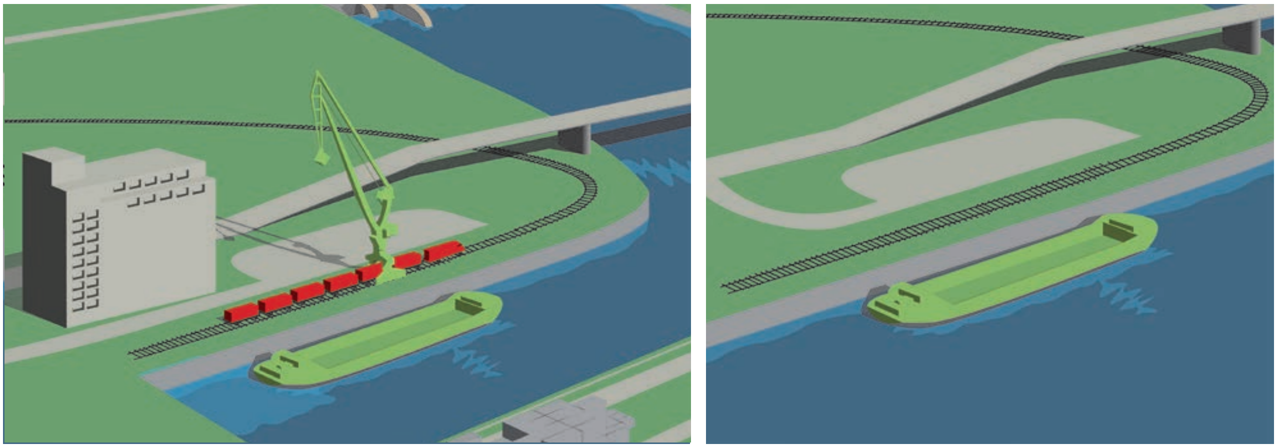
READER – PORTS AND INLAND VESSELS

Extract of relevant passages from the „Manual of Danube Navigation", via donau (2019) and of relevant passages from the "Annual Report of Danube Navigation", viadonau (2018).

Pictures: viadonau in Manual on Danube Navigation (2019), p. 79, 106

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.

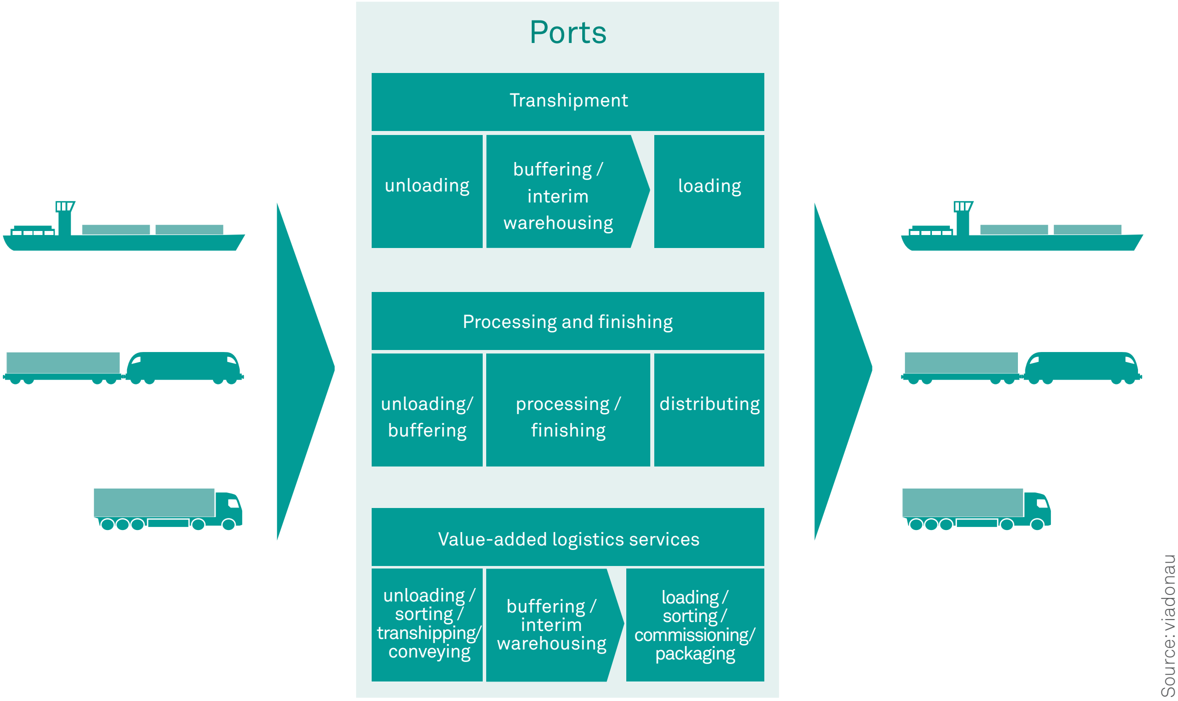
Ports as logistics service providers

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

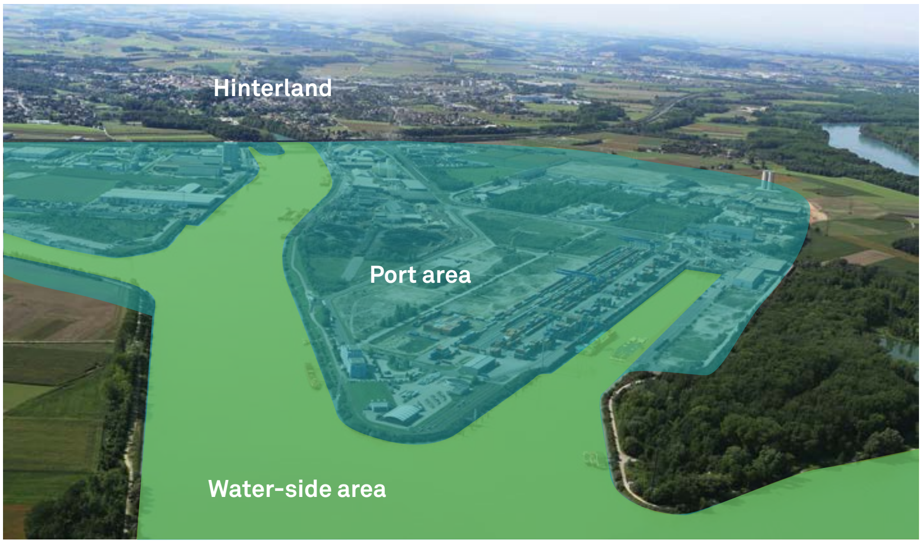
Every port is structured into three main areas:

- 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.

A port concentrates and distributes traffic flows from the **hinterland**, which is the catchment area of the port. The size of this catchment area depends on an economic distance which is not only defined by the geographic distance in kilometres, but also by transport costs and transport time.



Source: viadonau, EHG Ennshafen GmbH

Basic structure of a port

Types of ports

Sea-river ports such as the Danube port of Galaţi in Romania or the Rhine port of Duisburg in Germany can accommodate smaller sea vessels as well as inland vessels. However, **inland ports** can only accommodate inland vessels, due to shallower water depths.

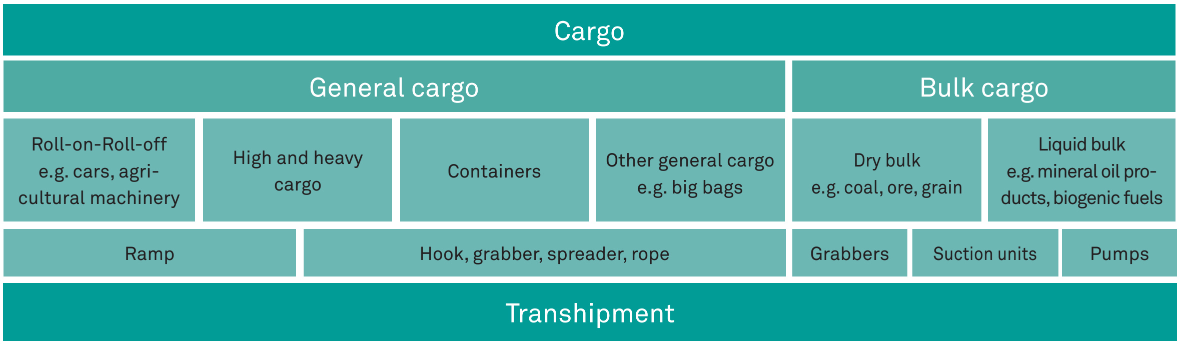
Ports that tranship various goods, such as general or bulk cargo, are called **multi-purpose ports**. If a port handles only one kind of cargo, such as mineral oil, the term **specialised port** is used.

Infrastructure and suprastructure

Ports have both an infrastructure and a suprastructure. The **port's infrastructure** is formed by quay walls, rail tracks and roads, as well as paved surfaces. **The port's suprastructure** is built on the infrastructure and includes cranes, warehouses and office buildings.

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**.



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

Cranes and ramps

Cranes are classified as gantry cranes, luffing and slewing cranes, mobile cranes or floating cranes. They can be distinguished by their features and hence with regard to their procurement and operating costs. The installation and acquisition of the cranes for specific terminals mainly depends on the types of goods being handled.

Source: Linz AG

Gantry crane at the Port of Linz

Gantry or portal cranes are mainly used for the transhipment of containers, although they can also handle cargo such as sheet metal and pipes. The capacity is approximately 25 containers per hour. A spreader – a special lifting unit – is used to achieve the full container transhipment performance.

A luffing and slewing crane is a multipurpose transhipment crane and is suited for transhipment of goods using hooks or grabbers. Procurement costs are significantly less than those of a gantry crane.

Source: viadonau

Luffing and slewing crane at the Port of Vienna

Mobile cranes can be used as primary equipment at a port and can also provide support for existing crane equipment.

Source: Ennshafen

Use of mobile crane at the Ennshafen

The transhipment of rolling cargo such as cars requires the ports to have **roll-on roll-off ramps** (Ro-Ro ramps). Numerous Danube ports are equipped with **Ro-Ro ramps**. A levelling ramp can be adapted to the respective water level with a cable winch and thereby provides optimal utilisation of the ramp. The angle of the ramp must not be too steep, especially during cargo handling of trucks, large agricultural machines or heavy cargo.

Source: Ennshafen

Ro-Ro transhipment

Loading hoppers

Loading hoppers are used for the transhipment of bulk cargo from an inland vessel to a railway wagon or to a truck. Due to the fact that an inland vessel can carry far larger amounts than a truck trailer or a rail wagon, a loading hopper is needed to accommodate different cycle times in the transhipment process. A crane loads the bulk cargo from the inland vessel from above into the hopper, while trucks or railway wagons located under the hopper are being filled at the same time. These loading hoppers can also be used as temporary storage facilities.

Source: Rhenus Donauhafen Krems

Loading hoppers at the Rhenus Donauhafen Krems

Suction and pumping equipment

Special suction and pumping equipment is needed for **transhipping liquid goods**. This equipment, so-called **fillers**, are connected to the tanker vessel using a swinging arm and the cargo is pumped directly into storage tanks or waiting railway wagons or trucks. Vice versa, tankers are filled from the warehouse. Since the majority of liquid goods are classified as dangerous goods, these transhipment facilities are subject to stringent safety standards.

Source: viadonau

Transhipment facility for liquid cargo at the Port of Vienna - Lobau

Floor-borne vehicles

Floor-borne vehicles are used for the horizontal transport of goods; they are mostly used internal at ground level.

Reach stackers are wheeled vehicles which can tranship containers using spreaders. These vehicles are predominantly used as a supplement to cranes or gantry cranes. Whereas a **forklift** can only hoist containers upwards in a vertical direction, a reach stacker can also move containers forward by using an extendable lifting arm. This allows for the vertical storage of containers in piles, which can reach a height of 4 to 6 containers.

In addition to reach stackers, **full and empty container forklifts** can be used for the horizontal manipulation of containers. When they are used for the efficient and safe transhipment of goods such as round timber, paper rolls or steel rolls, a special equipment, such as clamps or claws, is required.


