SSPA Research Report No. 126, 2004

TOHPIC – Tools to Optimise High-Speed Craft to Port Interface Concepts

Handbook on the Establishment of High-Speed Craft Operation

Reprint of TOHPIC Document No. 2.5.01.01

Linda Styhre and Per Stefenson

SSPA Sweden
Göteborg

TOHPIC is a project funded by the European Commission under the 5th Framework Programme (Contract No. G3RD-CT-2000-00491) and partly by the Swedish Agency for Innovation Systems VINNOVA (2001-04250)

SSPA Research Report No. 126,   2004

Handbook on the Establishment of High-Speed Craft Operation

Linda Styhre and Per Stefenson

SSPA Sweden AB
P O Box 24001
SE-400 22 Göteborg
Sweden
Telephone +46-31-772 9000
Telefax +46-31-772 9124
E-mail postmaster@sspa.se

www.sspa.se

Handbook on the Establishment of High-Speed Craft Operation

by

Linda Styhre and Per Stefenson

SSPA Research Report No. 126, 2004

ISBN 91-86532-39-1
ISSN 0282-5805

Published and distributed by:

SSPA Sweden AB
P O Box 24001
SE-400 22 Göteborg, Sweden

Telephone +46-31-772 9000
Telefax +46-31-772 9124
E-mail postmaster@sspa.se

www.sspa.se

Table of Contents

1. Introduction

This handbook is based mainly on four previous reports (D2.1-D2.4) from WP2 “Ship to shore interface and port infrastructure for high-speed craft”, with minor additions from other reports (D1.1, D1.4 and D3.1) within the TOHPIC project. The aim was to deliver a handbook, accessible to non-experts, but still comprehensive enough to be suitable for decision makers and other interested parties, to be used as a manual when new fast shipping initiatives or further developments are considered.

High-speed shipping has specific needs regarding infrastructure and service, and therefore considerations about the impact on surrounding activities and the environment have to be dealt with before it is introduced.

For high-speed craft (acronym: HCS) to be competitive in the present situation and in the long run, they cannot be regarded as a conventional vessel travelling at high speed, but should be considered as a new transport system. It is important that all activities are coordinated in order to achieve shorter total time in the transport chain for passengers and cargo, and to attain high utilization of the vessel and efficiency in the logistic flow.

So, why do we have high-speed shipping? The obvious answer is because it is faster; that answer, however, also implies that we want, or need, to go faster than conventional ships. It is of course one reason, but the reality is a bit more complicated.

In Norway coastal shipping has always been very important. Because of the topography, with high mountains and deep fjords, the easiest, and sometimes only, way to transport passengers and goods is by sea. Following the development of modern industrial society, the demand for more and better communications has increased and coastal shipping in Norway has developed to meet these needs. A large share of coastal shipping in Norway is today operated with HSC. This is mainly for passenger transport with or without cars but it is also used to some extent for lorries.

Another and different reason for the introduction of high-speed shipping could be found in Sweden. The topography makes it much easier to travel on land than in Norway and the road network was developed to serve the need for transport of people and goods within the country. However, shipping was, and still is, very important for export and import of goods. In fact, passenger shipping in Sweden is very closely related to pleasure cruises. Before 1999 a large portion of the income to the shipping companies came from tax-free sales. As a consequence of the new law stopping tax-free on inter European lines, the turnover for tax-free has substantially decreased and a new pronounced transport approach with a focus on increased sale of tickets was founded. The aim was now to make waterborne transport more competitive and effective compared to conventional passenger traffic as well as other transport modes. The introduction of high-speed craft was then an alternative.

The ports are currently the bottlenecks in the international transport system, as a result of primarily two facts. First, port management is a very traditional business and adapts slowly to changes. This is partly due to large costs associated with making changes in a port. The second reason is the difference in size between the vehicles and cargo to be transported and the size of the vessel. This creates a necessary waiting time for the vehicles, simply because it takes time to accumulate the volumes necessary. There are growing demands for transport in

Europe and people are travelling more often. Therefore, all activities need to be aligned in order to attain an efficient transport system that includes high-speed craft.

2 Basis for high-speed craft operation

2.1 Market needs/ Business opportunities

Contrary to most waterborne transport, high-speed craft often includes transport of passengers rather than goods, except for a few goods ferry services. The most important reason is that the fuel consumption for HSC is very sensitive to total weight, and this results in a high price level for transport of cargo. The investments cost for an HSC are also higher than for a conventional vessel of the same size, because of expenses for lightweight materials for the hull and fittings. Another reason for focusing on car and foot passengers instead of cargo are that punctuality in the industrial system is perhaps more important than high speed for cargo, and therefore a slower transport with a conventional vessel is more cost-efficient. In addition, in some cases it is risky to choose a high-speed transport since HSC are more susceptible than conventional vessels to cancellations due to bad weather conditions. To make a switch from road to sea possible a regular, daily sailing for cargo would have to be offered and a reliable service would have to be guaranteed regardless of weather conditions.

It is costly to transport cargo in high-speed craft at speeds of roughly 35-40 knots. From a general point of view, suitable goods for fast transport are perishables and goods of great value, and they are transported together with passengers. Depending on price and alternative mode of conveyance, other kinds of cargo would also be suitable to transport at high speed at sea. Since the cost for obtaining an HSC is high, maybe there is a possible market for second-hand passenger vessels for conveyance of goods in the future. According to EU research, the future potential of fast goods transport on sea will remain limited until road haulage rates rise and make sea transport at high speed more competitive. Development will also be dependent on reducing fuel consumption without foregoing high speed.

2.2 Location

Normally the ship operator has few possibilities to choose the location, but the following chapter focuses on parameters that need to be considered when setting up a high speed operation.

The terminal should be planned in an area close to open sea, because the transport distance with speed restrictions should be kept as short as possible. Transport distance in low speed areas such as in archipelagos where there could be interference from pleasure craft, water sports etc. or upstream in a river should be minimised. There is always a safety risk in narrow waterways and the low speed jeopardises the operational efficiency of HSC. An HSC should reach its cruising speed as soon as possible. The preferred situation is where the vessel can reach its cruising speed just outside the breakwater or in the mouth of a river.

Since there are a lot of people coming to and from the HSC terminal, on foot or in vehicles, there is a need for good transport connections. If the terminal is outside the city centre it has to be accessible by public transportation and by car in the easiest possible way. Parking places should be offered close to the terminal. When the terminal is located in the city centre, parking could be a problem that would need extra attention.

The physical surroundings around the port will have to be assessed. Industries handling dangerous goods or other hazardous operations close to the terminal will require specific risk assessments. Also the fact that people could feel unsafe in dark or deserted areas may require some actions be taken in order to make the area more attractive and secure.

2.3 The high-speed craft

The definition of the word "high-speed" depends on the circumstances under which the expression is being used. A technical definition of an HSC has been established based on a formula for a speed to displacement coefficient. According to the International Maritime Organisation (IMO) Code of Safety for high-speed craft, an HSC is a craft capable of a maximum speed (V), in meters per second (m/s), equal to or exceeding:

$$V \geq 3.7\nabla^{0.1667}$$

where ∇ is the displacement in cubic meters (m^3).

