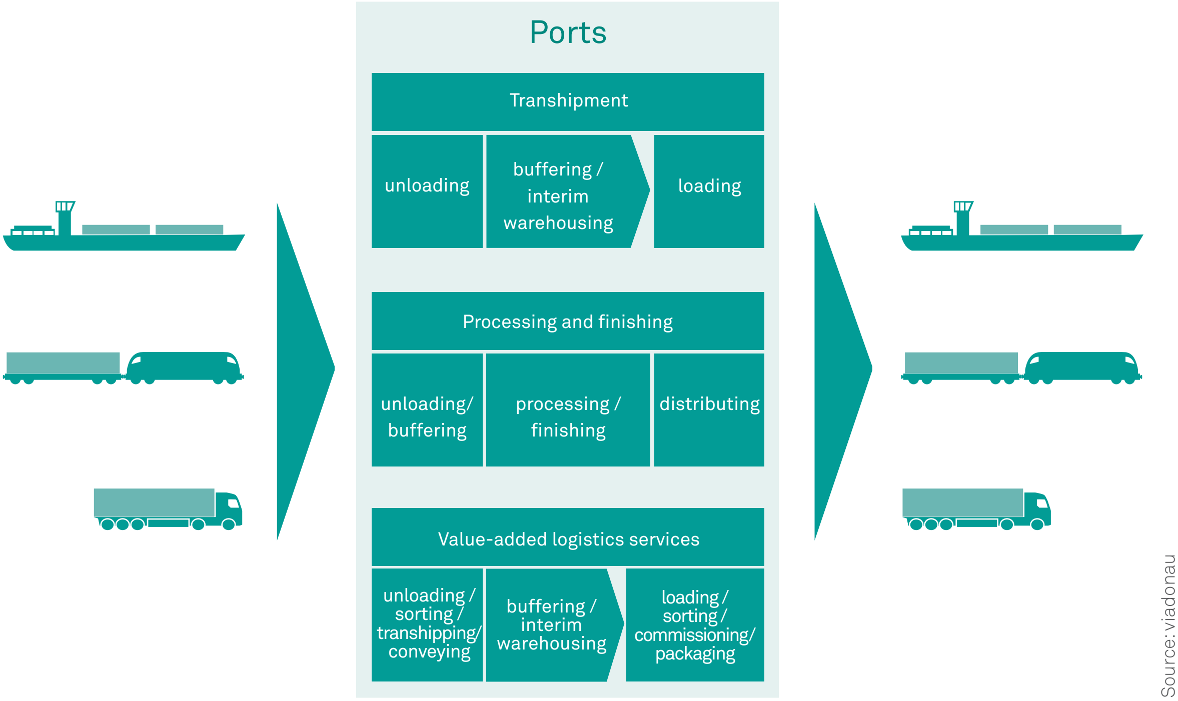
Ports as logistics service providers

Functions and performance of a port

Ports connect the transport modes of road, rail and waterway and are important service providers in the fields of **transhipment**, **storage** and **logistics**.

In addition to their basic functions of **transhipment** and **storage** of goods, they also often perform a variety of value-added logistics services to customers, such as **packaging**, container **stuffing and stripping**, **sanitation** and **quality checks**. This enhances ports as logistics platforms and impetus sources for locating companies and boosting the economy. As multimodal logistical hubs, they act as nodal points between the various transport modes.

Moreover, ports are points of entry into the European Union for goods that do not originate within the Union. Therefore, inland ports are often locations at which the customs clearance of imported goods is performed and customs duties and import turnover tax is collected.



The inland port as a multimodal logistics node

The total throughput for all modes of transport is an important indicator of the **performance** of a port. A port not only handles transhipments between waterway, road and rail, but also between non-waterbound modes such as rail-rail or road-rail.

Basic structure of a port

Every port is structured into three main areas:

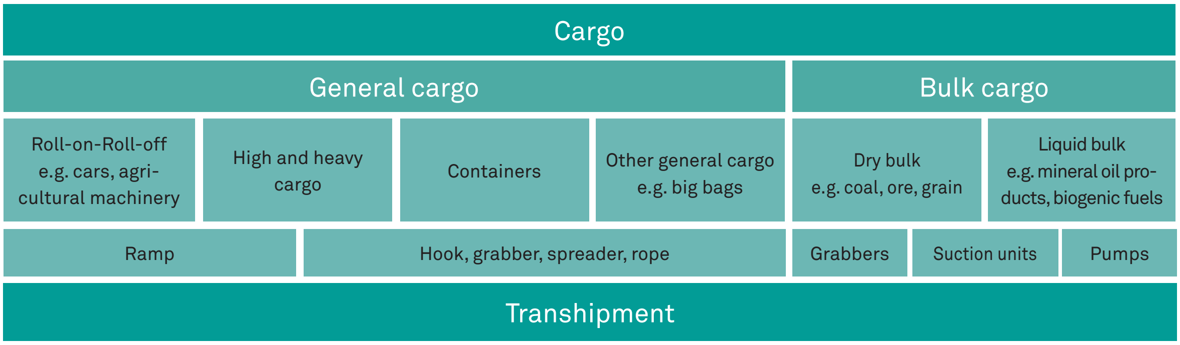
- Water-side area
- Port area
- Hinterland

The **water-side area** of a port is formed by a port basin and quay walls. The lengths of the quays in the port basin are divided up into multiple berths. A berth corresponds approximately to the length of an inland vessel, which is around 100 to 130 metres.

The handling area directly behind the quay walls is part of the **port area**. Cranes, crane tracks and quay tracks are located in this area. The adjacent areas are used as transhipment areas for indirect transhipment (e.g. containers from vessels will be provisionally unloaded onto the quay and later brought to the container depot). Besides areas used for industrial settlements, the port area also consists of areas for logistics service providers who provide transhipment services to third parties as well.

Transhipment according to cargo types

A number of different **goods classifications** are used in the transport industry. These classifications are frequently based on sectors and branches, the processing stage of the goods or their aggregate state. The two-dimensional goods classification system chosen for the following illustration depicts the transhipment methods and the classification of the cargo, whereby a distinction is made between **general cargo** and **bulk cargo**.



Source: viadonau

Transhipment by type of cargo

Performance of port transhipment equipment

The **performance** of port transhipment equipment is defined by the maximum lifting capacity as well as the hourly and/or daily output of each individual crane. Modern gantry cranes or mobile cranes can accommodate 30 tons with 20 metre outreach and thereby efficiently tranship full containers or heavy steel coils from vessel to quay or from truck to railway wagon.

With **Lift-on-Lift-off transhipment** (Lo-Lo) by cranes, the hourly output is estimated according to the number of crane cycles per hour, the capacity of the grabbers used (in inland ports usually between 2 and 15 m^3) and the specific weight of the goods handled. In specialised inland ports, up to 800 tons per hour of ore can be transhipped. The daily performance of a port determines the time that a vessel spends at a port, and therefore influences the total cost of inland vessel transport.

	Luffing and slewing crane up to 15 tons	Luffing and slewing crane up to 30 tons	Gantry crane (bridge) up to 40 tons
Grabber operations	120 tons/h	160 tons/h	200 tons/h
Hook operations	80 tons/h	100 tons/h	120 tons/h
Spreader		15 containers/h	25 containers/h

Source: viadonau

Performance of port transhipment equipment

Storage

Extended warehouse services are becoming increasingly important due to the modernisation of commercial logistics, for example as **distribution warehouses** offering more added value thanks to supplementary services (value added services) such as commissioning.