Source: viadonau

Reach stacker at the Rhenus Donauhafen Krems

Covered transhipment

Transhipment of goods in a building that is **cantilevered** over the water and protected along the sides from the rain allows moisture-sensitive goods, such as salt, magnesite, grain or fertilisers, to be manoeuvred regardless of weather conditions. The construction of the roof above the inland vessels protects the cargo from moisture caused by precipitation (rain, hail, snow). Some ports have buildings that can hold the entire inland vessel like in a garage. The transhipment in such halls is carried out by overhead gantries, which span both the storage area and the transport vessel.


Source: Industrie-Logistik-Linz GmbH & Co KG

Covered, indoor transhipment at the facility of Industrie-Logistik-Linz GmbH

Transhipment of bulk cargo without grabbers

Bulk cargo such as soya meal, grain, cement and fertilizers are most frequently transhipped without cranes or grabbers, but by means of **pneumatic or mechanical equipment**. When using pneumatic systems such as suction or pumping devices, the bulk goods are transported via fixed pipes or flexible hose connections with high pressure or suction. Mechanical systems such as conveyor belts, elevators or screw conveyors are also used in a similar way. In the case that only the loading of inland vessels is necessary, simple methods of transhipment (such as tubes) are also often used.

Source: Garant-Tiernahrung Gesellschaft m.b.H.

Unloading a vessel in Aschach

Heavy cargo transhipment

Heavy cargo transhipment requires special port infrastructure and suprastructure such as paved surfaces which can withstand an elevated floor pressure and suitable transhipment equipment, such as heavy-duty cranes.

Source: Felbermayr Transport & Hebetechnik GmbH & Co KG

Felbermayr heavy load port in Linz

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

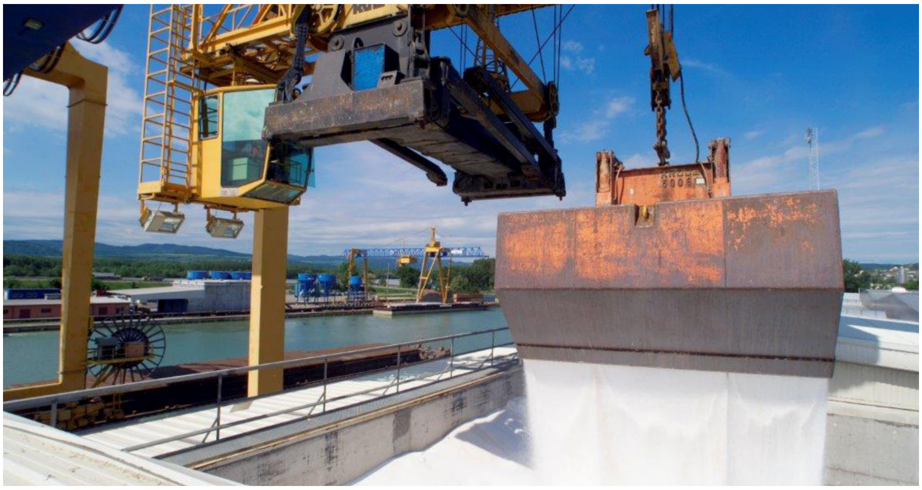
Special storage

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.

Source: Ennshafen

Water-side container transhipment

Management models

Owner-operator structure and type of service provision

The World Bank classifies ports into four categories (World Bank, 2007): public service ports, tool ports, landlord ports and private ports, i.e. private service ports. The differentiating factors include:

- Public, private and mixed provision of services
- Ownership of the infrastructure (including land and property)
- Ownership of suprastructure and equipment
- Status of port workers and management

Ports also differ depending on their type of service provision towards third parties. Public service ports are accessible to everyone. Semi-public ports do not manage transhipment on behalf of anyone. In private service ports, transhipment is generally not available to third parties.


Source: Hafen Straubing-Sand

Port of Straubing-Sand

While public service ports and tool ports focus mainly on the realisation of public interests, fully privatised ports serve private interests. Landlord ports have a mixed character aiming at a balance between public (port operators) and private (port companies) interests.

- **Public service ports**: In this model, the port authority provides all services relevant to the functioning of the port system. The port owns and operates all available fixed and mobile facilities and maintains them. Port transhipment is performed by personnel who are directly employed by the port authority. The main functions of a public service port include cargo transhipment activities.

- **Tool ports** are primarily of a public nature. In this model the port infrastructure and port suprastructure are owned by the port authorities. The authority is also responsible for their further development and maintenance. However, the port authority also provides land and suprastructure to private transhipment companies. These perform the transhipment by using their own staff.

- **Landlord ports**: The landlord model is predominant in large and medium-sized ports. While the port authority has the role of a public regulator and property owner ('landlord'), private companies carry out the port operation (especially cargo transhipment). The infrastructure is mainly leased by private companies such as refineries, tank terminals and chemical plants. Private transhipment companies provide the suprastructure including the buildings such as offices and storage and maintain them. Port personnel are employed either by private terminal operators or are also provided in some ports by a pool system.

- **Fully privatised ports** are found quite rarely along the Danube. The state does not intervene in the development or operation of the port. Public interest is only preserved at a higher level, such as building regulations or regional traffic planning. Land and property are both privately owned. The ports are self-regulating.

	Owner	Infrastructure	Suprastructure	Personnel
Public service port	Public	Public	Public	Public
Tool port	Public	Public	Public	Private
Landlord port	Public	Public	Private	Private
Private port	Private	Private	Private	Private

Source: World Bank 2007

Owner-operator structures of inland ports

The clear assignment of ports to one of the four models above is often difficult in practice, as numerous **mixed forms** exist. Nevertheless, the four criteria have proven effective as a means of assessing the owner-operator structure of a port and hence to acquire an overview of how its services are provided.

Management models of Austrian Danube ports

The table below classifies the four public ports along the Austrian Danube (Port of Linz, Ennshafen, Rhenus Donauhafen Krems, Port of Vienna) and the voestalpine industrial port in Linz based on their overarching functions.

Port of Linz	Ennshafen	Rhenus Donauhafen Krems	Port of Vienna	voestalpine industrial port
Public service port with subsidiary function as a landlord port	Mainly organised along the lines of a landlord port	Mainly organised along the lines of a tool port	Public service port with subsidiary function as a landlord port	Private service port / industrial port

Source: viadonau

Management models of Austrian Danube ports

Development trends

Specialisation of ports

The range of services offered at a port must be attractive to transhipment companies and logistics services providers. In addition to **multi-purpose ports, specialised ports** also exist which focus their business on a particular type of cargo. The specialisation of a port to specific transport sectors can lead to competitive advantages. The port may specialise in a specific type of cargo on the basis of greater demand for such goods and/or increased cargo volumes in the hinterland of the port. For this reason multiple specialised terminals may be found in a port.

A form of specialisation is, for example, the field of high & heavy cargo. Heavy cargo ports, which are specialised in over-sized cargo, require special technical equipment together with specialised logistics solutions. Approved lifting technology and equipment with high load capacity are the prerequisite of a heavy cargo port.

Example: Felbermayr heavy load port in Linz

The private service port run by Felbermayr Holding is specialised in the transhipment of heavy and oversized cargo (high & heavy). The industrial sector around Linz promises significant potential for the future development of this heavy load port. Pre-assembly facilities are located at the port and can be leased to customers. With this specialised focus, the port is an important addition to the logistics services along the Upper Danube. For a detailed description, refer to the Success Stories in the chapter 'Logistics solutions: The market for Danube navigation'.

Business clusters at the port

Ports can also pursue a development structure that is tailored to the local economy in order to create a unique selling proposition and hence utilise key competitive advantages. Added value can be created for all companies in the area (cluster formation) by establishing a network of cooperating businesses located close to the port. The location benefits and synergy that are produced in this way include reduced logistics costs, increased prestige, coordinated input and output streams and greater efficiency due to economies of scale.

Example: Focus on biomass at the port of Straubing-Sand

The port of Straubing-Sand has focused its strategic development on renewables and bio-economy. A large number of companies operating in this sector are located at the port. Dedicated cluster management helps to build networks between these companies and the research institutions in the direct vicinity of the port, as well as advertising the logistical benefits of the port location for the bio-economy. The targeted combination of different material and energetic applications for biomass makes a significant contribution to successful development of the port area and its consequent establishment as a sustainable industrial and logistics centre.

Green Ports

Green Ports, i.e. sustainable port management, is a trend which has become increasingly more predominant in the field of port development over the last few years. Green Ports aim to strike a balance between environmental impact and economic interests. Furthermore, national and regional political strategies are intended to lead to more sustainability in the field of port development. Together with the development of ports, the concept Green Ports also includes the total redesign of logistics chains.

Example: Shore-side electricity for inland vessels

Shore-side electricity facilities at the port allow vessels to source the power they need, even when their engines are switched off. Besides cutting fuel consumption, this leads to a reduction in pollutant, odour and noise emissions at the port. Efforts are therefore under way at European level to continue expanding the provision of shore-side electricity facilities.

Trend towards cooperation

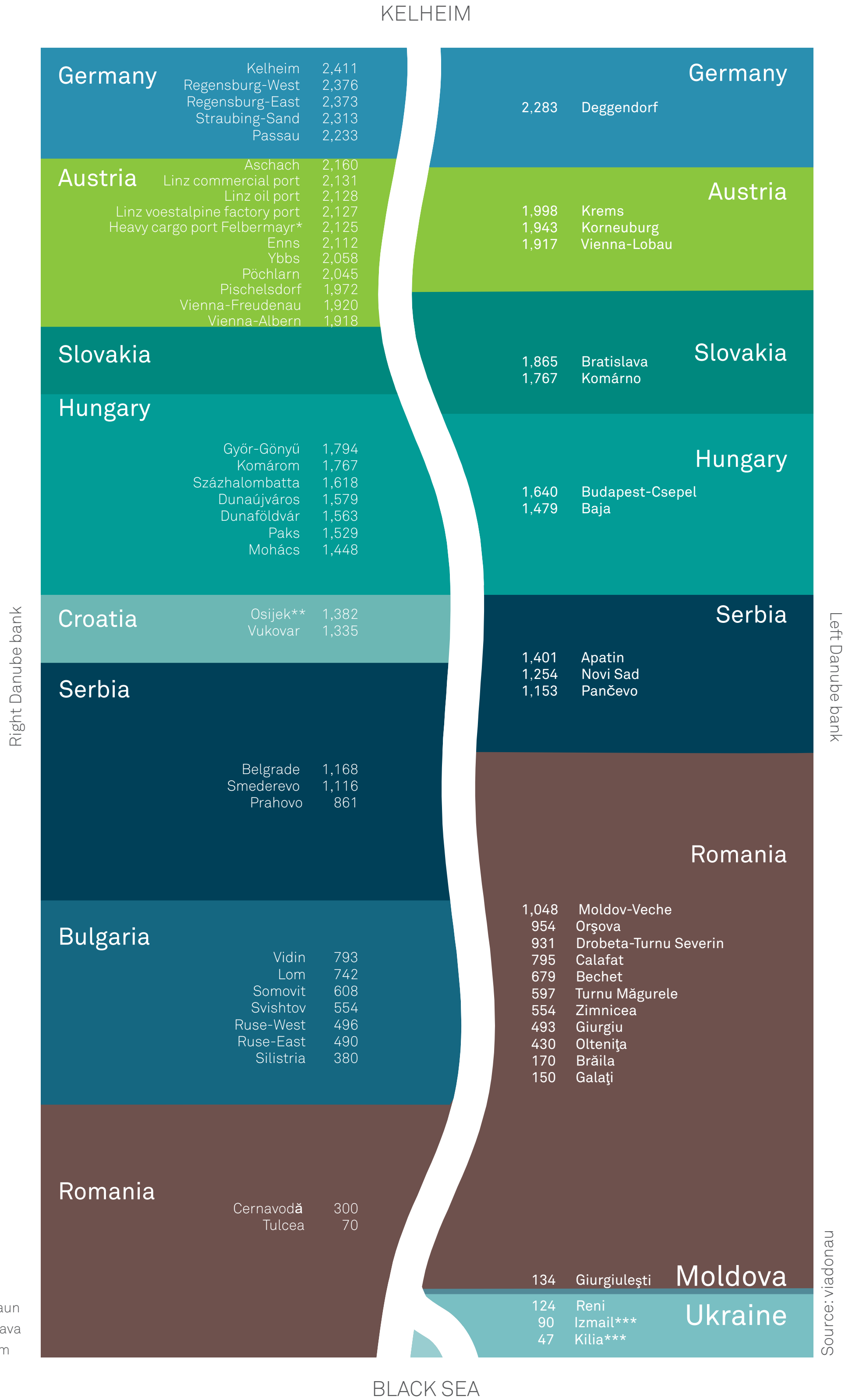
In order to maintain a hold in an ever changing environment, both competition and cooperation are required. 'Co-opetition', a combination of 'competition' and 'cooperation', is consistent with this approach (Brandenburger & Nalebuff, 1996). For this reason, ports in the same geographical region often cooperate with each other in areas such as marketing and locational development.