To simplify the characterisation of a high-speed craft a definition from an operational point of view, instead of a technical one, would be desirable. In sea transport the definition of one knot is the speed required in order to travel one nautical mile, i.e. 1852 meters, in 60 minutes. In this handbook an HSC is defined as a craft capable of an operational speed (V) of 35 knots or higher.

$$V \geq 35 \text{ knots}$$

HSC's light construction requires a careful organisation of heavy cargo and cars inside the vessel to preserve stability, without using more ballast water than necessary to avoid high levels of fuel consumption.

Two different kinds of high-speed craft are predominant today: mono hull ships and catamarans. It is difficult to categorise these groups clearly and it appears to be mainly subjective views that lead to the choice of one or the other (at least for sizes over 300 tonnes Dead Weight).

Figure 2.1. SNCM "NGV Liamone", a monohull HCS for routes between Nice and Corsica

Figure 2.2.Trasmediterranea Millennium catamaran, Barcelona

Figure 2.3. STENA HSS catamaran, Dun Laoghaire

When fast passenger ships were introduced in the middle of the seventies, they were mainly small passenger ships for 200-300 passengers and without any car-deck. The catamarans led the development at that time since the sea keeping performance (ship movements) was better and thereby the comfort was superior to similar sized monohulls. In the eighties the fast vessels grew larger and the capability to carry cars was added to the concept. The catamarans also led the development of these larger ships with a dead weight of 100 to 300 tonnes. In the nineties, the monohull managed to catch up with good sea-keeping performance resulting from new efficient stabilising systems. It is impossible today to state whether a catamaran or a monohull has the best sea performance.

2.3.1 Limitations on the HSC

In a recent report regarding passenger services over the Bass Straight between Australia and Tasmania, published by the State Government of Tasmania Department of Infrastructure, Energy and Resources on 16 April 2002, the following statements were made:

Wave heights of over four metres cannot be accommodated by fast vessel technology for passenger services at this time due to the sea state operational restrictions applying to all vessels built to the international High Speed Craft Code (HSC) adopted by the Australian Maritime Safety Authority (AMSA). These restrictions will continue to apply into the foreseeable future. This means that catamarans are not suitable for sea conditions in Bass Strait because they cannot provide reliable services due to wave height operating restrictions.

Even if it is somewhat surprising that the assessors claims that it is impossible according to the SOLAS High Speed Craft Code to operate HSC in a sea state above four meters significant wave heights (vessels certified up to five meters are known in UK and France), the report indicates the limitations of HSC operations quite well.

Vessel	Significant wave height	Hull
HSS 900 (Stena)	3.5 meters	Catamaran
HSS 1500 (Stena)	4 meters	Catamaran
NGV Liamone (SNCM)	5.5 meters *	Monohull

*6 meters with special course and speed towards seas

Table 2.1 Example of allowed significant wave height for three vessels with different size and type of hull

If the significant wave height is predicted to be above the limit, the journey is cancelled. Also people’s sense of well being on board is crucial. Passengers’ motion sickness dictates that they in general do not like being on an HSC for more than four hours. As an example, typical values for cancellation on the Irish Sea owing to bad weather are 4-6% for HSC and 1% for conventional vessels.

In the northern parts of Europe, mainly in the Baltic Sea, solid ice and drifting ice flows are limiting the use of light craft in wintertime. Fortunately this happens during the low season (January – March) and conventional ships can normally do the transport.

Another limitation is the prohibition on transport of dangerous goods on high-speed craft together with passengers, due to the light construction’s lower fire resistance. Sleeping cabins are prohibited for the same reason.

2.3.2 Delays and cancelled journeys

It is a fact that delays and cancelled journeys are costly. In addition to the obvious loss of income from tickets, there are operational costs (salary for employees, added harbour dues, etc.), passenger’s compensation for delay and reduced customer confidence in the company, i.e. they will probably not travel with your company again if there are other alternatives.

To avoid ending up in a bad financial position as a result of a high percentage of cancelled journeys, the weather conditions need to be investigated to determine whether or not they are favourable for high-speed service.

Cancellations are more acceptable if you can replace the cancelled HSC with a conventional ship. Since cancellations normally occur in low season, the net cost of cancelling might not be as high as expected if alternatives are available.

2.3.3 Fast Ro-Pax ships

Recently a new type of fast combined roll on / roll off and passenger ship, the so-called Ro-Pax ship, have been introduced to the market. These ships normally operate at a speed of around 28 to 30 knots. They are not lightweight craft but are built of steel in a more traditional way. However, significant efforts were directed towards weight optimisation and hull design. The power output is comparable with the larger HSCs but the machinery can be a little heavier which normally means better fuel economy and better reliability.

A fast (28-30 knots) Ro-Pax ship, with a typical power engine output of 67 MW, can have a deadweight in the range between 6000 and 9000 tonnes, while an HSC (40 knots) with the same power output has a deadweight up to 1000 tonnes. The price for ten knots is obviously very high. In the following diagram a comparison of fuel consumption and speed is made between HSC catamarans, HSC monohulls and fast Ro-Pax ships. The fuel consumption is calculated in kilograms per tonnes (dead weight) and kilometres. The large spread of the HSCs can partly be explained by inaccuracies in published fuel consumption figures and also by the fact that these ships are very sensitive and the difference between levels of efficiencies of the ships is rather large.

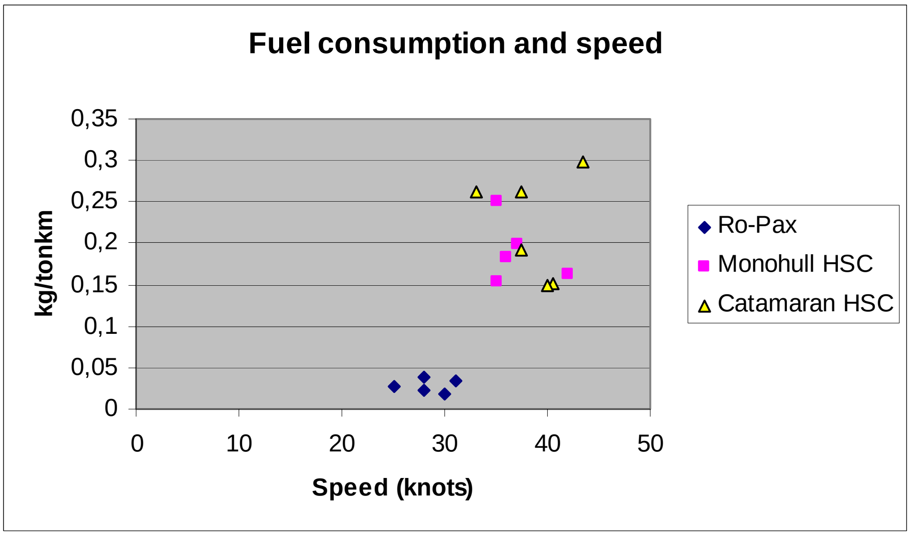


Figure 2.4. HSC and Ro-Pax fuel consumption in relation to speed

2.3.4 Ro-Ro Logistics

Different kinds of vessels affect the logistic flow in various ways, but the main aim for the ship to shore operations is to be safe and fast. Figure 2.5 illustrates methods for loading and discharging vehicles. Having more than one ramp in one or two levels and the possibility of driving through the vessel without turning reduces the required time and facilitates the flow of vehicles. The drive through concept also increases loading capacity with respect to the total number of cars and reduces the risk of running into somebody or something (like pillars), while turning the vehicle around.