An important function of a warehouse is to serve as a buffer, which means the **collection and distribution of flows of goods**. This is especially important when using different transport modes, since the capacity differs according to the means of transport being chosen.

Based on the different characteristics of the transported goods, a port must offer many **different types of storage facilities** in order to prevent damage to cargo. Depending on the intended purpose, there are three different kinds of warehouses: storage warehouses, transhipment warehouses and distribution warehouses. With regards to their **design**, there are open storage facilities, covered storage facilities and special-purpose storage facilities.

Types of storage facilities			
Design	**open**	**covered**	**special**
Examples	Outside storage at the port, container storage	Long cargo warehouses, general cargo warehouses	Grain silo, tank storage, hazardous goods storage, reefer storage
Cargo	Coal, ore, containers, gravel etc.	General cargo on pallets, goods packed in boxes	Grain, soya, petrol, oil, natural gas, chemicals etc.

Source: viadonau

Overview of storage types

Open storage

Source: viadonau

Open storage

This is the place where non-sensitive goods are stored, for instance ore. These goods have a comparatively low value and are not affected by rain or fluctuation of air temperature. Likewise, full and empty containers can be stored in open storage facilities because they are usually closed.

Covered storage

In a covered storage facility, goods are partly protected from adverse weather conditions and high value goods can be stored safely. In general, a covered storage facility is a storage area covered with a roof and located in a hall respectively.


Source: viadonau

Covered storage

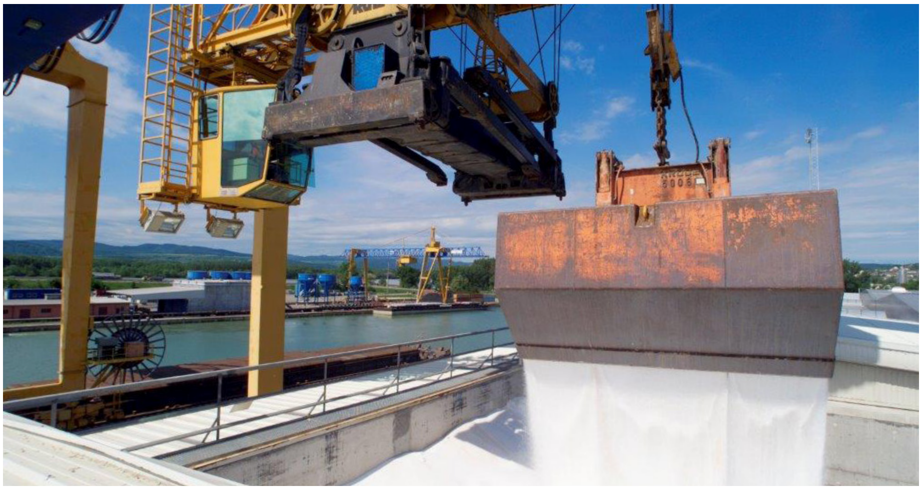
Special storage

Special depots can be silos, tanks, bulk goods storage facilities, refrigerated storage or freezer storage.

Agricultural bulk goods such as grain, soya and corn are stored in **silo installations.** Such facilities allow the storage of seasonal goods over longer periods of time, while guaranteeing storage and treatment such as dehumidification without loss of quality to the product. Goods in silos can be used continuously or transhipped onwards to other modes of transport. **Storage tanks** are used for the storage of liquid cargo and basically function in the same way as silo installations.

Some ports on the Danube have modern **storage facilities and boxes for bulk cargo** at their disposal. These boxes have a special roof construction with a wide opening, enabling the cargo to be unloaded directly from the vessel to the storage facility by crane. The goods are delivered as an entire vessel's load and transhipped directly into the boxes using gantry cranes with grabbers. Each box contains one type of raw material, ensuring that many different kinds of cargo can be stored, thus expanding the services provided by the ports.

Detailed data on transhipment and storage capacities available in the Danube ports is available at: www.danube-logistics.info/danube-ports



Source: Rhens Donauhafen Krems

Bulk goods storage

Value-added logistics services

Ports have become increasingly multifunctional service providers over the last few decades. In addition to basic services such as transhipment and storage, ports offer an extensive range of **logistics services** such as the packing, stuffing and stripping of containers, commissioning, distribution (pre- and end- haulage) or project logistics.

As **locations for commerce and industry** as well as **cargo handling and distribution centres**, ports contribute significantly to the creation of added value and employment. Due to the specialisation of comprehensive logistical concepts and services, ports have extended their range with value-added services in the logistics fields of containers, Ro-Ro and heavy cargo.

Austria's foreign trade links with the Black Sea region

Among the Black Sea riparian states, the Russian Federation is by far the most important trade partner for Austria. No clearly assignable data material is available for the region of Krasnodar bordering the Black Sea, so Russia was consciously omitted from the diagram in order to preserve the regional focus.

Despite fluctuating trade volumes, Ukraine is still one of Austria's most important trade partners in the Black Sea region, accounting for 3.9 million tons in 2018. Romania comes second with approximately 1.8 million tons, and trade volumes with Turkey, as the third most important partner, have risen steadily since 2006 (2018: 1.1 million tons).

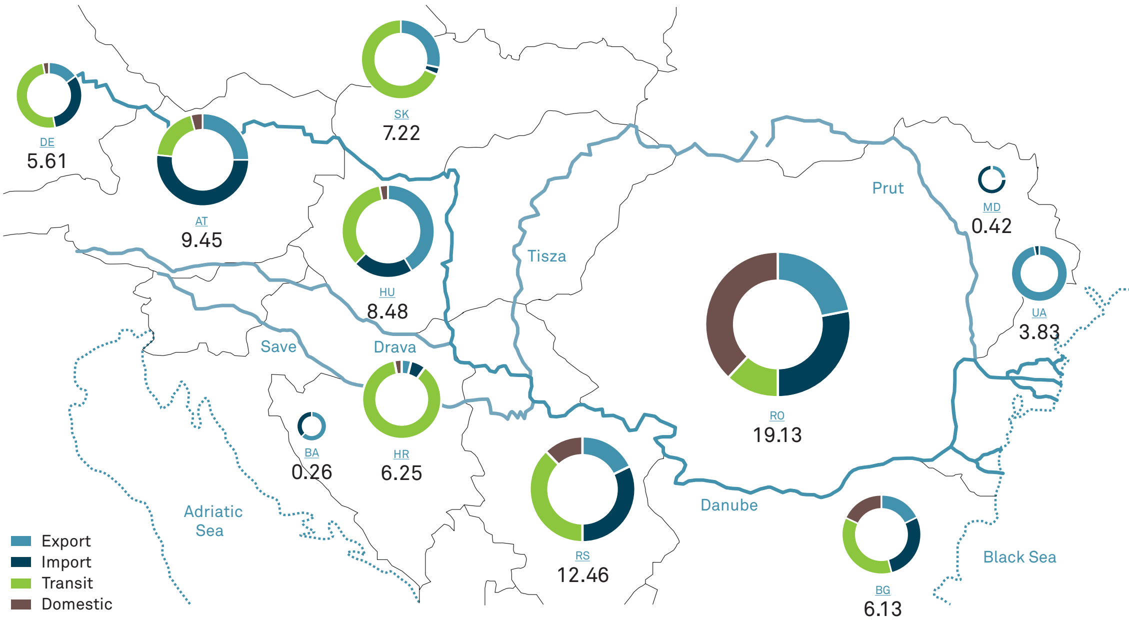
Processed goods (especially for Romania and Turkey), as well as chemical products and raw materials (for Romania) are Austria's principal **export** categories. Raw materials (mainly ores and steel from Ukraine), fuels (from Azerbaijan) and foods (from Romania) are the main categories on the **import** side.