Example: Interessensgemeinschaft Öffentlicher Donauhäfen in Austria (IGÖD)

IGÖD represents the ports of Linz, Enns, Krems and Vienna in international associations that share the same interests. The development and transfer of knowledge between members are also among the IGÖD activities.

Source: Port of Linz, Ennshafen, Port of Vienna, Rhenus Donauhafen Krems

The ports represented in the community of interests of Austrian public Danube ports: Port of Linz, Ennshafen, Rhenus Donauhafen Krems, Port of Vienna (in clockwise direction)



* located on the river Traun
** located on the river Drava
*** located on the Kilia arm

Significant ports and transhipment points on the Danube (including river-kilometres for their location)

Transhipment points on the Danube

Transhipment points in the Danube riparian states

According to the definition contained in the '**European Agreement on Main Inland Waterways of International Importance (AGN)**' (United Nations Economic Commission for Europe, 2010), more than 40 Danube ports are classified as '**E ports**', making them inland ports of international importance. The average distance between these Danube ports is around 60 km, but only approximately 20 km in the Rhine region.

For detailed information about the Danube ports, visit www.danube-logistics.info/danube-ports/

Transhipment points on the Austrian Danube

The following important transhipment points are located along the Austrian Danube:

Transhipment point	River-km	Type	Website & email
Aschach an der Donau	2,160	Transhipment site	www.garant.co.at office@garant.co.at
Linz commercial port	2,131	Port	www.hafenlinz.at hafen.linz@linzag.at
Linz oil port	2,128	Port	www.hafenlinz.at hafenlinz@linzag.at
Linz – voestalpine	2,127	Port	www.voestalpine.com info@voestalpine.com
Linz – ILL	2,127	Port	www.ill.co.at office@ill.co.at
Linz Felbermayr*	2,125	Port	www.felbermayr.cc hafen@felbermayr.cc
Ennshafen	2,112	Port	www.ennshafen.at office@ennshafen.at
Ybbs	2,058	Port	www.schaufler-metalle.at office@schaufler-metalle.com
Pöchlarn	2,045	Transhipment site	www.garant.co.at office@garant.co.at
Rhenus Donauhafen Krems	1,998	Port	www.rhenus-hafenkrems.com donauhafen@at.rhenus.com
Pischelsdorf	1,972	Transhipment site	www.donau-chemie.at office@donau-chemie.at
Korneuburg – MOL	1,943	Transhipment site	www.molaustria.at office_wien@molaustria.com office@molaustria.at
Korneuburg – Agrarspeicher	1,941	Transhipment site	www.agrarspeicher.at office@agrarspeicher.at
Vienna-Freudenau	1,920	Port	www.hafen-wien.com office@hafenwien.com
Vienna-Albern	1,918	Port	www.hafen-wien.com office@hafenwien.com
Vienna-Lobau	1,917	Port	www.hafen-wien.com office@hafenwien.com

Source: viadonau

* located on the river Traun
Transhipment points on the Austrian Danube

Legal provisions

International regulations

European inland ports of international significance, the so-called 'E ports', are listed in the European Agreement on Main Inland Waterways of International Importance (AGN) (United Nations Economic Commission for Europe, 2010). E ports should enable the operation of motor cargo vessels and convoys, which are navigating on the respective E waterway on which the E port is located. Furthermore, the ports should have respective connections to roads of international importance and main international railway lines at their disposal. These should include the European road, rail and combined transport freight networks as stipulated in other conventions of the UNECE (AGR, AGC and AGTC).

E ports should be able to carry an annual volume of cargo transhipment of a minimum 0.5 million tons and provide appropriate conditions for the development of port industrial areas. Moreover, the ports should facilitate the transhipment of standardised containers unless they are specialised exclusively for bulk goods transhipment.

Source: viadonau

Legal provisions in Austria

Legal provisions relating to the ports and their users, vehicles and floating bodies are enshrined in the **Navigation Act** (SchFG) (Federal Law Gazette I 62/1997). Among the provisions of this act are those contained in **Section 68 Port fees for public ports**. Port fees based on tariff rates are charged for the use of public ports. They include pierage, demurrage and winter berthing fees. The calculation of port fees is based on the cargo transhipment and/or the type and size of the vehicles and floating bodies.

The users are entitled to source the port facilities and services in return for payment of these fees. The port basin, including the mooring facilities and the waste and waste oil collection points can be used within this framework, as well as the sanitary facilities. Extraction of drinking water for the ship crew and de-icing of the port basin are also included. Private ports are also entitled to charge port fees.

The **Regulation for Shipping Facilities** (Federal Law Gazette II 298/2008) regulates the structure, operation and use of shipping facilities. It also includes provisions for other facilities along waterways, for instance floating restaurants, hotels or stages.

Digital services for ports

Port and terminal operators benefit from the transparent and electronic exchange of information provided within the framework of River Information Services (RIS). Ship owners, for instance, can transfer the entire route and/or load data to their business partners, as well as to port or terminal operators, in an electronic form. This takes place through the use of standardised **electronic reporting**, permitting predictive control of transhipment and storage processes. However, ports and terminal operators may only access the ship and load data with the data owner's consent to data transfer. In most cases this will be the shipping company.

Further information on theses services can be found in chapter 'River Information Services' in this manual.

At the same time, business partners can also use the same method to access information on the current position of vessels (for which consent has been provided), i.e. their estimated time of arrival (ETA), which permits improved and more precise planning of port and transhipment operations.

Access to DoRIS Portal for registered users: https://portal.doris-info.at/

RIS for port and terminal operators in Austria

In Austria, the DoRIS Portal, which is available to registered users free of charge, enables electronic reporting of hazardous goods to the competent authorities, as well as controlled access to ship positions and estimated times of arrival.

The 'arrival/departure service' was implemented in order to support port masters at Austrian ports. It sends automatic email notification to the competent port master as soon as a vessel enters or leaves the port area. This reduces communication, supports documentation and ensures quick and reliable distribution of information.

Meldung für Ausfahrt

MMSI:	203999450
Name:	HALBE MEILE
ENI:	04806500
Bereich:	Tankhafen Linz (ATLNZ00001J001621281)
Art:	Ausfahrt
Zeit:	03.10.2018 07:41:00

Das ist eine automatisch generierte E-Mail.

Das An-/Ablegeservice wurde im Rahmen des CENTRAL EUROPE-Programms von EFRE kofinanziert.

Source: viadonau

Example of a departure notification

PORT TRANSHIPMENT

Low water has a noticeable impact
Decline in waterside transhipment

- Low water in the last two quarters resulted in a massive decline in the waterside transhipment volume against 2017
- With around 2.6 million tons, the voestalpine industrial port remained the most significant port on the Austrian Danube

The year 2018 was impacted by low water in the Danube over the course of several months. The resulting reduction in transhipment volume was noticeable at all Austrian Danube ports and transhipment sites.

A total of 6.1 million tons were handled in 2018, which corresponds to a decrease of 23.3% or 1.9 million tons compared to 2017. Regarding the individual ports, the decline in transhipment volumes ranged from –7.7% to –35.3%.

As in the previous year, voestalpine's industrial port in Linz recorded the highest waterside transhipment volume of all Austrian Danube ports with a total volume of around 2.6 million tons. In total, around 42.6% of the total transhipment volume in Austria was therefore handled at this port. The difficult conditions during the year under review led to a decrease by approximately 1.0 million tons.

With 18.0% of the total volume, the other private ports and transhipment sites (Aschach, the heavy-cargo port at Linz, Pöchlarn, Pischelsdorf, Korneuburg and Bad Deutsch Altenburg) rank second among the Austrian ports and transhipment sites. In total, 1.1 million tons were handled waterside, which corresponds to a decline of approximately 0.3 million tons against the previous year.

The Port of Vienna with the associated ports of Freudenau, Lobau and Albern along with the transhipment sites Lagerhaus and Zwischenbrücken increased its share in the total Austrian transhipment volume. In 2018, waterside transhipment amounted to more than 1.0 million tons, which corresponds to 17.0% of the total volume. In 2017, this figure had been at 14.1%. At 7.7%, the Port of Vienna recorded the smallest decline in transhipment volume in Austria.

At the ports of Linz AG (industrial port and oil port), the cargo handling volumes declined by 15.3% to approximately 540,000 tons during the year under review. Compared to the previous year, it stands out that the two Linz AG ports handled more goods on the waterside than the port of Enns, which recorded a total volume of around 480,000 tons in 2018. The latter recorded a 28.3% reduction in waterside transhipment volumes.

The Port of Krems had to take the biggest percental decline in waterside transhipment. With 347,882 tons of goods handled waterside, the share of the total cargo handling volume decreased by 35.3% to 5.7%.

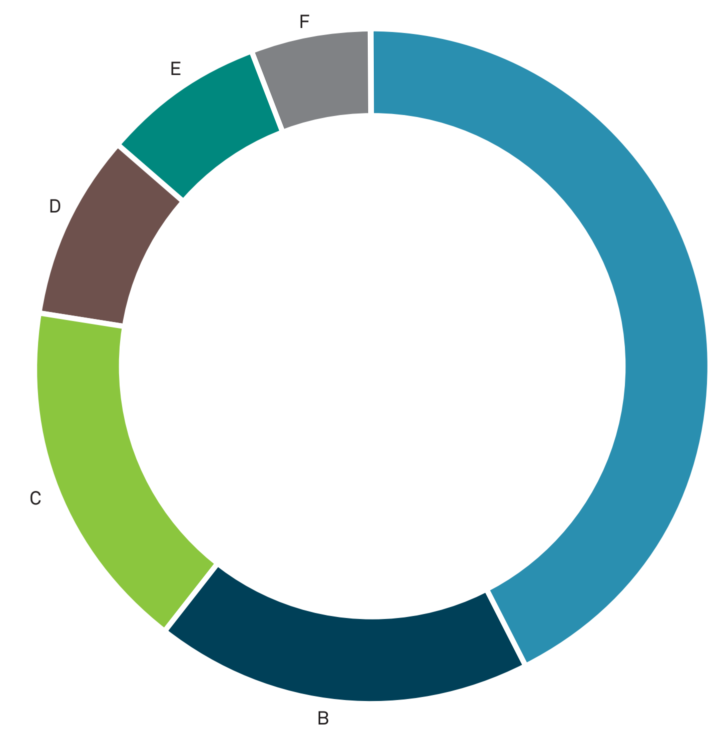
FIGURES DATA FACTS

Waterside transhipment at Austrian Danube ports and transhipment sites 2018

F
Krems
5.7%
347,882 tons
(–35.3%)

E
Enns
7.9%
483,340 tons
(–28.3%)

D
Linz AG[4]
8.8%
535,947 tons
(–15.3%)



A
Linz voestalpine[1]
42.6%
2,612,851 tons
(–27.3%)

B
Others[2]
18.0%
1,101,422 tons
(–22.0%)

C
Port of Vienna[3]
17.0%
1,042,111 tons
(–7.7%)

[1] Including waterside transhipment at Industrie Logistik Linz GmbH.
[2] Other ports and transhipment sites include: Aschach, Schwerlasthafen Linz, Pöchlarn, Pischelsdorf, Korneuburg, Bad Deutsch Altenburg.
[3] The three ports of Freudenau, Albern and Lobau (oil port) and the two transhipment sites Lagerhaus and Zwischenbrücken have been grouped together to compile the total turnover figures for the Port of Vienna.
[4] Data from both the commercial port and the oil port in Linz have been grouped together to compile the total turnover figures for the Port of Linz.