The examples in figure 2.5a and 2.5b are only efficient on wide catamarans and allow the vehicle to drive on and off only at the stern, while 2.5c and 2.5d are common and effective drive-through solutions used on most high-speed craft monohulls as well as conventional Ro-Ro ships.

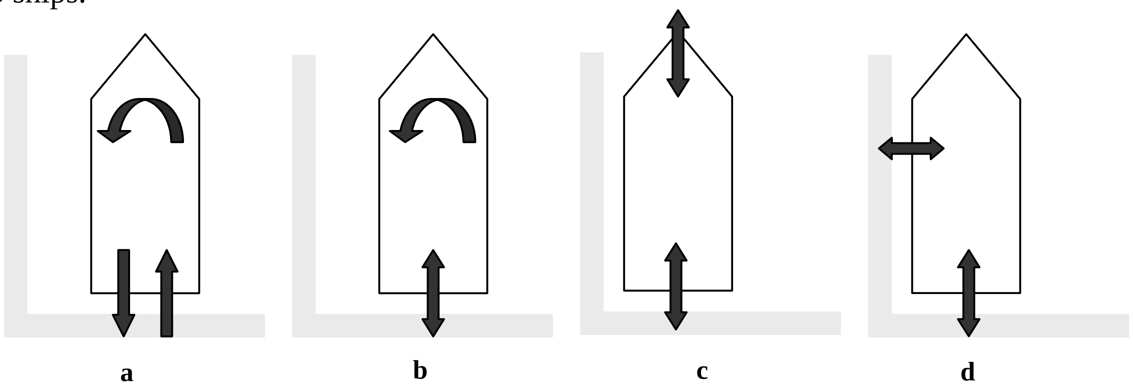


Figure 2.5. Methods for loading and discharging vehicles

3. The port and its surroundings

In addition to the quay, the port consists in short of a terminal building for sale and booking of tickets, check-in, information desk, waiting lounge, etc. There is a marshalling area for vehicles, i.e. cars, caravans, motorcycles, coaches, bikes and lorries, and a storage area for general cargo and trailers, for example. The port is open or closed (the latter will become more common) towards its surroundings. A schematic picture of the port is shown in figure 3.1.

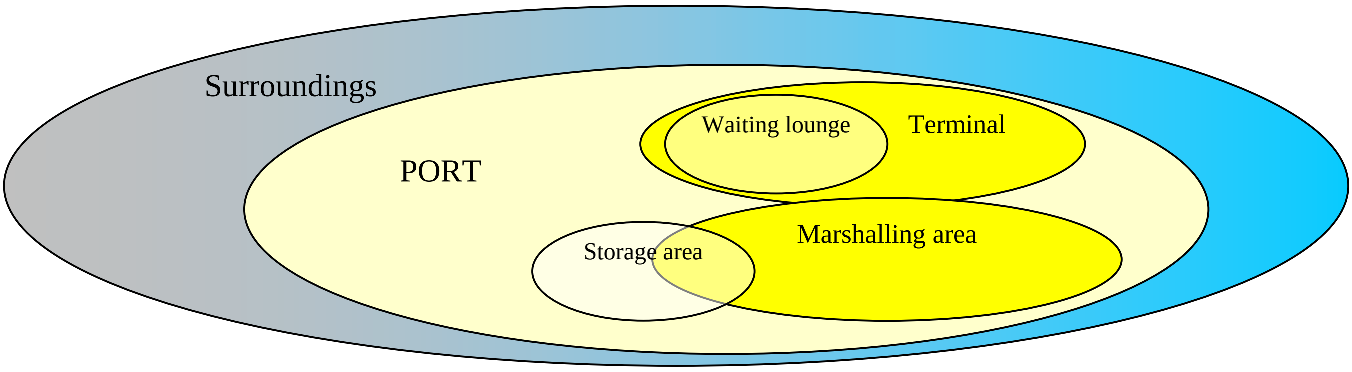


Figure 3.1. A port for passengers and cargo consists of a terminal building with a waiting lounge and a marshalling area including a storage space. The port can also dedicate areas for parking and storing cargo away from the vehicles in the marshalling area

Seaports, like airports, with goods storage depot and passenger flows, have a variety of security problems, including theft and terrorism. New regulations put greater demand on port security and this will result in more enclosed ports. The solution will depend on the extent and sophistication of the local problem and will cost money. What is sometimes overlooked is that most forms of security will take time, cause delays and involve a further layer of bureaucracy with all its related complications.

Before planning for the port layout, it is important to be familiar with the expected physical flow of goods, vehicles, and passengers, and with other premises that have effects on the complete port layout. As an example, a large flow of cargo and vehicles requires a large marshalling area and some categories of passengers might demand a waiting lounge. Separation of the various flows in the port is desirable and will improve safety and contribute to a more efficient and well-arranged logistic flow.

3.1 Port layout

All ports have different prerequisites to base the decision upon. In some cases dedicated facilities are necessary to reduce the turn around time, to improve efficiency or for other reasons. There are, however, places where the use of HSC is chosen for other reasons than optimal efficiency and the time in port is not a critical factor. In these cases heavy investments in the ports may not be of any benefit. Therefore, a port could also be very simple with more or less just a quay without purpose-built mooring equipment and terminal buildings. This will, however, increase the demands on the vessel. It is interesting to investigate transferability between different concepts and how it is possible to enhance the flexibility in service operations of high-speed craft while retaining efficiency.

Figure 3.2 Stena HSS terminal in Dun Laoghaire, a purpose-built high efficiency port with high investment costs, and with a turn around time of around 20 minutes

3.1.1 Terminal

The purpose of the terminal building is to serve the passengers. The information desk, booking office and such should be open to the public. A restricted waiting lounge separates passengers from other visitors in the terminal, and therefore the tickets don't need to be checked again before embarking. If required, customs checkpoints should be located inside the terminal. It is also easier to separate different kinds of passengers with dissimilar demands in a restricted area: first class passengers in luxurious and comfortable rooms, commercial customers in a separate area apart from tourists, and so on. A covered walkway from the terminal to the vessel protects the passengers from bad weather conditions, such as rain, wind or cold weather, see chapter *4.3 Passenger gangways*. This is perhaps more important in the north of Europe than in the south.