Transport volume

The latest figures available for the overall volume of goods transported on inland waterways within the Danube region date from the year 2017 (viadonau, 2019). This data provides a good overview of the volumes transported, major transport relations and the importance of Danube navigation in the riparian states.

In total, **39.3 million tons of goods** were transported on the Danube waterway and its tributaries in the year 2017. These and all the following figures include both transport by inland vessels and river-sea transport on the maritime Danube (Sulina and Kilia arm) up to the Romanian port of Brăila (river-km 170) as well as goods transported on the Romanian Danube-Black Sea Canal.

By far the largest transport volume for 2017 was recorded by Romania with 19.1 million tons, followed by Serbia with 12.5 million tons and Austria with 9.5 million tons. Romania was the **biggest** Danube **exporter** in 2017. In total, Romania shipped 4.2 million tons of goods in this year. Of all the Danube riparian states, Romania also had **the biggest volume of imports** in the year 2017 – standing at 5.4 million tons. As far as **transit traffic** on the Danube was concerned, the largest transport volume of 5.7 million tons was registered in Croatia. Romania was again by far the most important country for **domestic transport**, with 7.3 million tons.



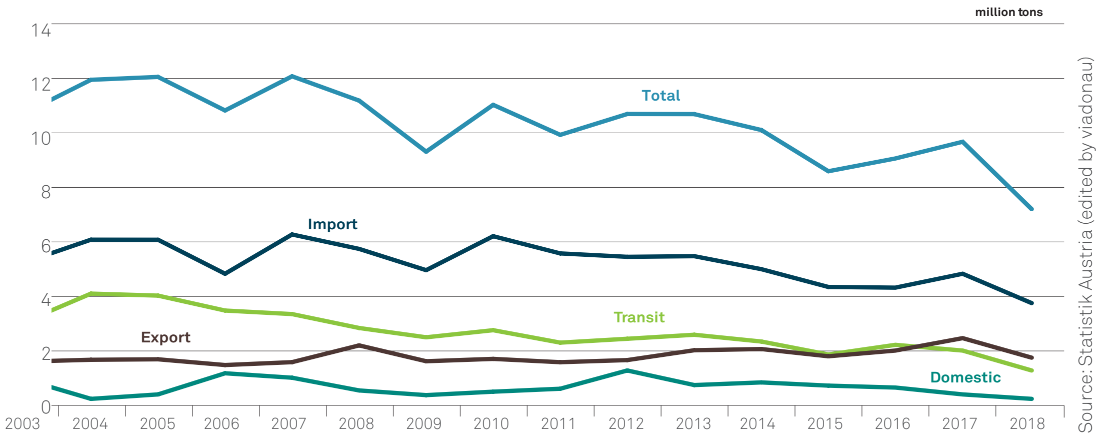
Million Tons	DE	AT	SK	HU	HR	BA	RS	RO	BG	MD	UA
Export	0.84	2.40	2.09	3.50	0.19	0.17	2.30	4.21	1.11	0.10	3.67
Import	1.81	4.82	0.10	1.81	0.33	0.09	3.96	5.40	1.73	0.32	0.15
Transit	2.78	1.84	5.01	2.92	5.67	0.00	4.76	2.20	2.20	0.00	0.00
Domestic	0.18	0.39	0.02	0.25	0.06	0.00	1.44	7.32	1.09	0.00	0.01
Total	5.61	9.45	7.22	8.48	6.25	0.26	12.46	19.13	6.13	0.42	3.83

Transport volume on the Danube and its navigable tributaries in 2017

Source: Eurostat, national transport statistics, viadonau (edited by viadonau)

Transport volumes in Austria

The following diagram visualises developments in goods transport on the Austrian section of the Danube in a long-term review. Besides the economic situation, low water periods especially have significantly affected traffic volumes on the Danube. These circumstances highlight the need for proactive transport policies to rectify the nautical issues along the Danube as quickly as possible and to introduce customer-oriented and proactive water management along the entire Danube based on the Austrian model. This is the only way to ensure an effective shift of transports towards Danube navigation.



Transport volume on the Austrian Danube 2003–2018

Dry bulk transports (coal, ore and corn) and **liquid bulk transports** (mainly petroleum) account for the largest share of goods transports. Industrial sectors in Austria that require high volumes of raw materials benefit in particular from this low-cost transport mode and its bulk freight capacity. For instance, most of the raw materials supplied to the voestalpine steel plant in Linz are carried by inland vessels.

The western section to the North Sea ports of Amsterdam, Rotterdam and Antwerp is predominantly used to transport **semi-finished and finished products**. Transits play an important role in the transport of **agricultural products** from Hungary, Bulgaria and Romania to Western Europe.

On the Austrian side, however, there are increasing volumes of **higher-quality general cargo** transports by inland vessel. Besides RoRo transports (e.g. new vehicles, as well as agricultural and construction machinery), the Danube is principally used to carry project cargo (heavy and oversized cargo such as transformers, turbines and generators).

Market characteristics

Liberalisation and deregulation of the transport markets have made great headway within the European Union. In the Danube region, however, the political and legal framework conditions remain relatively heterogeneous due to the recent, or rather not yet concluded, accession of individual Danube riparian states to the European Union. In this respect, **greater harmonisation** is expected over the coming years and this will favour the entry of additional buyers and sellers in the market and in turn promote the opening up of new transport potential.

To date, the largest portion of goods transported on the Danube waterway originate from a few **major cargo owners** who deal with only a relatively small number of service providers. The **large shipping companies** are, for the most part, derived from former state-owned enterprises mainly and provide cargo space for the transport of traditional bulk goods based on long-term open policies. Smaller shipping companies and **independent ship owners** (private vessel owner-operators) often have to be more flexible in finding cargoes and for the most part serve economic niches and short-term requirements for transport services.

Transport operations are carried out on the basis of a **freight contract** (or contract of carriage) which is concluded between the consignor and the freight carrier either directly or indirectly. In the case of direct conclusion, the contract is concluded directly between the cargo owner and the shipping company. In contrast, there is at least one other party involved who acts as an intermediary if a contract is concluded indirectly (e.g. a forwarder or freighting company). The freight contract is concluded consensually between the parties. There is no special form required (freedom from any formal requirements).

A consignment note that serves as documentation for the transport operation is drawn up for each individual freight order. A bill of lading often regulates the legal relationship between the freight carrier and the consignee in inland navigation. The bill of lading provides the consignee with evidence of the right to receive the consignment and obliges the freight carrier to hand over the goods only on submission of the bill of lading. This transport document is customary in inland navigation and constitutes a document of title, the submission of which leads to a transfer of ownership of the goods. In other words, the bill of lading functions as a certificate of receipt for the goods, as a carriage promise for the transport of the goods and a promise to hand over the goods to the legitimate owner of the bill.

The parties involved in the inland waterway transport market will be dealt with in detail in the following. The contract forms used for Danube navigation and the transport modes on which they are based are also described in this section.

Supply side of Danube navigation

Logistics providers on the Danube navigation market include primarily transport companies, companies acting as intermediaries (freighting companies, forwarders), as well as port and terminal operators.

Transport companies

Shipping companies are commercial ship transport companies that professionally organise and implement the transport of goods. They use their own vessels or those from other companies for this purpose. Several ships are operated in all cases. Shipping companies are distinguished by the fact that they prepare and direct transport from land (in contrast to independent ship owners who usually do not have such a 'land-based organisation').