Source: Statistics Austria, adapted by viadonau


ALBLASSERDAM
2318976
NL
ARIE-LEENDERT
NL

System elements of Danube navigation: Inland vessels

Source: viadonau

Types of cargo vessel on the Danube

Basically, inland cargo vessels operating on the river Danube and its navigable tributaries can be divided into three types according to the **combination of their propulsion systems and cargo holds**:

- **Motor cargo vessels** (or self-propelled vessels) are equipped with a motor drive and cargo hold. Motor cargo vessels can be subdivided into dry cargo vessels, motor tankers, container and Ro-Ro vessels.

- **Pushed convoys** usually consist of a pusher (motorised vessel used for pushing) and one or more non-motorised pushed lighters or pushed barges. They are firmly attached to the pushing unit, and at least one unit is positioned in front of the pushing craft. A coupled formation or (obsolete) pushed-coupled convoy means that a motor cargo vessel is used for propelling the formation or convoy instead of a pusher. A **coupled formation** or side-by-side formation consists of one motor cargo vessel with one to two lighters or barges coupled on its sides. A **pushed-coupled convoy** has one to two lighters or barges coupled to the motor cargo vessel on its sides with additional lighters or barges placed in front of it.

- **Tugs** are used to tow non-motorised vessel units, so-called barges (vessels for carriage of goods with a helm for steering). Towed convoys are rarely used on the Danube any more because they are less cost-effective than pushed convoys.

Source: viadonau

A 4-unit pushed convoy on the Austrian section of the Danube east of Vienna

The predominant form of cargo shipping on the Middle and Lower Danube is by means of formations (pushed convoys, coupled formations as well as pushed-coupled convoys). The majority of all transports are carried out by convoys and only a small share by individual motor cargo vessels. The situation of individual motor cargo vessels and convoys is more balanced on the Upper Danube. Individual motor cargo vessels are the principal form on the Rhine.

Pushed navigation on the Danube

When comparing all types of vessels operating on the Danube, the **bulk freight capacity of pushed convoys** is clearly the most impressive. The term bulk freight capacity indicates the possibility of transporting a large amount of goods on a vessel at the same time. A pushed convoy consisting of one pusher and four non-motorised pushed lighters of the type Europe IIb, for example, can transport around 7,000 tons of goods – equivalent to the cargo carried by 280 trucks (with 25 net tons each) or 175 rail wagons (with 40 net tons each). The 4-unit convoy mentioned above can navigate the whole stretch of the Danube between the German port of Passau and the Black Sea. Even more impressive is the transport capacity of a 9-unit convoy like those used on the Central and Lower Danube. A convoy of this kind can carry remarkable 15,750 tons of cargo and can therefore replace 630 trucks or 394 rail wagons (which is the equivalent of about 20 fully loaded block trains). Convoys comprising up to 16 pushed lighters are possible on the lower reaches of the Danube due to the width of the waterway and the fact that there are no limitations caused by locks.

i A Europe IIb type pushed lighter, which is typically used on the Danube, has the following dimensions:
length 76.5 m, width 11.0 m, maximum draught 2.7 m with a deadweight of 1, 700 tons.

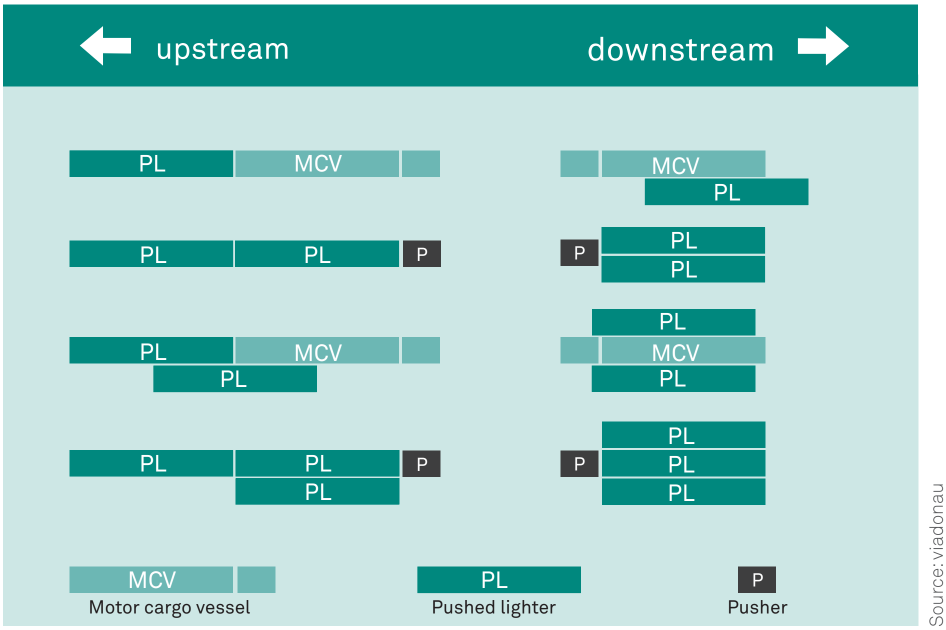
Source: viadonau/Andi Bruckner

Pusher belonging to the TTS Line shipping company from Romania

The basic rule for **creating formations for ship convoys** is: vessel units in pushed convoys are grouped so as to reduce water resistance when in motion as much as possible or so that sufficient stop and manoeuvre characteristics can be ensured (e.g. when navigating downstream). Lighters are arranged in a staggered manner toward the back in order to reduce resistance.

If the appropriate technical features of the units used in a convoy allow it, vessel units are not attached to one another rigidly, but rather coupled with **flexible connectors** to enable the convoy to negotiate curves in areas with particularly narrow curve radii.

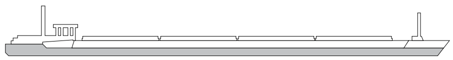
For **upstream** travel, the convoy should have as small a cross-sectional area as possible and thus the lowest possible resistance, which is why the lighters are arranged behind one another in a so-called cigar or asparagus formation. In contrast, the lighters are arranged next to each other together when travelling **downstream**, to facilitate the manoeuvrability of the convoy and most especially its ability to stop in the direction of the current.



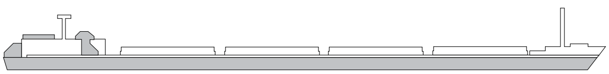
Arrangement of vessel formations on the Danube

Main vessel types based on their cargo

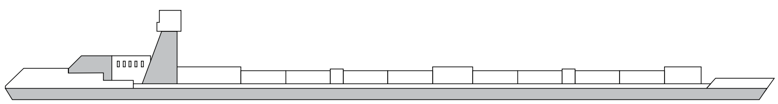
Dry cargo vessels are used for transporting a wide variety of goods including log wood, steel coils, grain and ore. These vessels can be used for almost anything and therefore reduce the number of empty runs (journeys with no return cargo). This class of vessel can generally carry between 1,000 and 2,000 tons of goods and is often used on the Danube in coupled formations or pushed-coupled convoys, which is why their break power is greater than that of individual cargo vessels (refer to large motor vessels, length = 95 metres). Dry cargo vessels can be divided into the three main classes that are shown in the figure below.



Gustav Koenigs	
Length	67 m
Width	8.2 m
Max. draught	2.5 m
Max. deadweight	900 t
Drive performance	450 kW



Europaschiff	
Length:	85 m
Width:	9.5 m
Max. draught	2.5 m
Max. deadweight	1,350 t
Drive performance	750 kW



Large motor vessel	
Length	95 m / 110 m
Width	11.0 m / 11.4 m
Max. draught	2.7 m / 3.5 m
Max. deadweight	2,000 t / 3,000 t
Drive performance	1,550 kW / 1,150 kW

Source: Voies navigables de France

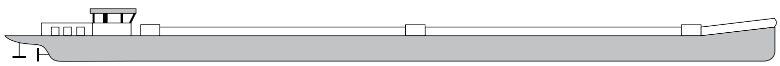
Main types of dry cargo vessels

Source: viadonau

Motor cargo vessel of the Europaschiff class

ADN = European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (United Nations Economic Commission for Europe, 2016)
All Danube riparian states and Russia are signatories to this agreement.

Tankers transport various types of liquid goods, such as mineral oil and derivatives (petrol, diesel, heating oil), chemical products (acids, bases, benzene, styrene, methanol) or liquid gas. The majority of the liquid goods mentioned above are hazardous goods which are transported using special tanker vessel units equipped with the appropriate safety devices. Of particular relevance in this regard is the ADN, which has completely replaced the previous ADN-D, as well as national legislation.



Tanker	
Length	110 m
Width	11.4 m
Max. draught	3.2 m
Max. deadweight	2,600 t
Drive performance	1,300 kW

Source: viadonau

Main characteristics of a tanker

Tankers used on the Danube have an average deadweight of around 2,000 tons. As is the case with the navigation of dry cargoes, the transport of liquid goods on the Danube is carried out primarily by pushed convoys.

Modern tankers have a **double hull** which prevents the cargo from leaking in the event that the outer hull is damaged. Stainless steel tanks or cargo holds with a **special coating** are used in order to prevent the cargo from reacting with the surface of the tank. The use of heaters and valves enable the transport of goods that freeze easily even in winter, and sprinkler systems on deck protect the tanks from the summer heat. Liquid gases are transported under pressure and in a cooled state using special containers. Most tankers have pumps on board which can load and unload the goods directly into the tanks in ports not equipped with such special loading systems.

Source: helmut1972, www.binnenschifferforum.de

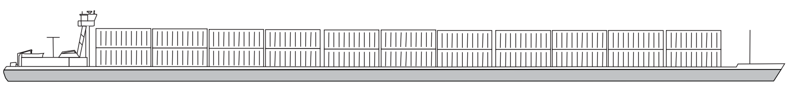
Tanker on the Danube.

Container vessels are ships constructed specifically for the transport of containers and are currently used primarily in the Rhine region. In the Danube region, container convoys with four pushed lighters are regarded as the best way to increase capacity. These pushed convoys have a total loading capacity of up to 576 TEU – each pushed lighter can therefore carry 144 TEU, i.e. three layers of containers with 48 TEU each.

TEU = Twenty-Foot Equivalent Unit. TEU is the measurement used for containerised goods and is equivalent to a container with the standard dimensions of 20 feet x 8.5 feet x 8.5 feet (around 33 m³).