When designing a terminal it is important to keep in mind people's different needs. Lifts, escalators, moving sidewalks, flat ramps, and short walking distances to the vessel facilitate access for handicapped people in wheel chairs or with walking-frames, injured persons as well as people travelling with prams, strollers, heavy luggage, pets, etc.

3.1.2 Storage capacity and marshalling area

The marshalling area must be adapted to both incoming and outgoing vehicles, as well as lorries, parked trailers, general cargo, new cars for export/import, etc. depending on which kinds of cargo the vessel is carrying. The size of the marshalling area should be at least twice as large as the vessel's capacity and there should be separated lanes for embarking and disembarking vehicles. The marshalling area should be located inside the port's gate to facilitate a better organisation. The disembarking area inside the exit gate is recommended to be large enough to offer space for all vehicles in the vessel, in case there is a traffic jam or a red traffic light outside the gate. It also makes extra control (e.g. health or customs) possible if necessary without delaying the vessel, see figure 3.3. Finally, areas for storing and warehousing could be necessary in some cases and mapping of the possible flows of goods are important before planning for the need of a storage area.

Figure 3.3 Marshalling area at the STENA HSS terminal in Dun Laoghaire. Queues of vehicles are waiting for the foot and mouth disease control and customs chech

Another essential issue is parking places for foot passengers, who arrive at the port with cars. For security reasons, the parking places should be located outside the gates, but within a short walking distance.

3.1.3 Facilities

Facilities in port support the logistic flow and facilitate mooring and loading/discharging activities, as well as contribute to a safer and faster handling. For example, a manifold for fuel will result in faster refilling, prevent spilling and reduce the need for staff since it is manoeuvrable by one person (see chapter *3.2.5 Bunkering*). Further, an automatic mooring system, so-called automooring, will result in fewer risks for personal injury on land and also to a shorter turn around time (see chapter *4.4 Automooring*).

A simple ship to shore interface with no equipment on land for loading and discharging of cargo or embarking and disembarking of passengers is not suitable for handicapped people. The percentage of elderly people is rising in Europe, and with the increase in age comes an increase in disabilities. Recent guidelines point out the necessity of improved transfer between terminal and vessel for disabled persons. Passenger walkways with moving sidewalks and lifts are probably the best method to create a continuous flow of passengers.

There are also advantages of not having special purpose infrastructure and facilities in port for HSC. It gives greater flexibility as it allows other vessels to use the quays and the high-speed craft to moor in less developed ports. However, the benefit of flexibility must be compared with the drawback of carrying the ramps on board. It is recommended that lightweight vessels travelling at high speed install facilities for mooring/unmooring and loading/discharging ashore, as these heavy facilities raise fuel consumption greatly. Figure 3.4 and figure 3.5 below show two different kinds of ramps, one installed on the vessel and one on land respectively. The size of the ramp depends on the vehicles and cargo the vessel is carrying. Lorries or heavy general cargo require more robust ramps and are therefore also heavier. In that case facilities installed on land are even more preferable. It is furthermore not always a question about money when choosing between two solutions. Sometimes the surroundings and local conditions (e.g. tides) set the limit and put demands on the port.

Figure 3.4 Ramp built on the NGV Liamone

Figure 3.5 Ramp installed on land in the port of Barcelona for the Trasmediterranea Millennium

3.2 The logistic flow in the port

A general principle is that a separation of the flows reduces the risk of an accident. Therefore, the separation of the flows of vehicles, goods and passengers should be kept in mind throughout the development project.

3.2.1 Vehicles

Vehicles on board a high-speed craft can include cars, caravans, motorcycles, coaches and bikes. They all wait in the marshalling area before embarking, but in different lanes if possible. Bikes should be checked in separately from the cars and other motorized vehicles, and also from foot passengers. Figure 3.6 shows a sketch of the flow of vehicles at a conceptual port of departure. The passengers arrive at the port entrance to obtain a boarding card at the latest about 30-45 minutes before departure and immediately afterwards place their vehicle in an assigned lane. It should be possible for the car passengers to wait in their vehicle or in the terminal. After the vessel discharges incoming cargo, vehicles and arrivals, people embark and park their vehicles on the vessel’s car deck. Next, they walk upstairs to the passenger deck and stay there during the crossing for safety reasons.

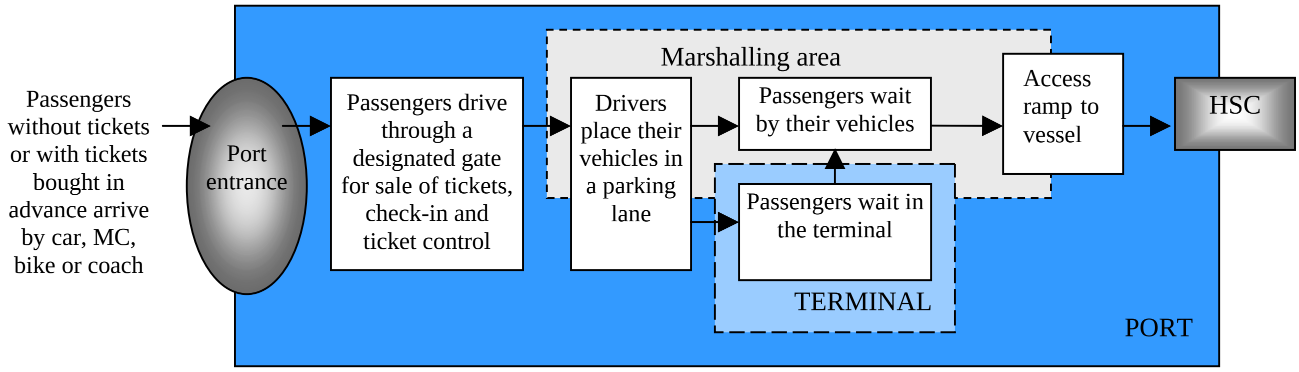


Figure 3.6 A general outline of a conceptual port of departure

When the HSC has reached the port of arrival the vehicles disembark and drive through immigration and customs (not necessary in all ports) and towards the port exit, shown in figure 3.7.

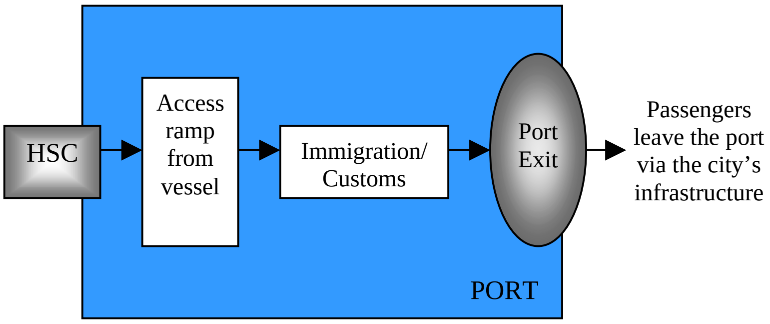


Figure 3.7 A general outline of a conceptual port of arrival

Each car passenger waiting in the marshalling area should have visual contact with the entrance opening at the vessel, where the easiest route onboard the vessel’s car decks is clearly indicated.