In addition to such shipping companies, the independent ship owners (**private vessel owner-operators**) mentioned above are also active on the market. Most of these operate a single motor cargo vessel, some own up to three vessels. As a rule, independent ship owners also act as captains of their own ships and do not normally run any land-based commercial offices. In many cases they are organised into co-operatives.

Source: viadonau

Motor cargo vessel

Companies acting as intermediaries

Companies without their own fleet of vessels can also act as intermediaries for the provision of cargo space. In such cases, contracts of carriage are concluded directly.

In order to market their services, both shipping companies as well as independent ship owners often use ship brokers. The ship broker is the contract partner of the enterprise placing the order for transport and functions as a broker for rented cargo space. As a rule, the relationship between the owner of the vessel and the **ship broker** is regulated by means of a subcharter. In other words, the broker acts as both freight carrier and consignor.

Forwarders specialised in inland waterway transport or forwarders' specialised business units also play an important role in Danube navigation. Here, too, the freight contract is concluded indirectly: The forwarding company, in its function as a service provider, concludes a forwarding contract with the shipper. The forwarding contract differs from the freight contract in that it obliges to provide the transport of the goods. The shipping company or the independent ship owner is obliged to transport the cargo. A freight contract, which is concluded with a shipping company or an independent ship owner in the name of the forwarder, but at the cost of its customer, regulates the relationship between these two parties.

(Shipping) agencies mostly represent several shipping companies and carry out all the tasks of a commercial agent on another company's behalf but for their own account. These tasks include freight acquisition, preparation of documents, invoicing, collection of charges or complaints processing. Freight contracts are in turn concluded indirectly between agents and consignors.

Port and terminal operators

Ports and terminals can be operated privately or as public facilities. However, provision of the logistic services at one port or transhipment site often comprises of co-operation between private and public parties.

Further information on ports and terminals can be found in the chapter 'System elements of Danube navigation: Ports and terminals'

The transhipment and storage of goods are among the basic functions of ports and terminals. As a rule, ports also offer a whole series of logistical value added services for customers such as packing, stuffing and stripping of containers, sanitation and quality checks for customers and border checks at the outer borders of the Schengen Area (Croatia, Romania and Bulgaria are not yet members of the Schengen Area; Serbia, Moldova and Ukraine are not EU Members).

Transport companies operating on the Danube

The Blue Pages

'The Blue Pages' have been an indispensable source of information for cargo owners in the Danube region since 2009. The comprehensive directory of shipping companies and ship brokers operating on the Danube can be accessed in English at www.danube-logistics.info/the-blue-pages. Companies are invited to create a free business profile to field enquiries for transport services.

Danube Ports

'Danube Ports' provides information and data on more than 60 ports and terminals along the entire Danube. The online platform can be accessed at www.danube-logistics.info/danube-ports. Besides general information, the detailed port profiles include contact details of the port operator and administration, important data on the infra- and suprastructure, as well as on storage and transhipment facilities. The local terminal operators and their services are described as well.

Demand side of Danube navigation

The demand side of the inland waterway transport market firstly includes, for the most part, cargo owners, i.e. industrial companies that receive or convey goods. Secondly there are forwarders and logistics service providers operating in this field who carry out transport for third parties as well.

Traditional markets of Danube navigation

Due to the large volume of goods that can be transported on a vessel unit, inland navigation vessels are ideally suited to the transport of bulk cargo. If planned and carried out correctly, transport costs can be reduced in comparison to road and rail and this in turn compensates for longer transport times. The inland vessel is especially suitable for the transport of large quantities of cargo over long distances.

However, the system requires the availability of high-quality logistics services along the waterway (transhipment, storage, processing, collection and/or distribution). Many companies use Danube navigation as a fixed part of their logistics chain. Currently, the great bulk freight capacity of inland vessels is utilised predominantly by the metal industry, agriculture and forestry and the petroleum industry.

Inland navigation is a vital transport mode for the **steel industry**. Iron ore accounts for example for 25-30% of the total transport volume shipped on the Austrian stretch of the Danube. Due to their heavy weight, semi-finished and finished goods such as steel coils can also be transported economically using inland navigation.

The most important steel plant in Austria is voestalpine, which is headquartered in Linz. This company operates a private port on its own premises that has an annual waterside transhipment of 3-4 million tons. This is also Austria's most important port in that it has handled almost half of all waterside transhipment in Austria in recent years.

Source: viadonau

Transhipment of steel coils

Other major steel plants in the Danube region are located in Dunaújváros/Hungary (ISD Dunaferr Group), Smederevo/Serbia (HBIS Group) and Galaţi/Romania (Arcelor-Mittal).

The demand and, therefore, also the flow of goods from the **agriculture and forestry sector** can fluctuate greatly from one year to the next. Agriculture is dependent to a great extent on weather conditions (precipitation, temperature, days of sunshine per year). Crop failures in a region due to bad weather conditions can lead to a fluctuation in the volume of transported goods required to cover the needs of the affected region. Grain and oilseed are the main products transported on the Danube. Wood transports (for instance logs, pellets) vary greatly, depending on the regional raw material availability.

Agricultural and forestry products together account for around 20% of the total volume of goods transported annually on the Austrian stretch of the Danube. Many Austrian companies trading in agricultural products or involved in the processing of such goods (i.e. starch, foodstuffs and animal fodder, biogenic fuel) have settled directly on the waterway. Many companies have already established factory transhipment sites or have settled in a port where they operate their silos or processing facilities. This enables transport on inland vessels with no pre- or end-haulage, thereby enabling companies to benefit from particularly low transport costs.

Source: Voies navigables de France

Transhipment of agricultural goods

Petroleum products from the **mineral oil industry** account for a large share of total transport volumes on the Austrian stretch of the Danube and therefore constitute a key market. In the Danube region there are many refineries located either on or near the waterway.

Due to their great bulk freight capacity, low transport costs and high level of safety, inland vessels are absolutely ideal as a significant means of transport for petroleum products in addition to pipelines. The fuel tanks of around 20,000 cars can be filled up with the cargo of a single tanker. As a transport axis, the Danube waterway therefore makes an important contribution to the security of supply in the region.

Petroleum products and their derivatives are classed as hazardous goods and for this reason are transported in special vessel units equipped with the respective safety equipment. European regulations and national hazardous goods legislation have particular relevance for tanker shipping.

Other branch-specific potential for Danube navigation

In addition to traditional bulk cargo transport, there are numerous sectors involved in the transport of high-value goods, which, due to their specific requirements, represent a great challenge but at the same time a substantial potential for the development of logistics services along the waterway.

Due to their size and/or their weight, as well as the available infrastructure, inland vessels are ideally suited for special transport such as **heavy goods or oversized cargo** (high & heavy), e.g. construction machinery, generators, turbines or wind power plants. The greatest advantages here compared to conventional road transport are that no special authorisations or modifications are needed along the route, e.g. the dismantling of traffic lights and traffic signs or protective covers for plants. In addition, charges such as toll or axle load taxes are not levied on international waterways like the Danube. Another benefit is the fact that there is no inconvenience to the general public due to street closures, restrictions on overtaking or noise when such goods are transported by inland vessel.

Source: viadonau

High & heavy transport by inland vessels

The increasing scarcity of non-renewable raw materials and the requirements introduced by the European Commission to increase the proportion of final energy consumption through renewable energies necessitate innovative logistics solutions for the inclusion of **renewable resources**.