Source: viadonau

Pushed container convoy entering the Austrian Port of Linz

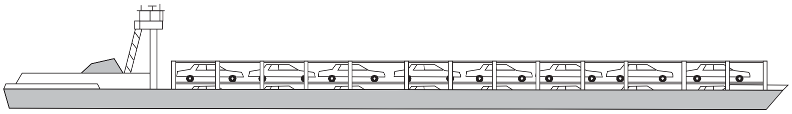


Container vessel	
Length	135 m
Width	17.0 m
Max. draught	3.7 m
Max. deadweight	470 TEU
Drive performance	2,000 kW

Source: Voies navigables de France

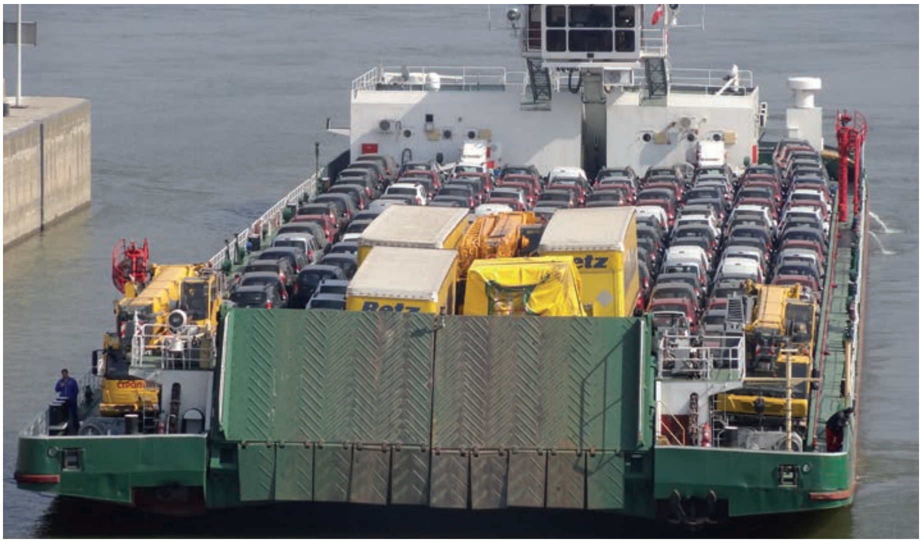
JOWI class Rhine container vessel

RoRo vessels: Roll-on-Roll-off means that the goods being transported can be loaded and unloaded using their own motive power via port or vessel ramps. The most important types of goods transported in this way include passenger cars, construction and agricultural machinery, articulated vehicles and semi-trailers ('floating road') as well as heavy cargo and oversized goods.



RoRo vessel	
Length	115 m
Width	22.8 m
Max. draught	1.65 m
Drive performance	1,850 kW

Main characteristics of a Ro-Ro vessel



Ro-Ro catamaran on the Danube

Most of the Ro-Ro transports are performed using specially constructed vessels, for instance catamarans. **Catamarans** are vessels with two hulls, which are connected by the deck, forming a large loading surface for the rolling goods.

Types of passenger vessel on the Danube

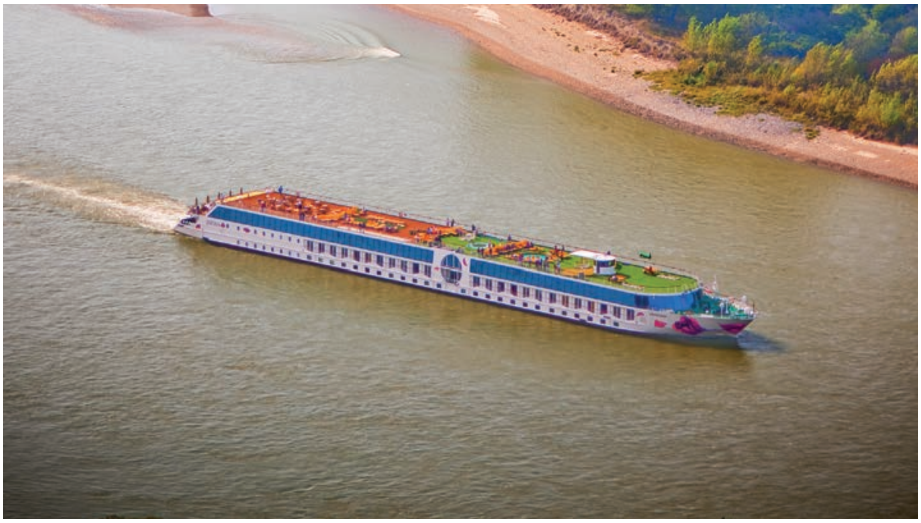
The Danube has become significantly more attractive in recent years, even for longer **river cruises** along its whole stretch between the Main-Danube Canal and its Black Sea estuary. As a logical consequence of this trend, the number of new passenger vessels is also rising.

Year	Number of vessels (units)	Number of passengers
2012	124	19,980
2013	137	22,300
2014	150	24,700
2015	170	28,100
2016	168	27,700
2017	170	28,100

Source: Danube Commission (2017a)

Development of capacity of cruise vessels on the Danube

New cruise or cabin vessels for navigation on the large waterways of Europe set top standards as far as comfort, safety and nautical properties are concerned. **Large river cruise vessels** that are up to135 metres long offer space for around 200 passengers who are usually accommodated in two-bed cabins. Thanks to their dimensions, these vessels can pass through locks 12 metres in width and can therefore be used along the whole stretch of the river between the North Sea and the Black Sea. Cruise or cabin vessels that are designed for voyages on the Danube alone may even be wider than the standard width of 11.45 m. The MS Mozart, for instance, has a width of 22.85 m, although this is an extreme case that is rarely encountered.



Source: viadonau/Andi Bruckner

Cruise vessel on the Danube

A low draught of between 1.2 and 2.0 metres, plus ingeniously constructed superstructures and deckhouses, ensure smooth operation in very low water depths and safe passage under bridges in periods with higher water levels. Nonetheless, extreme low or high-water situations can bring cruise and cabin ship navigation to a standstill. The larger vessel units are particularly affected in these cases. The recent introduction of diesel-electric propulsion systems with gondola propellers now guarantees virtually silent operation, as well as enabling relatively high speeds of up to 24 km/h in shallow waters. Unlike the cargo shipping market, a cruise or cabin vessel is equipped with a large number of **power consumers** such as bow thrusters and systems required for hotel operations. Hence, the generator performance required for their operation can have the same or even a negligibly larger capacity than the drive performance.

Performance indicators for examples of cruise/cabin vessels

Small cruise/cabin vessel	
Length	79m
Width	7.75 m
Max. draught	1.15 m
Drive performance	550 kW
Speed	20 km/h
Passengers	80

Source: viadonau

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel Diana

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel River Art

Large cruise/cabin vessel	
Length	110 m
Width	11.45 m
Max. draught	1.50-2.00 m
Drive performance	1,500 kW
Speed	24 km/h
Passengers	160

Source: viadonau

Source: Gerd Schuth Koblenz

Motor passenger vessel Viking Njord

Largest cruise/cabin vessel class (e.g. Viking Longships)	
Length	135 m
Width	11.45 m
Max. draught	2.00 m
Drive performance	1,260 kW
Speed	20 km/h
Passengers	190

Source: viadonau

In addition to the cruise and cabin vessels used for long-haul navigation, there are also **day-trip and passenger vessels** that usually only operate local liner services. These passenger vessels are used mainly for day trips, round trips and charter trips on the more attractive stretches of the Danube or for round trips in or to larger cities located along the Danube.

Three different types can essentially be distinguished from a structural perspective: Mono-hull vessels (**displacers** or **boats with planing hulls**), twin-hull vessels (**catamarans**) and **hydrofoils**.

Most of the mono-hull vessels are designed as displacers. Travelling at a low speed, the hull remains in the water (displacing it), unlike boats with planing hulls that are designed specifically to rise out of the water to enable high speeds. Most day-trip vessels belong to this type. Broadly speaking, they have the following characteristics: The length varies between 30 and 70 m, the width between 6 and 11 m, the draught between 0.8 and 1.6 m, the speed between 20 and 27 km/h and the maximum number of passengers between 230 and 600.

Performance indicators for day-trip vessels (displacers)

Small day-trip vessel	
Length	38.35 m
Width	6.5 m
Max. draught	1.30 m
Drive performance	350 kW
Speed	23 km/h
Passengers	230

Source: viadonau

Source: Martin Cejka

Motor passenger vessel Vienna

Source: Sonnburg, www.donau-schiffahrt.at

Motor passenger vessel Kaiserin Elisabeth

Large day-trip vessel	
Length	57 m
Width	10.63 m
Max. draught	1.35 m
Drive performance	650 kW
Speed	25 km/h
Passengers	600

Source: viadonau

Twin-hull vessels (**catamarans**) and **hydrofoils** are seen comparatively rarely on the Danube. They are mainly used when high speeds (for instance 60 km/h) or transports of large passenger numbers are necessary, for instance in liner services between two cities. They are high-speed vessels.

A catamaran consists of two very slender hulls. This results in a rather small ratio of width to length and a favourable interference of the wave systems created by the hulls. As a consequence, the vessels require relatively low power to travel at high speeds, although the power is several times greater than that of the slower displacement vessels.

A hydrofoil has foils fitted below the body of the vessel that lift the boat out of the water as it accelerates, which can reduce the draught of boats travelling on the Danube (for instance) to around 1 metre. Only a small portion of the vessel's body remains surrounded by water, leading to a noticeable reduction in resistance and hence the necessary propulsion power. Very high speeds can be achieved as a result.

Performance indicators for fast passenger vessels

Catamaran:Twin-City-Liner III	
Length	39.90 m
Width	11.00 m
Max. draught	0.80 m
Drive performance	3,381 kW
Speed	70 km/h
Passengers	250

Source: viadonau

Source: Central Danube Region GmbH

Twin City Liner III

Hydrofoil: Meteor IV	
Length	34.50 m
Width	9.50 m
Max. draught	1.20 m
Drive performance	1,764 kW
Speed	70 km/h
Passengers	112

Source: viadonau

Source: Sonnburg, www.donau-schiffahrt.at

Hydrofoil Meteor IV

The Danube fleet

Due to the economic model that prevailed in the eastern area of the Danube region until the political reforms of the 1980s, large shipping companies remain dominant on the Danube. These **large shipping companies** have been successively privatised since the early 1990s. This is the opposite of the situation on the Rhine, where small 'one-ship companies', i.e. private vessel owner-operators, are predominant.

i The figures quoted here for the Danube fleet do not include the vessel units of Western European countries such as Germany or the Netherlands that operate for the main part with self-propelled vessels in shuttle transport on the Main and the Rhine.

With very few exceptions, these large Danube shipping companies use large **pushed convoys** (occasionally still towed convoys) to transport bulk cargo due to the relatively low gradient of the Danube in its middle and lower stretches. The share of cargo space of non-self-propelled units in the Danube fleet stood, for example, at around 87% at the end of 2016 according to statistics published by the Danube Commission (2017b). In absolute figures, this amounted to **1,668** pushed lighters with an average tons deadweight of almost 1,300 and **503 towed barges** with and average tons deadweight of 670. A significant number of towed barges have been converted into pushed lighters and, as a result, have not been taken out of service.

Source: C.N.F.R. NAVROM S.A. Galaţi

Pushed convoy operated by the Romanian Danube shipping company C.N.F.R. NAVROM S.A. at the Iron Gate.

In the year 2016, the fleet of motorised units in pushed convoys comprised, in total, of **331 pushers** with an average output of 1,090 kW. In addition, there were still 245 tugs in operation on the Danube in the same year.

The **pushed Danube convoys** from Romania and especially the Ukraine are by far the largest and youngest that are currently in operation.

In contrast to the Rhine region, the proportion of **self-propelled units with a cargo hold** accounts for 13% of the Danube fleet and is hence relatively low.

62 percent of the Danube fleet was built between 1971 and 1990. The average age of all units was 41 years in 2018.

There were **418 motor cargo vessels** registered in the Danube riparian countries in operation during 2016; they had an average performance of 560 kW and an average deadweight of 950 tons. However, the formerly extremely low proportion of self-propelled vessels on the Danube has risen in recent years due mainly to the decommissioning of older barges and lighters as well as the purchase or acquisition of second-hand motor cargo vessels from the Rhine Corridor. Newer cargo vessels for operation on the Danube and its navigable tributaries are still a rare exception.