If required, it is possible to offer tickets divided into different classes. People willing to pay extra for late arrival in the port and fast disembarking from the vessel could be placed in a dedicated lane in the marshalling area.

3.2.2 Cargo

There are two principles for loading and discharging cargo onboard a ship: to lift on and lift off (lo-lo) and to roll on and roll off (ro-ro). The latter is most likely the method suitable for cargo handling for high-speed craft. There are various kinds of cargo that need separate treatment, which are shown in table 3.1. Trailers, cars for export, and general cargo are often loaded and unloaded by transport carriers or personnel working in the port, and do not require people on board the vessel during crossing. A lorry, on the other hand, is handled by the lorry-driver, who almost always travels with the vessel if the distances are not too long. General cargo in containers and on pallets is taken on board with lift trucks and trolleys. It should be pointed out that some high-speed craft are not able to carry lorries and trailers, because of their design.

Cargo	**Cargo carrier**	**Cargo handling**
All categories	Lorry	Lorry-driver loads and discharges the lorry and will in general stay on board during the crossing
All categories	Trailers	Trailers are loaded by a terminal tractor, which will not be transported on the vessel
New cars	———	The cars are driven on board from a storage area and are lashed down on board the vessel
General cargo	Pallets, containers, RORO-cassettes, parcels etc.	General cargo are taken on board by lift trucks, trolleys, crane etc.

Table 3.1 A general chart describing different kinds of cargo and carriers and how to load and discharge the cargo

HSC's light construction requires a careful organisation of heavy cargo and cars inside the vessel to preserve stability, without using more ballast water than necessary to avoid high levels of fuel consumption.

3.2.3 Foot passengers

Foot passengers arrive at the entrance to the port and terminal area by foot, public transport, taxi, etc. Next, they pass through sales of tickets / check-in and wait for embarking in the terminal. Some ports offer a restricted area for their passengers to wait in. A passenger walkway takes them from the waiting lounge to the vessel, shown in figure 3.8.

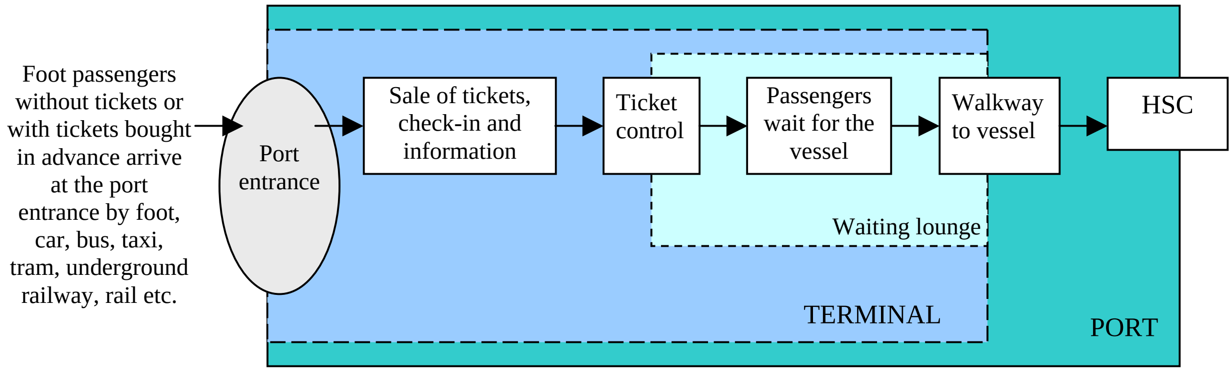


Figure 3.8. A general outline of a conceptual port of departure for foot passengers

Figure 3.9 shows the gangways from the vessel to the terminal. People walk through immigration and customs if requested, and leave the port. Simultaneous embarking and disembarking of foot passengers in separated gangways cut down the foot passenger's total time in transit. It should, however, be mentioned that there could exist restrictions or laws in some countries that forbid this, due to safety or security.

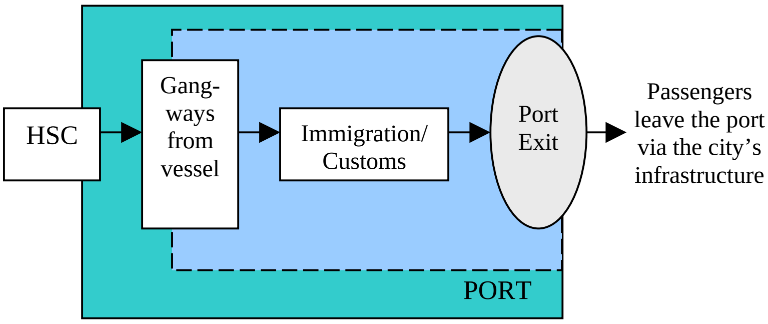


Figure 3.9. A general outline of a conceptual port of arrival for foot passengers

Some ports differ a great deal from the outlines shown above; ports could be in quite undeveloped areas and do not need specialised facilities and equipment. Other ports are an integrated part of the city and could, for example, have free access for pedestrians to the quay, which will affect the port layout.

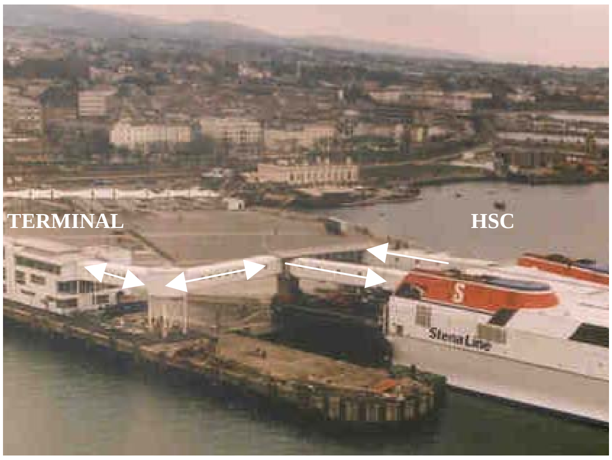


Figure 3.10 Embarking and disembarking of passengers in separated gangways in Dun Laoghaire

3.2.4 Luggage

In most ferry services the passengers carry their own luggage on board, but for some there are possibilities to check-in luggage as at an airport. The luggage is then loaded onto a small lorry for this special purpose. The luggage lorry leaves the vessel first before other vehicles and is discharged in the terminal.

3.2.5 Bunkering

In some respect, a high-speed craft is like an aircraft, which means that the operator (i.e. the ship-owner) wants to keep the displacement as low as possible and take the minimum required amount of fuel onboard. Consequently, bunkering is carried out on every journey, which requires special attention, especially during a short port stop.