Today already, the Danube is a logistics axis of pan-European significance for the bundling, storage and processing of renewable raw materials (for instance grain, oilseed and timber). Cultivation areas for renewables are readily available along the entire course of the river. Numerous companies from the biomass sector – producers, traders, processors and consumers – are located close to the Danube and represent an immense potential for inland navigation. In addition, there is a large number of Danube ports with efficient equipment for the transhipment and storage of renewable resources existing already.

Source: viadonau

Storage of rapeseed

The recycling sector is also becoming an increasingly important economic factor for Danube logistics due to the progressive, global scarcity of resources and the simultaneous, immense demand for secondary raw materials. Cost-efficient planning and execution of transports are essential factors due to the high price sensitivity associated with **recycling products**. With its capacity to handle bulk transports and the consequent low of cost of transport itself, inland navigation is a useful transport solution for the recycling sector. This is among the most important arguments for transport by inland navigation, combined with the significant prevalence of recycling products in the Danube riparian states. The major urban areas located directly on the Danube (e.g. Vienna, Bratislava, Budapest and Belgrade) are reliable suppliers of secondary raw materials. Moreover, the Danube region is home to numerous companies that process recycling products and that would be able to integrate inland navigation as a crucial link in their logistics chains.

Old metals and scrap, old glass and old plastics are particularly suitable for transport as bulk or general cargo on inland vessels.


Source: viadonau

Scrap metal warehouses close to the Danube

The **construction materials sector** is also a promising industry for Danube transports: The transport of mineral raw materials, as well as products and semi-finished products that are used in the building industry, has particularly significant potential for relocation to the waterways. Numerous infrastructure projects along the Danube corridor present an opportunity for inland navigation as well. Included in this category are bridge building and roadworks projects in Austria, Hungary, Bulgaria and Romania. Other ventures with relevance for Danube logistics are railway and port infrastructure projects along the Middle and Lower Danube.

Inland vessels can be used for (dry) bulk cargo, general cargo (for instance concrete components) and for rolling cargo (e.g. construction machinery and cranes).


Source: viadonau

Transport of construction materials by inland vessel

The **chemical and petrochemical industry** is another important sector for shipping.

Large quantities of fertilisers in particular are currently being transported on the Danube. They account for approximately 10% of the total transport volume on the Austrian stretch of the Danube.

Plants from the petrochemical industry are often found in the immediate vicinity of refineries; these plants manufacture plastics and other oil-based products from the oil derivatives. Due to its great bulk freight capacity Danube navigation is also the ideal solution for this market segment. The development of cost-efficient concepts for pre- and end-haulage as well as the establishment of warehouse space for bulk cargo are auspicious opportunities to improve the integration of inland navigation within the logistics chains of the chemical industry along the entire transport corridor.

Source: viadonau

Storage of chemical products

Types of contract and transport solutions

Transport companies offer cargo space either in its entirety (full load) or as part of the available cargo hold (part load). However, the freight contract concluded with the client can also apply to the transport of individual 'packages'. This is known as general cargo transport. The transport of heavy and oversized goods (project cargo) differs from traditional shipping of general cargo primarily due to the need for special vessel and transhipment equipment and long-term transport planning.

Conventional bulk cargo transport on the Danube usually takes the form of **contract trips**, meaning several trips on the basis of a contract for a specific period of time. Contract trips are often agreed for a longer period in the form of an annual contract. This type of transport has the following characteristics:

- An agreed annual total quantity, whereby the time of the transport operations involved as well as the size of the part deliveries is not specified (this allows for the prevention of goods being transported during low-water periods)
- Transport of full loads by motor cargo vessels or pushed convoys
- More generous timeframes regarding arrivals and departures
- Transport of the goods between one port of loading and one port of discharge
- Involvement of just one consignor and one consignee

In addition to contract trips, ship transports are also carried out on the spot market, which means on the basis of a freight contract that is concluded for individual trips or ship loads according to the current market prices.
Spot transport has the following characteristics:

- Conclusion of a freight contract (contract of carriage) applicable to a full, part or package good load
- Specification of fixed delivery times (in part involving contractually agreed payment of penalties)
- Fiercer competition before conclusion of the contract, because several quotes from different transport companies are generally obtained at short notice
- Regular involvement of several actors (for instance forwarders, agencies)

Decreasing shipment sizes and an increasing number of suppliers and customers means that a high degree of punctuality and reliability with regard to departure and arrival times is expected. **Multimodal liner services** offer a solution in this case. Like passenger ships or regular-service buses, the cargo vessels of a liner service travel according to a fixed timetable to specific ports in which the cargo is generally transhipped for further transport by truck or rail. The flexibility in the formation of pushed convoys enables the simultaneous transport of different types of goods (for instance rolling goods, containers or bulk cargo) and helps to counterbalance disparity of traffic, i.e. different transport volumes on the route travelled.

Liner services on a waterway are distinguished by the following features:

- Agreed departure and arrival times according to a fixed timetable
- Accessibility of the services for all players in the market
- Possibility of shipping part loads (for instance 10 containers)
- Concept for adhering to the timetables even in the event of nautical restraints (replacement services by rail or road could be necessary)

Business management and legal aspects

Cargo owners and logistics service providers always select the mode of transport based on the **price-performance ratio** for each individual consignment. Planning ability, reliability, transport duration and the handling of transport damage are regarded as the primary components of such performance. This section provides an overview of the individual parts of the **transport cost calculation** for the inland vessel.

In addition, a detailed description of the most important legal regulations pertaining to inland waterway transport is also provided. It is intended to offer a brief overview of the latest legal framework conditions applicable for Danube navigation.

Basic principles of an inland navigation calculation

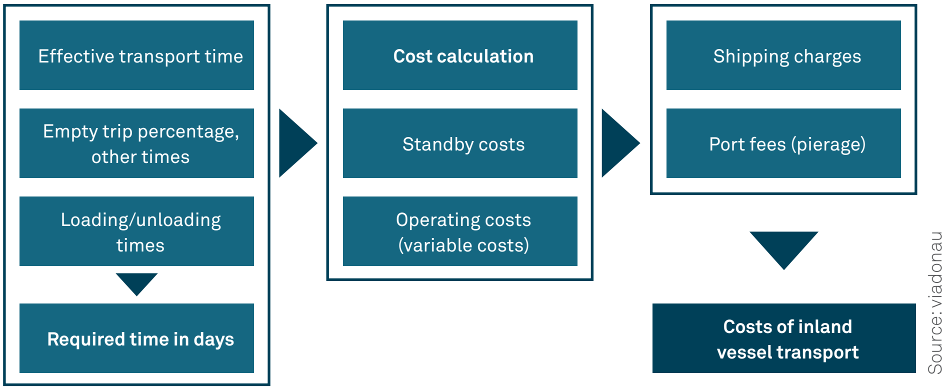
A difference is generally made between two types of costs for a transport by inland vessel, depending on whether the costs are fixed or variable: **Standby costs** and **operating costs**. Both cost types are dependent to a large extent on individual factors and framework conditions such as the bunker costs or maximum draught loaded, and therefore need to be calculated, as far as possible, on the basis of current values. The composition of the fleet and the underlying organisation also play a key role here.

The chart on the following page illustrates the cost structure of an inland waterway transport from the port of departure to the port of discharge excluding the costs for transhipment, pre- and end-haulage.

As limiting factors, both the draught loaded and the maximum available cargo space volume play a key role when planning a transport.