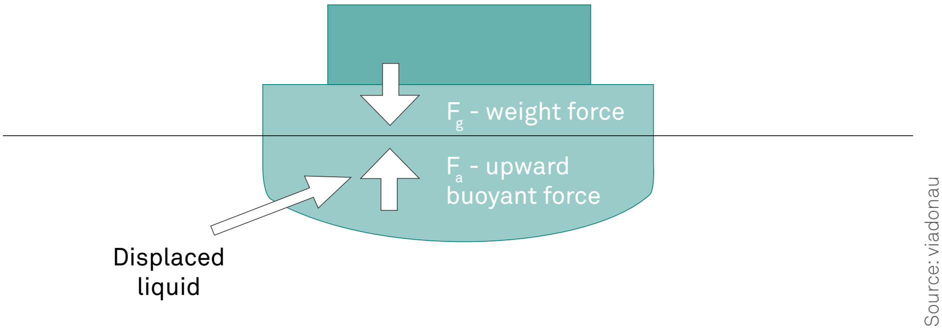
In 2017, there were around **170 cruise vessels** with the capacity to accommodate 28,100 passengers operating on the Danube. The average age of the cruise vessels travelling the Danube is 10 years, whereby around nine new vessels entered service every year over the last few years. There are currently no reliable figures available for the total number of **day-trip vessels** in operation in the Danube region.

Physical and technical aspects

Archimedes' Principle

The Archimedes' Principle was first discovered by Archimedes of Syracuse. It states: 'The **upward buoyant force** that is exerted on a body immersed in a fluid is equal to the **weight** of the fluid that the body displaces.' This discovery is the theoretical expression of a physical fact that had been used for the transport of goods, animals and people by waterway for several thousands of years before Archimedes.

With respect to navigation, the Archimedes' Principle means that the upward buoyant force of a ship is equal to the weight of the fluid displaced by the ship (refer to the diagram). The immersion depth of the ship also reflects the principle that the upward buoyant force is equal to the weight of the ship. If a ship is loaded, its weight increases, causing the ship to sink deeper into the water in an amount that is necessary to restore balance between the additionally displaced water and the additional load. As water has a density of approximately 1 t/m^3, exactly 1 m^3 of water is displaced for each additional ton of ship mass. The tare weight of a vessel and its possible carrying capacity are hence mainly determined by the structure of the vessel, meaning its length and width, as well as the shape of the hull and the material from which it is built.



Weight force of displaced liquid = upward buoyant force F_a = weight force of vessel F_g

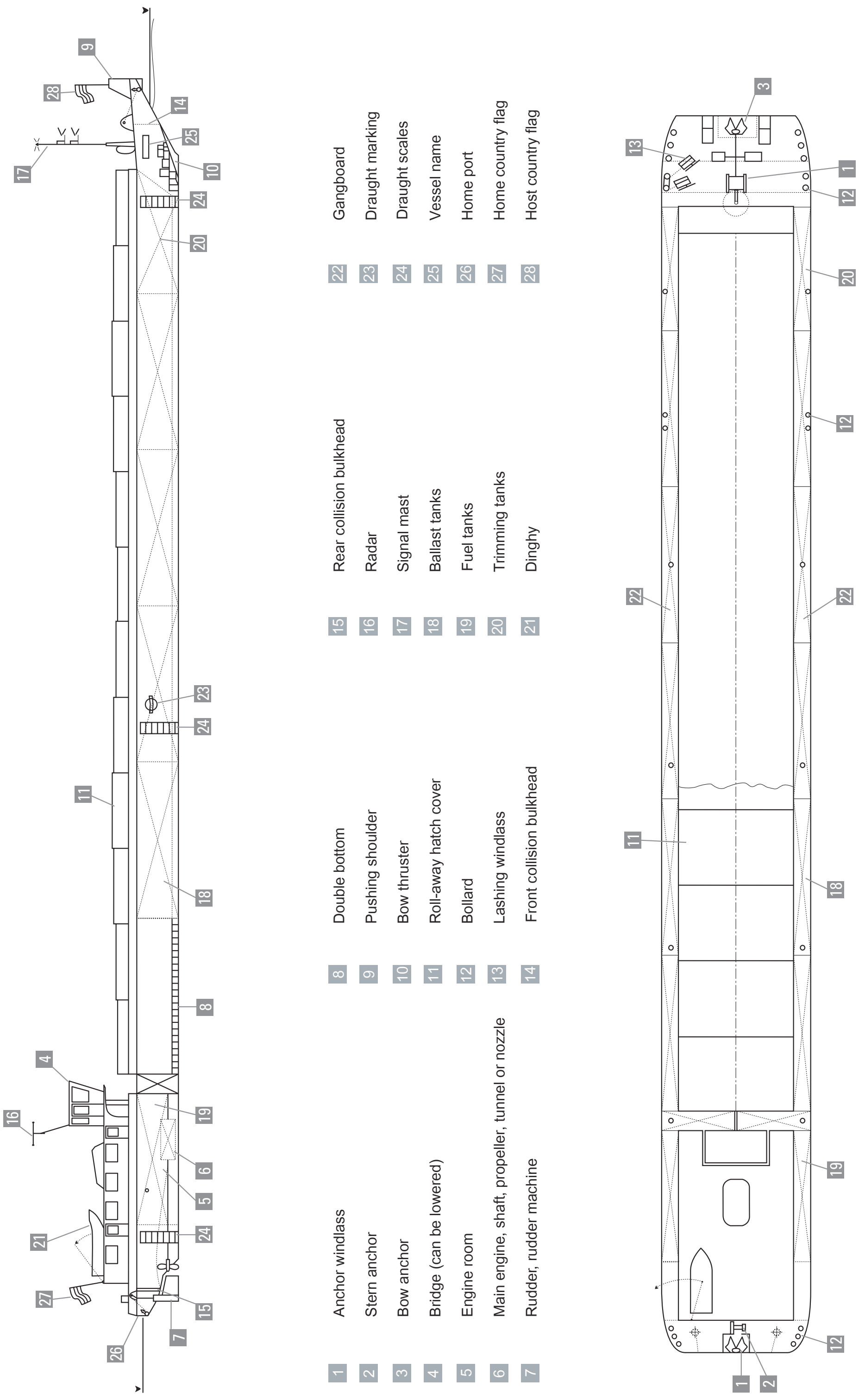
The Archimedes' Principle applied to ships

Hydrodynamic resistance

When a ship moves through water it experiences a force acting against its direction of motion. This force is the resistance to the motion of the ship and is referred to as total resistance. A ship's total resistance is a function of many factors, including ship **speed**, the **shape of the hull** (draught, width, length, wetted surface), the **depth and width of the fairway** and **water temperature**. The total resistance is proportional to the total surface in contact with water and the ship speed squared. The propulsion power even takes the cube of the speed, which is why the avoidance of high speeds is essential to fuel-efficient travel. The hydrodynamic resistance of a ship increases in shallow waters and its manoeuvrability is reduced, which in turn increases the fuel consumption of the ship.

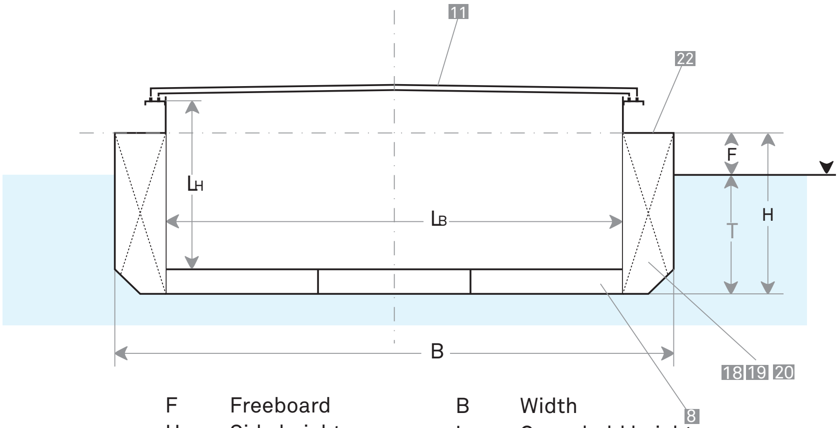
Components of an inland waterway vessel

The most important designations and dimensions of a Danube cargo vessel are depicted in the following based on the example of a 'DDSG-Steinklasse' **motor cargo pusher** (large motor vessel). This type of vessel is used as a drive unit in coupled and pushed-coupled convoys for the most part due to it being equipped with pushing shoulders.



Source: Helogistics Holding GmbH, viadonau

The most important components of an inland waterway vessel based on the example of a DDSG Steinklasse motor cargo pusher



F	Freeboard	B	Width
H	Side height	LH	Cargo hold height
T	Draught loaded	LB	Cargo hold width

Source: Helogistics Holding GmbH, viadonau

Key data	
Length	95 m
Width	11.4 m
Side height	3.2 m
Max. draught	2.7 m
Fixed point above base	6.5 m
Maximum tons deadweight	2,000 t
Cargo hold length	69.5 m
Cargo hold width	8.8 m
Fuel tank	110 m^3
Ballast tank	380 m^3
Potable water tank	38 m^3

Source: Helogistics Holding GmbH, viadonau

Key data and cross section of a DDSG Steinklasse motor cargo pusher

Propulsion and steering systems

A ship's motion through the water is enabled by its propulsion and steering devices. The most common propulsive device used for ships is the **propeller** due to its simplicity and its robustness. It consists of several blades (two to seven) that are arranged around a central shaft and functions like a rotating screw or wing. Three, four or five blade propellers are the types used most often. High blade numbers reduce vibrations but increase production costs.

Due to the problems of seasonal low water on certain sections of the Danube self-propelled Danube vessels are usually **twin-screw ships**, i.e. equipped with two propellers. In the case of twin-screw propulsion the propellers have a smaller diameter and so remain completely immersed even if the draught of the vessel is significantly lower. Due to the higher investment costs, the total fuel consumption in deeper waters and the costs of maintenance and repair this propulsion system is more expensive than the single-screw types used predominantly on the Rhine.

For reasons of efficiency, usually only **a single screw is used** in relatively deep waters. In the case of a 'standard vessel' with a performance of between 700 and 1,000 kW, a width of 11.4 metres and a normal draught of 2.5 metres, single-screw propulsion is technically possible (from a hydrodynamic perspective) and commercially justified as well.

The most common and simplest steering device for a ship is the **rudder**. Steering a ship means having control over her direction of motion. The working principle of a rudder is similar to that of an aerofoil. The flow of water around the rudder blade in inclined position generates a transversal force tending to move the stern opposite to the rudder inclination. The common characteristic of all rudders is that the generated transversal force depends on the flow velocity around the rudder: the higher the velocity, the stronger the rudder effect. The transversal force also depends on the cross-sectional and rudder shape, rudder area and the angle of attack.

Modernisation of the inland waterway fleet

Framework conditions

Based on centuries of experience, Danube navigation has adapted to the predominant fairway conditions on the river. This is also in line with the legal traffic regulations, because according to the '**Convention Regarding the Regime of Navigation on the Danube**' from the Danube Commission (§ 1.06 – Utilisation of the waterway) cargo vessels must in principle be adapted to the conditions of the waterway (and its facilities) before they are permitted to navigate it (Danube Commission, 2010).

Nevertheless, in order to further exploit existing potential in the field of ship design, hydrodynamic parameters such as shape, propulsion and manoeuvrability are being continuously optimised. However, technical innovations can only contribute to the further optimisation of cargo vessels within the **given physical and economic limitations** – the overall system of vessel-waterway must be kept in view and what is technically possible combined with what is economically viable. Cargo shipping must remain economically competitive if it is to survive the fierce competition with road and rail – only those transport operations on the Danube that have a competitive price-performance ratio are ever carried out.

Modernisation potential

The average age of the European inland waterway fleet is rather high. New vessels are often built according to standard designs that were developed decades ago. Numerous technical alternatives exist to improve the existing fleet in regard to its hydrodynamics as well as the engine systems.

With regard to hydrodynamics, improved propulsive efficiency and manoeuvrability, as well as reduced resistance (modification of the ship's hull), are the most important factors and can be achieved with already existing technologies. With regard to **engine systems**, the most important areas for modernisation are the reduction of fuel consumption and exhaust gas emissions, as well as compliance with strict emission regulations.