There are three main techniques to provide high-speed craft with fuel, see figure 3.11:

- Tank lorry
- Lighter (bunker ship)
- Manifold connected to storage tank

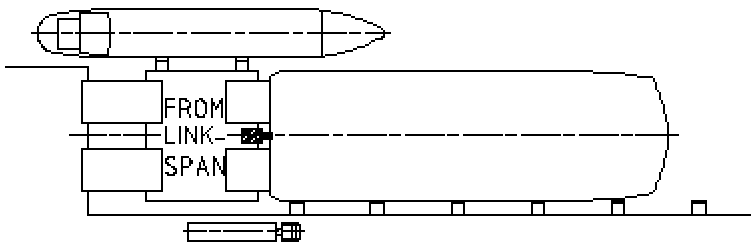


Figure 3.11 Three techniques to provide HSC with fuel

Using a tank lorry or a lighter for refuelling results in lower investment costs, though it will also lead to higher safety risks that are particularly a problem in ports where people have free access. Transport of highly inflammable liquid warrants very careful consideration. Furthermore, tank lorries and lighters need to be just in time to make refuelling possible in order to avoid delays. In other words there are great demands on the fuel transport system.

Figure 3.12 Tank lorries providing fuel to an HSC in the Port of Nice

An alternative is to have storage tanks in the port, allowing the lighter or the truck to deliver at any time. One feasible alternative is to install storage tanks in the pontoon of the linkspan. The tank is then hidden and won't interfere in the port area. For reasons of safety, it is recommended to fill the storage tank when the vessel is out on a journey and the port area is free of people.

Using a storage tank with a manifold is a very fast operation, allows frequent refuelling to keep the weight of the vessel down, and enables short turn around times. One person could carry out refuelling with the manifold in less than 10-15 minutes. Figure 3.13 shows a bunkering manifold that handles 5 different media simultaneously: diesel, sewage, bilge, sludge and fresh water.

The investment costs for a linkspan are rather high; the facilities take space and the manifold has low flexibility since it is installed for just one kind of vessel, but the handling is very efficient and safe. In order to keep the costs for facilities down, the fuel storage can be placed at the port of arrival *or* the port of departure. However, when storage is only in one port, reduced costs for facilities have to be compared with increased costs of transport (as a result of additional weight of fuel in the vessel), in order to avoid sub-optimisation and keep the total costs for the operation down.

Figure 3.13 Manifold in Holyhead that provides HSS 1500 with fuel and fresh water and receives liquid disposals

3.2.6 Fresh water

Fresh water is loaded into the ship's tanks through the manifold or a hose connected directly to the city water system or to a water reservoir. It is also possible to use a water lorry for lower investment costs than the first alternative, but with higher operational costs.

Refilling of fresh water is a fast and safe operation and does not require expensive special purpose facilities. Consequently, in order to keep the weight of the vessel down water can be loaded in each port before departure.

3.2.7 Catering

Food, beverage and tax-free goods (if present) require special attention. Catering handling is important in consideration of time to load catering onboard the vessel. By using catering prepared ashore the requirements for kitchen facilities on board are reduced (refrigerated storage areas and heating equipment for pre-catered food are still needed on the vessel) and by this means the total weight of the vessel is reduced. This also results in a reduction of the number of crewmembers.

The method of loading could be lifting with any type of lifting/hoisting machinery; rolling with the cargo placed on a trolley towed by means of a truck or a self-propelled rolling unit; or transporting on conveyor belts, see figure 3.14. Transport can also be carried out using combinations of these alternatives.

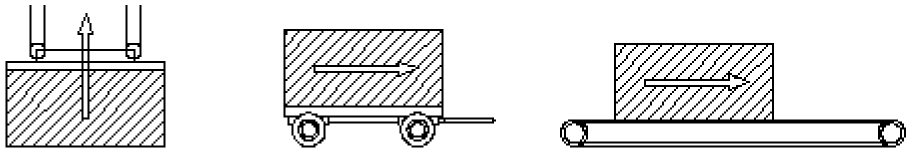


Figure 3.14 The basic principles for provisions handling

3.2.8 Wastes

Wastewater includes greywater, i.e. shower and dishwater, and blackwater, i.e. toilet water. Wastewater can in most countries be unloaded directly to the public sewage disposal system through a pipe or via a manifold to a storage tank. It can furthermore be unloaded to a lorry, but the operation is more time consuming and costly. Vessels are also allowed to discharge the dirty water at sea if the vessel is more than 12 nautical miles from land. This will, however, contribute to eutrophication and environmental pollution of the sea and is therefore not a sustainable action. The port also needs systems to handle bilge and sludge.

The garbage is discharged in a small container or is handled separately from the rest of the flow of cargo and vehicles.

3.3 Bottlenecks in flow efficiency

Bottlenecks are limitations or hindrances to the flow of objects, which involve time-delays and often also additional costs. Loading and discharging goods are probably the most time consuming operations in port especially if many units need to be handled. Consequently, the turn around time is prolonged.

One way to reduce or avoid heavy queues in the ticket office for foot passengers and at the designated gates for sale of tickets for car passengers is to increase the number of possible places of purchase. If customers buy tickets via internet, mail, by phone, travel agency or ticket machines, the check-in procedure will be faster and more efficient.

Broader passenger gangways, ramps for simultaneously loading and discharging, and extra entrance gates and lanes for vehicles can reduce problems such as blocked thoroughfares.

3.4 Variations in demand for a high-speed craft

When considering a new ferry service, or upgrading of an existing one, there are many factors to be taken into account in order to ensure commercial success. Most ferry services that fail do so because of inappropriate vessel selection, too high initial investment costs and overconfidence relative to the market that might be attracted. Therefore a market survey to determine the characteristics of potential customers and passengers is necessary as well as a financial analysis to establish profitability of the proposed service. In order to achieve efficiency, the flow should be as steady as possible. Hence, to get a sustainable shipping line, long-term variations in people's preferences as well as knowledge about seasonal variations and unbalances in the logistic flow are factors that need to be taken into consideration. Likewise external factors, which are very hard to control but are still very important to determine, should be considered.

3.4.1 People's long-term preferences

People may change their way of travelling for many reasons. Occasionally an external factor is the cause, for example a large shipping disaster makes people scared of travelling by sea. Other factors that affect the service are advertisement, a newly opened rival company, a circulated rumour about the service, good or bad reputation, etc. Under certain circumstances company needs some time to set up its business to gain a market share, but in other cases when the charm of novelty diminishes, the company will have problems achieving profitability. It is of course hard to foresee the need for new investments when there is uncertainty in decreased or increased demand.

When a newly established HSC service competes with an existing ferry service, it is particularly important to give the passengers a feeling of improvement and satisfaction compared to the old system.

3.4.2 Seasonal variations in cargo and passengers

Most routes for passenger traffic show seasonal variations, with a peak during summer holidays when people tend to travel more. The flow of cargo can also show variation depending on, for example, transport of a seasonal commodity or the state of the market. Ferry services try hard to improve the balance by offering cheap low season tickets or, if it is possible, to use the vessel on another more attractive route. If profitability falls below a critical value, the ferry service may adjust onboard staff or, if this is not enough, put the vessel temporarily out of operation until high season.