Where inland waterway cargo transport is concerned, the available fairway depth and, therefore, the **possible draught loaded** of a cargo vessel is a decisive economic criterion in shipping operations. A fairway depth of 10 cm, for example, corresponds to a load of between 50 and 120 tons, depending on the size of the cargo vessel used. Higher draughts loaded, and therefore better load factors of the vessels used, reduce transport costs per ton drastically. Therefore, the continuous availability of suitable fairway depths is a crucial criterion for the competitiveness of inland navigation. The critical points are not reached until after 5 to 10 days on the long-distance transports. As it is difficult to predict water levels, the possible draught loaded during loading (departure) of the vessel cannot be determined exactly and a safety margin is therefore usually necessary. The safety margin is based on the empirical values of the shipping company.

In addition to the currently possible immersion depth, the shipping company must also determine whether the **maximum available cargo hold volume** is sufficient to take the planned size of the cargo. The specific weight of the cargo indicates the ratio of the weight force to volumes and therefore also the utilisation of the available space in the cargo hold.



Schematic overview of the cost calculation

Calculation of transport times

The **effective transport time** is determined by the speed of the vessel, the flow velocity of the body of water as well as the number of locks and time spent for lockage. Lockage from Vienna westwards generally takes approximately 40 minutes or approximately 1.5 hours travelling eastwards downstream from Vienna.

The following **table of travel times**, which takes the Austrian Danube port of Linz as the start and end point, has been calculated for typical types of vessel or convoy using the travel times for the most important routes in the Danube Corridor. They include times for lockage but exclude intermediate stops at ports, delays caused by unfavourable nautical conditions and waiting times at borders. The mode of operation for all types of vessel and convoy is considered as continuous navigation for 24 hours per day with the exception of the 1,350 ton motor cargo vessel, which is usually operated for 14 hours a day.

Empty trips occur primarily due to disparate traffic, i.e. transport of goods that takes place in only one direction – upstream or downstream. But they may also be caused by different transport flows between two regions. Another key reason for empty trips is the fact that the loading and unloading ports for subsequent transports are often far apart. Empty trips can vary according to the different sections of the route or the different companies and are incorporated into the transport time as surcharge rates.

Other unproductive times occur due to unplanned waiting caused by lightering (in other words when the cargo of a ship has to be divided among several vessels due to shallow water) or due to blockages of navigation in the case of ice or high water levels.

Loading and unloading times vary greatly from one case to another. They depend on the transhipment facilities and their availability at the respective ports.

Travel time in hours							Travel time in hours			
4-unit pushed convoy	2-unit pushed convoy	MCV 2,000 tons	MCV 1,350 tons	Distance in km	Port	Number of locks	MCV 1,350 tons	MCV 2,000 tons	2-unit pushed convoy	4-unit pushed convoy
	174	161	172	1,454	Ghent	62	159	149	165	
	170	157	168	1,419	Antwerp	61	155	145	161	
	163	151	160	1,325	Amsterdam	61	149	140	154	
	163	151	161	1,336	Rotterdam	58	147	138	152	
	145	135	142	1,119	Duisburg	58	135	127	141	
	119	113	113	835	Mainz	58	119	111	125	
	115	109	109	808	Frankfurt	56	116	108	122	
	43	41	41	380	Nuremberg	17	55	47	55	
	26	25	25	280	Kelheim	8	39	31	39	
	23	22	22	242	Regensburg	6	33	26	34	
	14	13	13	153	Deggendorf	4	21	17	21	
				0	**Linz**	0				
2	2	2	2	19	Enns	1	3	2	3	3
7	6	6	6	73	Ybbs	3	10	8	10	11
13	10	10	10	133	Krems	4	17	14	17	19
20	17	17	17	211	Vienna	7	27	22	27	30
26	22	22	22	263	Bratislava	7	36	30	37	41
42	37	37	37	491	Budapest	8	60	51	61	70
51	45	45	45	652	Baja	8	75	63	76	88
61	54	54	54	798	Vukovar	8	90	76	91	106
67	60	60	60	878	Novi Sad	8	99	85	100	117
73	65	65	65	978	Belgrade	8	109	93	110	128
98	88	88	88	1,340	Vidin	10	142	120	140	164
115	103	103	103	1,639	Giurgiu	10	167	140	163	191
135	121	121	121	2,007	Reni	10	197	164	192	224
142	128	128	128	2,131	Sulina	10	208	173	201	236
133	120	119	120	1,891	Constanța	12	190	159	185	216
139	125	125	125	2,074	Izmail	10	203	169	197	231
141	127	127	127	2,120	Kiliya	10	207	172	200	235

Source: viadonau

Table of travel times from/to Linz (MCV = motor cargo vessel)

Cost categories

The following **ship parameters** should be taken into account and calculated on the basis of current values when working out the cost of a ship transport:

- Size and capacity of the vessel, as well as draught and possible draught loaded
- Age and condition of the ship to be used
- Flag under which the ship is registered
- Operator structure (independent ship owner, shipping company)
- Mode of operation (operating time 14, 18 or 24 hours a day)
- Crew (number, qualification, type of contract)

Other calculations of the estimated travel time between two selected ports on the Rhine-Main-Danube-axis can be made using the Travel Time Calculator at: www.danube-logistics.info/travel-time-calculator

Standby costs are the costs for maintaining a vessel ready for use, not taking operating costs into account and that fall due even while the vessel is stationary. These include, for example, crew wages, maintenance and repairs, amortisation of the vessel or interest and insurance.

Operating costs are costs incurred during operation of the vessel, i.e. dependent on the number of kilometres or hours travelled. These include, for example, bunker and lubricant costs, commission for brokering the contract or dues and fees.

Inland vessels are normally driven by combustion engines and use gasoil as fuel. **Average fuel consumption** is dependent on three factors: the utilisation of the vessel (due to loading limitations), the parity of traffic (empty trips) and the prevailing fairway depths (shallow water resistance).

Nautical conditions (impounded sections, free-flowing sections, characteristic current velocities) also have an impact on fuel consumption in each individual case. Fuel prices are linked to the price of oil and can therefore fluctuate considerably.

As the section of the Danube from Kelheim to Sulina is defined as an international waterway, in compliance with the 'Convention Regarding the Regime of Navigation on the Danube' dated 18 August 1948 (Belgrade Convention), and can therefore be used free of charge by navigation, it is not subject to any **navigation dues**. The 63-km Sulina Canal used almost exclusively by sea-river or seagoing vessels is an exception. The Romanian River Administration of the Lower Danube charges dues calculated per ton deadweight of a vessel for maintenance purposes.

The authorities charge dues for infrastructure maintenance on national waterways that do not fall under the Belgrade Convention. This applies to the Ukrainian Bystroe arm (maritime stretch of the Danube) and to the Romanian Danube-Black Sea Canal (links the Danube to the Black Sea and the seaport of Constanța at Cernavodă).

More information concerning the Danube Commission and the Belgrade Convention can be found in the chapter 'Objectives and strategies'.

Port fees are charged for the use of the port basin and also frequently for waste disposal, power connections or drinking water supply, and are calculated according to the volume of transhipped cargo.

Operative cost management

Full-costing systems for calculating the daily rates for keeping a vehicle on standby are traditionally widespread in inland navigation. This entails registering and adding up of all periodic individual and overhead costs – e.g. costs for the crew, amortisation and insurance – and dividing the total by the number of operating days in the given period. Costs calculated in this way are called daily standby costs and are average values or **fixed costs** incurred independent of the contract.