Source: Ludovic Péron

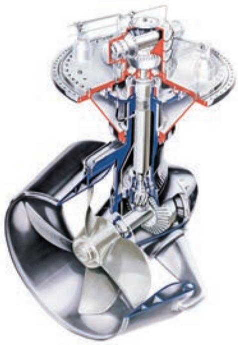
Twin-screw propulsion with ducted propellers

Improvement of propulsive efficiency and manoeuvrability

A reduction in fuel consumption can be achieved by improving the propulsive efficiency of the vessel or by reducing its resistance in water. The **propulsive efficiency** can, for example, be increased by the following technologies:

- **Ducted propeller (Kort nozzle):** A propeller that is fitted with a nonrotating nozzle, which improves the open water efficiency of the propulsive device. The advantages of the ducted propeller include increased efficiency, better course stability and lower susceptibility to damage caused by foreign bodies.

- **Z-drive (SCHOTTEL rudder propeller):** A rudder propeller is a robust combination of propulsion and steering devices, whereby the drive shaft is deflected to the propeller twice at an angle of 90° giving it the form of a Z. As the underwater components can be turned through 360°, the system enables maximum manoeuvrability. Other advantages include optimum efficiency, economical operation, space-saving installation and simple maintenance.



Source: Schottel GmbH

SCHOTTEL rudder propeller (Z-drive)

- **Azipod propulsion devices:** This system consists of a rotating gondola that hangs below the ship's stern and that fulfils both propulsion and steering functions. The propeller is powered by an electric motor arranged in the gondola. The advantages of the propulsion gondolas include, among other things, reduced exhaust gas emissions, fuel savings due to improved hydrodynamic efficiency, good manoeuvring properties, flexible machinery layout and improved use of space in the standard configuration.

- **Controllable pitch propeller:** The pitch of the propeller blades of a controllable pitch propeller can be adjusted to the existing operating conditions leading to achievement of the maximum open water efficiency.

- **Adjustable tunnel:** A device at the stern of the vessel consisting of fins which can be folded down to create a tunnel in the direction of the propeller. This prevents air suction in shallow water operation in a partly loaded condition with the result that the propeller remains fully functional, even if operated in extremely shallow water.

- **Pre-swirl duct:** The purpose of this device is to improve the incoming flow to the propeller resulting in increased propeller efficiency and a reduction in the propeller loading (and as a result a possible cavitation), in vibrations and in fuel consumption.

- **Propeller boss cap fins:** An energy-saving device that breaks up the hub vortex that forms behind the rotating propeller. This reduces the torque of the propeller and increases fuel efficiency by three to five percent.

The **manoeuvrability** of a vessel can sometimes be improved by applying simple measures. These measures include adding end plates to the rudder or increasing the rudder area, resulting in an increased rudder force. Studies have shown that the rudder area is one of the most important parameters for course keeping and the turning abilities of a ship.

Many rudder shapes and improvement measures have been developed over the years in order to improve manoeuvring efficiency and increase navigation safety.

Below are a few examples:

- **Schilling rudder:** A high-performance fishtail rudder whose single piece construction with optimised shape and no moving parts improves both course keeping and vessel control characteristics.


Source: Brosen

Bow thruster

- **Flap rudder:** These rudders consist of a movable rudder with a trailing edge flap (comparable to an aerofoil with a flap) which enable a much higher lift per rudder angle and a 60 to 70% higher maximum lift compared to conventional rudders.

- **Bow thruster:** Water is taken up from underneath the vessel using the help of vertically mounted propellers (propeller shafts). The water is guided into one or two channels at an angle of 90° by a drum rotating at 360° making the vessel manoeuverable. A major advantage of this system is that maximum thrust can be achieved with minimum draught without any parts protruding through the ship's hull.

- **Articulated coupling:** An articulated coupling between a pusher and a pushed lighter comprising a hydraulically operated flexible coupling to facilitate steering in sharply meandering sections of the waterway.

- **Dismountable bow filling for coupled vessels:** The gap between a pusher and a pushed lighter impacts on smooth flow around the formation. The installation of a flexible bow filling between the pusher and the lighter is a simple way of reducing vortex formation and separation.

Improvement of emission characteristics

It would appear that **diesel engines** will remain the most common form of propulsion for inland navigation in the medium term. In the long term, it is conceivable that **gas-powered engines** and fuel cells may be used as well. They have great potential to enable a significant reduction in the emissions of inland vessels.

Legislation addressing the issue of emissions has become increasingly strict in recent years, and green standards are now more and more important as competitive advantages.

Publication of Directive 2009/30/EC laid a foundation for the improvement of environmental performance of inland navigation. Since 1 January 2011, this Directive has **limited the sulphur content in all fuels** used for inland navigation in the European Union to 0.001 percent (10 ppm). Hence, the fuel that is currently used is virtually sulphur-free, which has led to negligible levels of sulphur dioxide emissions. Particle emissions have also been cut noticeably as a result. Moreover, this fuel enables the installation of extremely effective emission reduction technologies.

i The thresholds imposed by Regulation (EU) 2016/1628 have been applicable since 1 January 2018 and 1 January 2019.

Regulation (EU) 2016/1628 defines the **thresholds for exhaust emissions in new engines**. The mandatory thresholds are very strict, which will probably necessitate the installation of emission reduction technologies such as exhaust gas after-treatment by selective catalytic reduction (SCR) and particle filters. The first mandatory threshold for the particle count has also been introduced (engines with a performance P ≥ 300 kW).

i The CCNR levels describe the emission thresholds published by the Central Commission for the Navigation of the Rhine (CCNR). For more information, visit the CCNR website at: https://www.ccr-zkr.org/

The European Commission has since started discussing **voluntary environmental standards** that might be applied to vessels that are currently in operation. Standards like this already exist in Belgium and the Netherlands. The Green Award indicates their compliance. Vessels that have received this Award can receive reductions in port fees of up to 30 percent. Another example is the Port of Rotterdam, which from 2025 will only admit vessels whose engines satisfy the requirements of CCNR II at least.

Current legislation means that inland shipping operations are already virtually sulphur-free. In future they will be free of exhaust gas emissions and also produce lower emissions of greenhouse gases. New vessels will represent a quantum leap in regard to environmental performance. A major challenge in the years ahead will be to improve the green credentials of the current fleet.

It is therefore necessary to **optimise engines** in regard to their **fuel consumption and exhaust gas emissions**. The diesel engines currently in operation in inland waterway transport are emission-optimised engines and their specific fuel consumption is approximately 0.2 kg/kWh. This value has remained unchanged for several years due to the fact that nitric oxide emissions had to be reduced at the expense of fuel consumption. The average age of a ship's engine before its replacement is around 15 years or more. If you compare this to the average service life of truck engines, which is five years, it is obvious that it will take much longer to fulfil emission standards in inland navigation.

Possible measures for reducing the emission characteristics of ship engines include the following:

- Reduction in sulphuric oxide emissions:
  - Low-sulphur fuel

- Reduction in hydrocarbon and carbon monoxide emissions:
  - Diesel oxidation catalysts (require low-sulphur fuel)

- Reduction of nitric oxide emissions:
  - Exhaust gas recirculation (requires low-sulphur fuel)
  - Humidification of engine inlet air
  - In-cylinder water injection
  - Use of an emulsion comprising water and fuel
  - Selective catalytic reduction (i.e. injection of a reduction agent for the effective removal of nitric oxide emissions)

- Reduction of particulate matter emissions:
  - Particulate matter filters (PMF, require low-sulphur fuel)

According to the results of international research projects and experiments, the most effective techniques regarding the reduction of engine emissions and fuel consumption are:

- Engines for liquefied natural gas (LNG)
- Low-sulphur fuel
- Diesel oxidation catalysts (require low-sulphur fuel)
- Selective catalytic reduction
- Particulate matter filters
- Fuel-efficient travel, for instance by using an Advising Tempomat (ATM – a computer-assisted system giving information about the most economical speed and minimum fuel consumption of the ship's engines based on prior inclusion of the calculation for limitations of the navigated waterway)

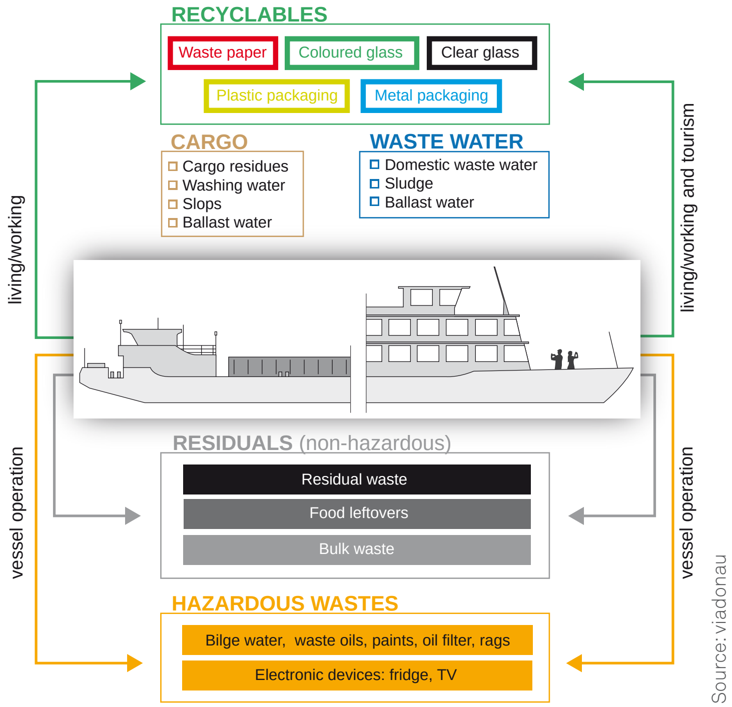
The first applications using **hydrogen** and **fuel cells** in inland navigation (e.g. the ZemShip) have since been released. There are also ongoing discussions on the introduction of **fully electric drive systems**, although this is associated with challenges in regard to the supply infrastructure, regulatory matters, storage capacity, size of the storage medium, charging time, range of the vessel and ultimately a reduction in the currently inefficient costs of the technology that need to be overcome.

Waste management in inland navigation

Inland navigation is an environmentally friendly and viable transport mode. Nonetheless, the operation of vessels, as well as life on board, produce **waste** that needs to be disposed of professionally. Where this is not assured, illegal or unprofessional disposal of waste can pollute valuable ecosystems and jeopardise the fundamentals of life required by human beings, plants and animals.

A characteristic feature of ship-generated waste is that many different types are produced in a small space. Waste is generated by **operating and maintaining the ship** (especially engine waste products containing oil and grease), **by the people onboard**, as well as related to the **cargo**. Some of the waste is hazardous, for instance residue of paints and coatings that are produced during maintenance tasks like painting, as well as engine oils and oily rags. Besides liquid and solid waste, CO_2 and other gases are emitted by the vessels engines.

Depending whether it is a cargo or a passenger vessel, amounts and composition of produced waste can differ significantly. The large number of persons on board means that considerably bigger quantities of domestic waste and waste water accumulate on passenger ships (which can be considered as floating hotels) than is the case on cargo vessels. The age and equipment of the vessel, as well as its maintenance, are major contributors, also, and can significantly affect the quantities generated.



Types and production of ship-generated waste

Collection systems for ship-generated waste

A variety of collection systems are available for the reception of ship waste along the Danube. Besides land-based, stationary systems, there are also mobile collection vessels and suction vehicle systems available.

- Land-based, stationary collection points
  Stationary collection facilities are available for example in Hungary (Baja, Budapest) and Croatia (Vukovar). These stations are usually installed on pontoons and offer – depending on the equipment – possibilities for disposing of different types of waste. Suction systems for disposing of liquid wastes (bilge water, waste water) are sometimes complemented by appropriate containers for the collection of solid waste (residual waste, solid oily materials). Furthermore, in some cases, stationary facilities are directly connected to a sewer system.

- Mobile collection vessels
  Mobile collection vessels are available in Germany, Bulgaria and Romania to enable the mobile extraction of bilge water – even while navigating. Depending on the equipment, other types of waste like waste oil can also be disposed. By use of onboard treatment plants, bilgewater can be separated in its oil- and watercontents. Subsequently – if meeting the threshold values of the concerned national regulations – residual treated water can be discharged into the waterway.