3.4.3 Unbalanced logistic flow

Sometimes people's travelling habits cause unbalances in the flow of passengers, i.e. the need for transport is larger in one direction than in the other. This occurs when there are alternative modes of conveyance on the return journey. Unbalances are especially a problem for transport of cargo. For instance, imagine a large city without manufacturing industries with great flows of food, commodity, etc. to the city but almost nothing except wastes leaving.

One way to handle the problem with unbalances in the logistic flow is to offer cheap return tickets for passengers and hauliers with the need of transport in the other direction. A well-balanced flow can be secured and costs for empty spaces can be reduced.

3.4.4 External factors

There are also external factors that cause fluctuations in the volume of different flows: a political decision may favour some transport mode, world economy and financial climate influence the flow of goods and passengers for all transport modes, competitors appear and vanish and customers' travelling habits change, just to mention some. The question is how is it possible to take all external factors into consideration when planning for an HSC service, especially when many of them are time dependent. Some external factors have an influence over a short time duration, but others change the whole transport service, for example when tax-free was stopped in 1999. One very essential factor for high-speed craft is the fluctuation of the bunker oil market prices.

Since long-term forecasting is almost impossible for a system when changes can occur unexpectedly, flexibility and adaptability are essential for a transport service to survive.

3.5 The port in the city

Heavy congestion in port areas that causes bottlenecks is an important issue. This is above all an infrastructure related problem on land, especially in larger ports, but there are also problems with the shore to port leg of the journey, which is especially critical for high-speed craft. The arrival and departure of the HSC will therefore put important demands on the existing infrastructure. These demands have the potential to increase if there is an increase in the flow of passengers, goods and vehicles, after the service has been operating for a few years.

Many ports have developed over the centuries and are therefore often located in the city centres, which puts great demands on the infrastructure connected to, and in the area around, the port. Ports for HSC need to be easily accessible and need to be located in areas that are easily reached by passengers. The resulting space limitations for the craft can cause problems such as small marshalling areas for lorries and little space for handling general cargo.

Port congestion and delays arise when port capacity is insufficient to cope with the traffic leaving from or arriving at the port. It can occur at any port if there is a sudden upsurge in local demand, seasonal variations or many other reasons. The designated gates for car passengers and lorry drivers should be placed in the best possible way to avoid queues at the port that disturb the city's road network system.

For regular passenger services port congestion as a consequence of few berths is most likely not the problem, as they often have dedicated berths. The problem is congestion in the harbour entrance and harbour area. In some ports high-speed craft traffic needs to compete for space with cruise ships, transport ships, yachts and pleasure boats. The presence of these other vessel types can mean that there is less room to manoeuvre, a lower speed is required in port, turn around times are longer, and finally, safety can be reduced.

4. Design of ship to shore facilities

As previously described there are a number of factors influencing the level of technology and as a result the investment level at a terminal. One example is the berthing condition at the port of call, e.g. the level of tide fluctuations and weather conditions. The need for short turn around time is also crucial. If the ship stays in port for hours between its journeys it is not necessary to build up a state of the art port, but if the time schedule is tight, advanced equipment will save money and time.

The terminals developed for Stena Line's high-speed services in the Irish Sea and the North Sea are examples of very advanced technology. In the following sections the technical state of the art will be described, and also some shortcomings that could be further developed. The existing terminals are tailor made for one ship type and one challenge is to develop a standard that would allow different types of catamarans and monohulls to use the same equipment.

4.1 Berthing possibilities

There are three main types of berthing/loading operations:

- L-shaped berth with loading via the stern or with the stern connected to the quay for stern loading
- Normal quay with vessel berthed longitudinally and loading via the shipside
- L-shaped berth with loading via the bow

The most common berth configuration is an L-shaped quay with an extension. This berth configuration allows accurate and exact positioning for fast and simple mooring, and covers both L-shaped loading alternatives. Longitudinal berthing has limitations with regards to loading of coaches and lorries as vessels normally load via the bow or stern. The different berth configurations are shown in figure 4.1.

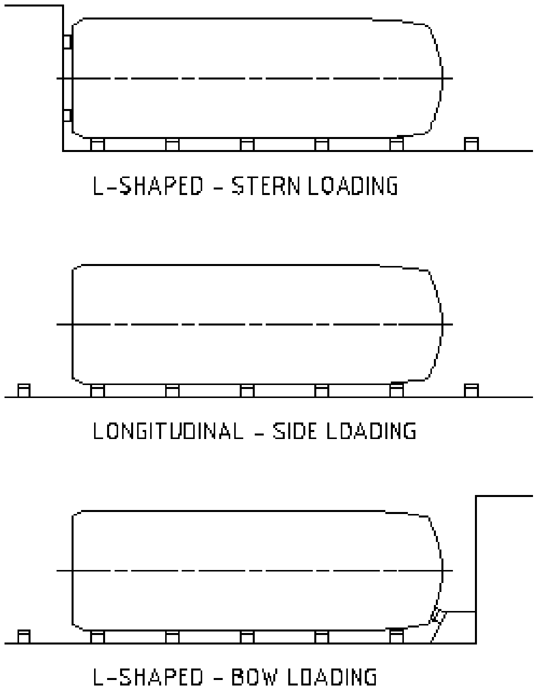


Figure 4.1. Main positions for berthing

4.2 Linkspan

A linkspan is installed to provide access to the vessel for the wheeled vehicles, and is the link for bridging the height differences between the quay and the ramp or the entrance deck. With the aforementioned berthing pattern the access could be carried out with a linkspan fitted to the stern, see figure 4.2. Stern access requires the ship to have a sufficient beam dimension to allow the vehicles to turn inside the vessel in the cargo hold. This is suitable for catamarans carrying lorries, with beams of 30 metres and larger.

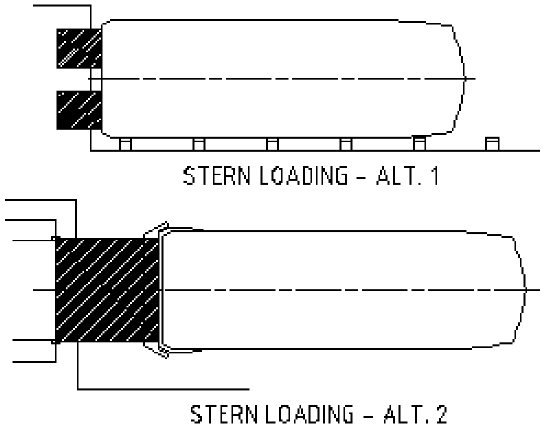


Figure 4.2. Linkspan arrangement connected to the stern

With the vessel berthed for bow loading at an L-shaped quay, a continuous flow through the vessel is possible, see figure 4.3. The principle provides even faster cargo handling when the embarking vehicles enter via the bow.