In addition, operating costs per travelled hour are charged for specific routes and types of vessel. These are **variable costs** that can be added to each individual contract.

Variable vessel costs include:

- Fuel and lubricant costs
- Costs for non-permanently employed crew members, e.g. temporary workers
- Route-dependent costs, e.g. costs for pilots
- Commissions for brokering the contract
- Charges, e.g. shipping tolls or port fees
- Costs for cleaning the vessel

A contract is not accepted on principle unless the standby and operating costs, i.e. the fixed and variable costs, are covered and a profit over and above this amount can be generated.

If no such contract can be found for a vessel, a transport price can also be accepted if it is higher than the variable costs but lower than the fixed costs. This means that at least a sum can be achieved that will cover the fixed costs, which is known as the **contribution margin**. Any commercial activity will only increase losses if the transport price is lower than the variable costs.

Legal regulations and agreements

As the majority of transport on the Danube waterway involves cross-border transport, international agreements play a vital role in the structuring of concluded transport contracts and the contractual and liability aspects involved. The following section outlines in detail three international agreements that have a great impact on inland waterway transport.

The **Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway (CMNI)** is an international convention that harmonised the legal provisions governing contracts for the cross-border transport of cargo on inland waterways for the very first time. The convention was concluded on 22 June 2001 under the patronage of the Central Commission for the Navigation of the Rhine, the Danube Commission and the United Nations Economic Commission for Europe and came into force on 1 April 2005 (Central Commission for the Navigation of the Rhine et al., 2000). The convention applies to all contracts of carriage for transporting cargo

Introduction

This chapter was developed together with the LOGISTIKUM, the logistics research institution of the Upper Austrian University of Applied Sciences and is partially based on content from the Manual on Intermodal Transport (Gronalt et al., 2010), Intermodal Transport in Europe (Posset et al., 2014) and the Yearbook of Logistics research (Dörner et al., 2017).

A 2015 study by the European Commission predicts that cargo transport volumes in the 28 states of the European Union will rise by 1.6% each year between 2020 and 2030. The reasons for the predicted sharp rise in cargo transport volume lie with the **internationalisation of production activities** and the **high level of consumption** in Europe.

Production facilities will be moved to cheaper regions that will usually be located at some distance. In particular, this will affect the production of labour-intensive goods in low wage countries. Due to the fact that single product components have to be combined into one joint product, transport of the components to a suitable location is necessary. Another reason for an increase in traffic volume is the trend towards a **minimisation of warehousing** in order to cut costs. This requires just-in-time delivery and will lead to a reduction in delivery quantities. Warehousing usually takes place on route – motorways, for instance, are often called 'the Storehouse of Europe'.

In order to minimise the negative results of rising traffic volumes on society and the environment, a **shift towards more environmentally friendly transport modes** such as waterways and rail is absolutely necessary. This shift can reduce negative results such as noise or CO_2 emissions significantly. An improvement of the situation can be consequently achieved by multimodal transport solutions, i.e. the ideal combination of vessels, rail and trucks.

Source: Port of Linz

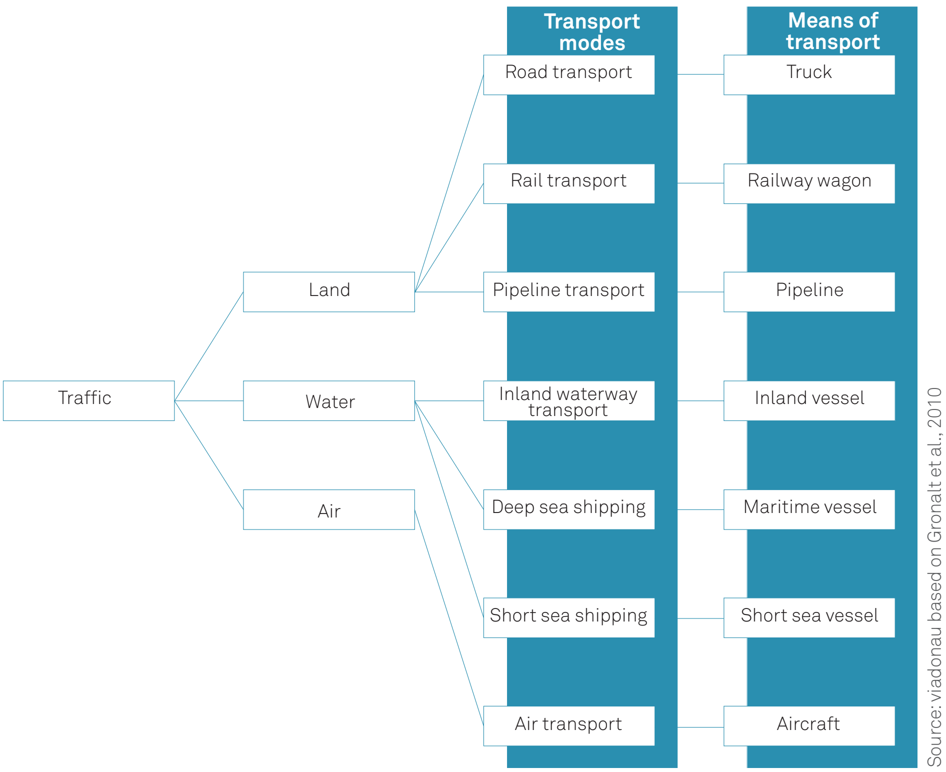
Transhipment in the Port of Linz

Terminology

Modes and means of transport

There are several transport modes and means of transport. A **transport mode** provides the necessary infrastructure for using a certain means of transport. Without this infrastructure, no transport would be possible. The transport modes are situated on land, on the water and in the air. Road, rail and pipeline transports are among the land-based transports. Inland waterway transport, deep sea and short sea shipping are among the modes of water transport. Air traffic accounts for transports by air.

Means of transport are technical facilities and equipment for the transport of people or goods. Means of transport in freight transport are, for example, inland vessels, trucks or aeroplanes. Due to the fact that transport cannot usually be handled using a single mode or means of transport (e.g. because of geographic conditions), varying forms of transport have been developed, which are described in the following.



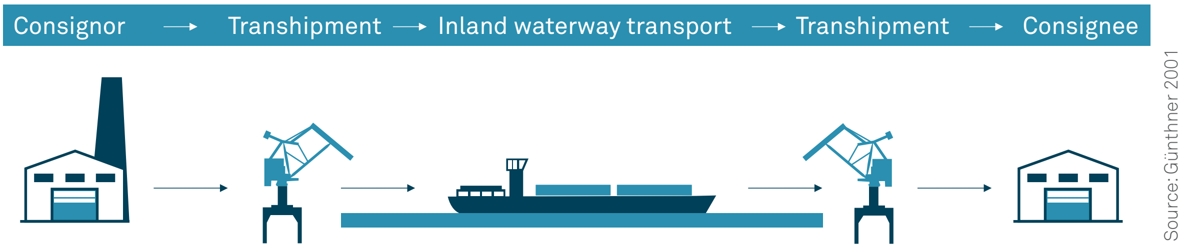
Overview of the transport modes and means of transport

Transport processes

Transport can be processed in several forms (e.g. either directly or by making use of several modes of transport) and it is therefore necessary to further specify these processes.

Transport processes can be initially classified into direct and non-direct transport. In the case of a **non-direct transport process**, goods are transhipped, whereas in **direct transport** no transhipment is needed.