- Suction vehicles
  Suction trucks are often used in combination with other collection systems. Through suction hoses bilge water and waste oil are pumped off the vessel and subsequently transported to onshore treatment facilities. Special suction vehicles can also collect waste water and sewage sludge, whereas for filters, batteries etc. additional collection vehicles are necessary.

Legal framework for the management of ship-generated waste

From a legal perspective, ship waste management is a cross-sectional topic that falls within the purview of several national and internationale laws. Beside regulations for navigation, waste and water legislation also need to be considered.

The Danube is an international river that flows through 10 countries, which means that a variety of legislative frameworks are relevant at national and international level. Moreover, there are bilateral agreements and international recommendations, such as those issued by the Danube Commission on the organisation of ship-generated waste collection in Danube navigation or the Danube River Protection Convention. On the Rhine and the German part of the Danube the CDNI - The Strasbourg Convention on the collection, deposit and reception of waste generated during navigation on the Rhine and other inland waterways has to be applied. In the Danube delta the provisions of MARPOL have to be taken into account as it is the interaction zone of river and sea.

Source: viadonau

Legal framework & international conventions for ship waste

The following **EU-Directives** envisage framework conditions for ship waste management and have been implemented in national law:

- Water Framework Directive
- Waste Framework Directive
- Technical Requirements for Inland Waterway Vessels
- Directive on Port Facilities for Ship-generated Waste and Cargo (for maritime Danube Ports)

Legal framework conditions in Austria

Detailed regulations for the handling of ship waste exist within the Austrian navigation laws (e.g. the Waterway Traffic Regulation (WVO)). They set out the duties for the crew on board, as well as obligations for the operators of waterway infrastructure (ports, transhipment sites, facilities for cabin vessel navigation) in regard to equipment, acceptance and payment of waste collection points. Waste management law as well plays an important role in the establishment and operation of waste collection points. Furthermore, the Austrian Water Rights Act provides a framework for any kind of interference or impact on water; this legislation may be applicable to the introduction of purified waste water into the rirver or to the sewage system.

Digital services on vessels

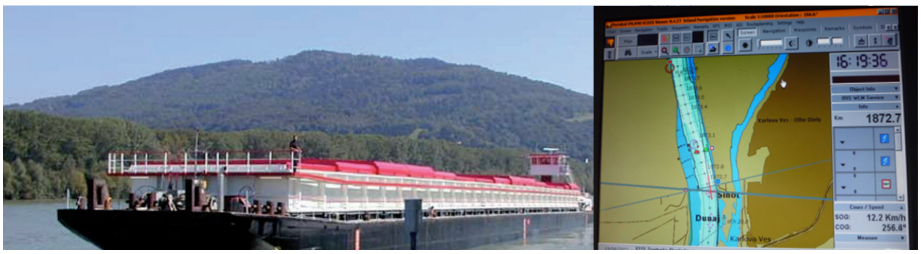
River Information Services can be used as tools from the planning of ship voyages to their implementation.

RIS for planning support

The River Information Services such as voyage planning or electronic reporting of route and cargo data can be used as planning tools prior to embarking on the voyage.

Voyage planning is defined as the planning of the route, including all stop-overs, the amount and type of the cargo to be loaded and the time schedule. Particular emphasis is placed on planning the vessel's maximum cargo load, which depends primarily on the available water levels.

A large number of commercial **software products** are available, in addition to the official services such as those for electronic reporting. The outlined basic functions can also incorporate other features, for instance route management, stowage calculations or fuel saving algorithms, depending on the individual supplier.



Source: viadonau

RIS for support with planning ship voyages

All voyage planning applications are based on the use of **fairway information**, such as water levels and vertical bridge clearance. **Traffic information** can be considered additionally in some cases:

- Current restrictions along the route
- Journey and average speed of the vessel
- Any speed limits that might apply on part sections
- Effects of flow directions and speeds
- Lock times
- Average waiting times at locks
- Traffic density

Depending on national or international legislation, shipping operators must notify different authorities of the planned voyage and the cargo on board. Thanks to the use of **Electronic Reporting**, data relating to the cargo and voyage only need to be entered once and can be used as a template for similar voyages in the future, which will further reduce the effort associated with data entry.

RIS for support with navigation

A large variety of information is available on board a vessel to assist with the safe and efficient performance of a voyage. In particular, fairway information such as electronic charts, current water levels, vertical bridge clearance or information on shallow sections contribute to the safe use of the channel. Displaying the position of nearby vessels on the electronic inland navigation chart (Inland ENC) promotes more predictive navigation and enables faster responses to the behaviour of other vessels. At the heart of this **tactical traffic image** is the on-board Inland-AIS transponder.

Where this tactical traffic display is connected to the radar image and the rate of turn indicator, it can be used to help safe navigation – for instance during poor visibility.

Source: viadonau

Display of current traffic conditions on an electronic navigational chart

RIS on board a vessel in Austria

The River Information Services available for boatmasters on board their vessels in Austria include high-quality electronic waterway charts (Inland ECDIS), as well as all kinds of fairway information that can be accessed using for instance the DoRIS Mobile app. Not only do Inland AIS transponders permit the timely identification of another vessel's position, they also deliver ongoing information about water levels or vertical bridge clearance. A comprehensive information and navigation tool is made available by connecting the Inland AIS transponder to an Inland ECDIS chart display. It is also a convenient way of submitting the **mandatory report on hazardous goods** in an electronic form.

Use of these services is voluntary. However, for harmonised vessel identification on the Austrian section of the Danube, Austria has put into force a **requirement for carrying and operating a transponder**.

Digital monitoring of vessel operating data

This involves the measurement and collection of the vessel's operating data and its transfer to the user. Typical data that is collected includes: date, time, position of the vessel (latitude, longitude), ground speed, engine speed, fuel consumption per hour and engine workload as a percentage.
Among other things, this data permits an assessment of how a voyage has proceeded and whether a change in the estimated time of arrival is necessary. In addition, the data provides information on fuel consumption along various nautical sections of the waterway, any overruns of a critical speed above which consumption will rise noticeably, as well as the occurrence of any overload situations in the engine.

The data can be used to optimise vessel operations in regard to travelled route, engine operation and fuel consumption, both in real time and through analysis of historical records.

Automatic course tracking

The AlphaRiverTrackPilot, which was developed by Alphatron Marine in collaboration with Argonics, enables a vessel to travel along a predefined course, regardless of the prevailing weather conditions. It is therefore a fully automatic system for course tracking that contributes to minimising course corrections by the helmsman and hence improves the vessel's energy efficiency. The system operates by identifying the correct rudder position that is needed to control the ship and compensate for lateral drift.

The MS Robert Burns by Scylla became the first cruise liner to use the AlphaRiverTrackPilot when it was put into operation at the end of 2017.

Collective measurement of fairway data on board vessels

The measurement of fairway data on vessels can yield a significant amount of valuable information, in addition to the waterway data that is made available to the shipping sector by the individual waterway authorities or companies. This data is especially helpful in areas that are barely surveyed or not at all, i.e. whose riverbeds are exposed to considerable morphological changes.

Collective measurement of fairway data on board vessels is based on the use of echo sounders that measure the distance between the sensor and the bed, as well as recording the vessel's position at the moment of measurement. These findings can then be converted either into a water depth or a point on the waterway bed contours at the moment of measurement. The best case scenario is that this data can reconstruct a waterway map when benchmarked against suitable reference systems, for instance satellites or gauges (provided they are available in sufficient numbers).

Initial applications have been tested in the EU projects NEWADA duo, MoVe IT! and Prominent, whereby Prominent also featured measurements of the current speed and a combination of fairway data measurements with operational data from the vessels themselves.

The Dutch initiative CoVadem has since been launched with over 50 companies as members. This means that a large number of vessels are involved in the collaborative measurements and are providing additional waterway information from the Netherlands in particular.

Crew members on inland vessels

An inland vessel is operated by a crew comprising of different members with different competencies and tasks. The **minimum crew** for inland vessels and the **composition of the crew** depends on the size and equipment of the vessel and on its operating structure.

Recommendations with respect to the crew of inland vessels can be found in Chapter 23 of **Resolution No. 61 of the United Nations Economic Commission for Europe** (UNECE) concerning the technical requirements for inland vessels (United Nations Economic Commission for Europe, 2011). The minimum crew number and composition as well as the competencies of crew members are regulated by national legislation along the Danube. On the Rhine, the relevant requirements are laid down by the Rhine Vessel Inspection Regulations (Central Commission for the Navigation of the Rhine, 2018b).

Overview of crew members

The crew prescribed for the respective operating modes must be on board the vessel at all times while it is travelling, with due consideration of worktime and rest period regulations. Departure is not permitted without the prescribed number of minimum crew. The number of members of the minimum crew for motor cargo vessels, pushers and vessel convoys depends on the length of the vessel or convoy and the respective **mode of operation**.

The following distinctions are made for modes of operation:

- **A1**: Daytime navigation for maximum 14 hours within a period of 24 hours
- **A2**: Semi-continuous navigation for not more than 18 hours within a period of 24 hours
- **B**: Continuous navigation for 24 hours and more

The **minimum crew** required for safe operation of a vessel can consist of various crew members which are specified in detail in the following table:

Captain (boatmaster)	Sole person responsible on the vessel in matters of expertise and staff, holder of a captain's certificate and hence entitled to operate a vessel on the sections of the waterway indicated in the certificate	
Helmsman	Assists the captain	
Deck crew	Complete crew with the exception of the engineering staff; carries out various assistant tasks during the journey; consists of:	
	Boatswain	Intermediate superior for the deck crew
	Crewman/woman	Subordinate member of the deck crew
	Ordinary seaman (ship's boy)	Member of the crew still undergoing training
	Deckhand	Untrained beginner
Engineer/ Engine-minder	Monitors and maintains the propulsion motor and the necessary concomitant systems	
Pilot	Instructs the captain on board in certain nautically difficult stretches of the route (requires certification)	

Source: viadonau

Crew members and their tasks

Source: viadonau/Reinhard Reidinger

Crewmen connecting a tank lighter

Discharge book and ship's log/logbook

Each nautical member of the minimum crew must be able to **demonstrate their technical qualifications and suitability for a function on board** by presenting a discharge book. For crew members in possession of a boatmaster certificate (ship master's certificate), these qualifications will replace the discharge book. The boatmaster must make regular entries of travel times and routes in the discharge books of crew members.

The boatmaster is also responsible for keeping the ship's log/logbook. It contains records of the voyages conducted by a vessel and its crew, as well as details concerning worktimes, breaks and daily and weekly rest periods.

Seeking to modernise inland navigation, to continue reducing the administrative workload and to make certification less vulnerable to manipulation, efforts are currently under way to replace proof of qualification, discharge books and ship's logs kept in a paper form with **electronic professional IDs and electronic on-board devices**. For this purpose, the European Commission will submit to the European Parliament and Council its assessment of forgery-proof, electronic discharge books, ship's logs and professional IDs by 17 January 2026.

Education and further training for inland navigation

Education and further training differs greatly between the individual Danube countries, as well as in Europe as a whole. The approaches vary from very practical concepts with no obligation to attend a training institute, through to the award of academic qualifications. Some countries have several courses of education running parallel to each other.

Introduced in January 2018, Directive (EU) 2017/2397 creates a common framework to guarantee **minimum professional qualifications in the area of inland navigation**. This Directive defines the requirements and procedures for the award of certificates of qualification and their mutual recognition in the Member States. The qualifications apply to persons involved in the operation of a vehicle on the inland waterways of the European Union.

@ Information on education, training and certification in inland navigation is provided on the website of Education in Inland Navigation: www.edinna.eu

EDINNA, the association of inland waterway navigation schools and training institutes in Europe, provides an overview of the training opportunities in Europe on its website. EDINNA supports the European Commission in its efforts to harmonise education and its certification in inland navigation.

Sources

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