In **direct transport** (single-stage transport chain), goods are transported directly from a point of departure to the destination. For this reason, it is also called door-to-door transport. In this case, the means of transport (e.g. vessel, truck or railway) is not changed and there is also no change of transport mode (e.g. rail or inland waterway). In short, direct transport can always be classified as **unimodal** (goods are transferred from the starting point to the end point by one means of transport). An example is port-port transport by inland vessel (e.g. transport of mineral oil from storage facility A to storage facility B).



Direct transport by inland vessel

Multimodal transport is characterised by the transport of goods using two or more different transport modes (e.g. change from waterway to rail). In order to change the means of transport, transhipment of the goods is required. In doing this, the strengths of the several individual transport modes can be used and the cheapest and most environmentally friendly combination can be chosen. Since each transhipment involves additional time and causes additional cost, multimodal transport is often used for long-distance transport where delivery time is not an important factor.

Multimodal transport by inland vessel

The first part in a transport chain is called **pre-haulage** and constitutes the delivery of a cargo to the first point of transhipment (such as a port). Pre-haulage is often carried out by trucks. Nevertheless, if companies have access to the railway network, they are also able to use the railway for pre-haulage.

Transhipment means the switching of the cargo or intermodal loading unit from one means of transport to another. A shift of transport modes, e.g. from road to inland waterway (multimodal transport) can also take place.

The term **main leg** describes the transport of goods or loading units from the consignor's transhipment point to the consignee's transhipment point. The word 'main' results from the fact that the longest part of the transport is performed between these points. Ships or rail are mostly used in this case.

End-haulage describes the delivery of the cargo from the consignee's point of transhipment to the consignee's location. Usually, end-haulage is carried out by trucks.

Pre- and end-haulage activities should be kept to a minimum, due to the fact that their costs are especially high. Additionally, handling during transhipment itself should be optimised as far as possible in order to save on time and costs.

Types of multimodal transport

Split transport

In split transport, two or more different means of transport or transport modes are used and the cargo itself is transhipped. This is the main difference compared to intermodal transport: in the latter case, it is not the cargo itself, but only the loading units (including cargo) that are transhipped.

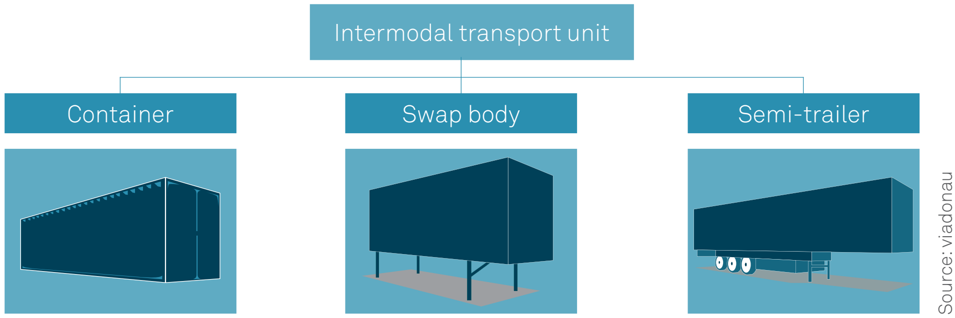
Based on the type of cargo, split transport can be distinguished into split bulk cargo transport and general cargo transport:

- **Split bulk cargo transport** is classified as the transport of fragmented, granular, powdery, liquid or gaseous unpacked goods. As bulk cargo cannot be transported individually, it is generally measured in units such as tons or litres. Grain, coal and ore are good examples of dry bulk, while oil products or bio diesel can be classified as liquid bulk.

- In contrast, **traditional general cargo** means the transport of distinguishable and individualised goods. The goods can be handled individually, whereby the inventories can be quantified in units such as pieces or packages (bales, pallets, boxes). In fact, everything which is transported as single units without special containers can be classified as general cargo. The transport of machinery, pallets or heavy and/or oversized cargo are good examples of general cargo.

Intermodal loading units

Each transhipment is associated with time and costs. This is why **standardised loading units** are used in intermodal transport during the transhipment process. Because of the standardisation of the loading units' size and the necessary equipment (spreaders), easier handling, better scheduling and higher exploitation of space (stackability of containers) can be achieved. Intermodal loading units – also: intermodal transport units (ITUs) – are transhipped between road, rail and waterway using specialised facilities.



Classification of intermodal loading units

Containers are standardised receptacles made of metal and available in different sizes and forms. Their main advantages are their extreme robustness and high stackability, resulting in optimum utilisation of space. In addition, the container protects its load from damage and to an extent from theft as well.

Containers can be classified into different types:

- **ISO containers** are the best-known and most frequently-used loading units. A basic distinction is made between 20-foot and 40-foot containers. They are used for road, rail and waterway transport. Unfortunately, they do not efficiently match the size of euro-pallets and are therefore mainly used for maritime or overseas transports in the international exchange of goods.

- **Continental containers** have been designed according to the UIC standard to fit the size of euro-pallets. As a result, these containers are usually used for continental intermodal transport in Europe.

- In general, containers are available in numerous **special forms**, e.g. containers for reefer cargo or liquid cargo.

An important international term for container transport is the **Twenty-foot Equivalent Unit** (TEU). This standardised unit is used to calculate a cargo vessel's maximum loading capacity (e.g. the number of 20-foot containers that fit onto a vessel). A 40-foot container is the precise equivalent of two TEUs.

Swap bodies (also known as swap trailers or swap containers), are trailers for trucks without a chassis and fully compatible with euro-pallets. The sizes of swap bodies are standardised in principle, although many companies use various company-specific lengths. Essentially, a distinction can be made between a box body (made of metal and wood) and a tarpaulin body (light-alloy frame with tarpaulin structure).
The main advantage of a swap body is its ability to stand freely using four foldable legs that enable easy loading and unloading. However, swap bodies are not often used for inland waterway transport because – unlike containers – they are difficult to stack.

Semi-trailers are non-motorised vehicles used for the carriage of goods intended to be coupled to an articulated vehicle. They can be divided into craneable and non-craneable models:

- **Craneable semi-trailers** are equipped with biting edges which enable them to be grabbed by a transhipment device (e.g. a crane or a reach stacker) for loading purposes. This means that they can be used in intermodal transport.

- In contrast, **non-craneable semi-trailers** cannot (or only by using special equipment) be lifted, as they do not have biting edges. As a result, an articulated vehicle is required to roll them onto an inland vessel ('floating road') or a special low-floor wagon ('rolling road').

Organisation of intermodal transport

As a rule, logistics service providers will organise and carry out intermodal transport, although the first stage may also involve the consignor's internal departments.

In practice, the planning and implementation of continental intermodal and combined transports are provided by a variety of actors in differing degrees. For instance, a freight forwarder may complete pre- and end-haulage on behalf of a major forwarding company, which also purchases other transport services directly from rail providers and inland navigation companies on behalf of its customers. The rail or inland waterway networks are used for the main leg of intermodal transports.

For decision guidance concerning the composition of combined transport chains please refer to the book 'Intermodaler Verkehr in Europa' (Posset et al., 2014)

Digitalisation in multimodal transport

New and innovative transport concepts are changing the way that logistics works and therefore how it is organised. The following section addresses current trends within logistics that are influencing multimodal transport.

Digitalisation is one trend that is affecting all areas of our lives and therefore logistics as well. Within logistics, digitalisation mainly enables **improvements** within traffic and transport management, for instance by ensuring an **improved flow of information on traffic and infrastructural conditions**, as well as on the **precise location of means of transport and goods**. Improved access to and the sharing of digital transport data along the supply chain enable an end-to-end flow of information.