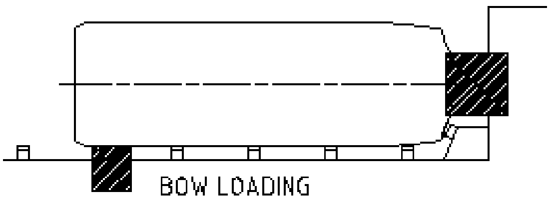


Figure 4.3. Linkspan arrangement built on quay and quay extension

With the vessel berthed along the quayside, loading through side doors is an alternative, see figure 4.4. Side ramps are placed at the bow and at the quarter to ensure continuous traffic flow through the vessel. Side ramps limit rolling cargo to passenger cars, because it is normally narrow in the cargo hold, preventing larger commercial vehicles from turning inside the vessel. The quayside alternative is suitable for areas with limited water level variation.

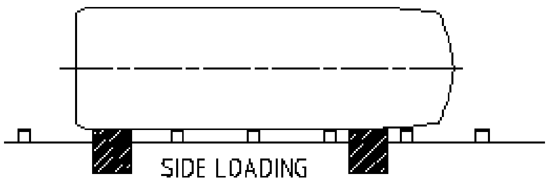


Figure 4.4. Linkspan arrangement built along the quay

The linkspan can be divided in 3 different main types: floating, semi-floating and quay based, shown in figure 4.5.

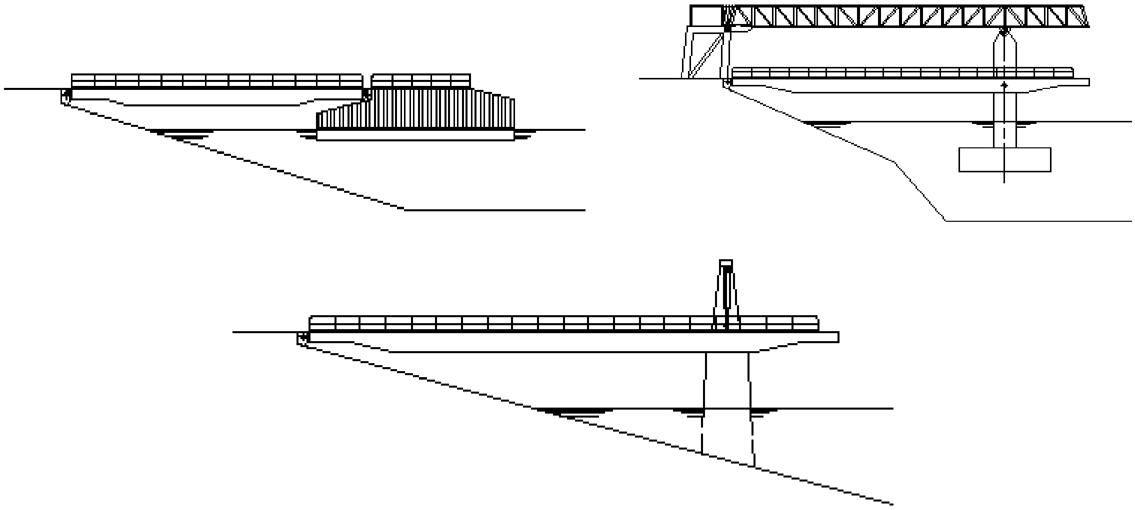


Figure 4.5. Principles for a floating type linkspan, semi-floating linkspan of the type used by Stena Lines HSS 1500 catamaran and quay-based linkspan operated by means of hydraulic cylinders and without counter weights

An important factor for the linkspan, and likewise the ramps, is the transition angle, which is recommended to be less than 5 degrees to guarantee safe boarding. The distance between the knuckles varies depending on the axle configuration of vehicles using the facility. The clearance between the chassis and the ground has been reduced in recent years to increase lorry carrying capacity without increasing height. Bridges and overhead wires in the road infrastructure have limited extensions in height. Furthermore, the shape of the linkspan and ramps is recommended to be as straight as possible and bends are to be avoided to ensure fast and safe cargo handling.

Figure 4.6. Linkspan for Stena Line Catamaran HSS 1500 in Dun Laoghaire, including passenger gangways

4.3 Passenger Gangway

A passenger gangway is usually a tube construction with a movable telescopic part that can be placed against the vessel. The gangway is normally built as a truss and in general the sides and roof are covered with glass or sheeting to protect foot passengers from wind and rain. The gangway separates the foot passengers from all wheeled vehicles, and is normally located 3 to 5 metres above the lanes.

It is practical to locate the waiting lounge for departing passengers on the same level as the entrance deck for a vessel in mean draught in a mean water level. With this arrangement the access will be rather horizontal, and slopes are avoided or minimised. Slopes in passenger gangways will have to meet guidelines for disabled persons in the near future, which means that all fixed structures need to follow the local building codes in respective countries. Arrangements with stairways and lifts can also be used if the elevation difference between the terminal floor and vessel entrance deck is large.

Passenger gangways can be arranged in three main locations:

- Access from the terminal via the passenger gangway through a door in the bow
- Access from the terminal via the passenger gangway through a stern door
- Access from the terminal via the passenger gangway through a side door on the vessel

Loading via the stern or bow is common in the United Kingdom and it is a good solution when vessels are operating in waters with extensive tidal variations or when the vessel is berthed parallel to a narrow pier without any possibilities to build facilities for passenger transfer. In this case the terminal building must be built in proximity to the stern or bow, see figure 4.7.

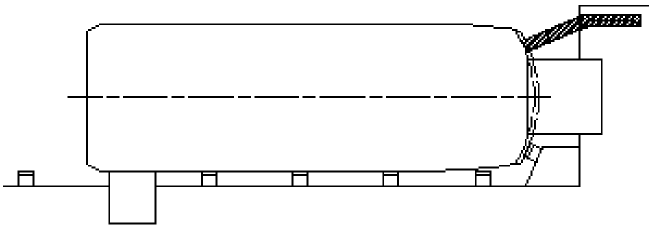


Figure 4.7. A passenger gangway for handling foot passengers via the bow

A special installation was made for transfer of foot passengers onboard and off Stena Lines HSS 1500: it was outfitted with two 3.5 metres wide passenger gangways. The reason for the two gangways in this case was the great number of foot passengers and the very short turn around time of less than 20 minutes. The arrangement is shown in figure 4.6 and 4.8.

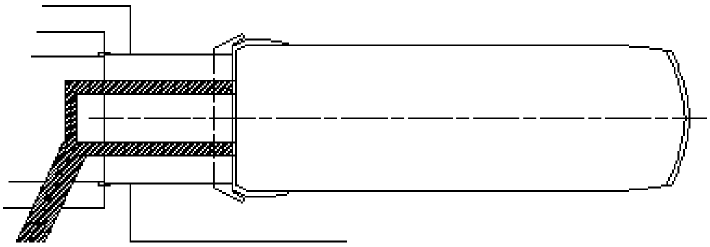


Figure 4.8. Passenger Gangways connected to the stern of Stena Lines HSS 1500

The most common arrangement for foot passenger access is via a side opening in the vessel, see figure 4.9. Normally, this solution gives the shortest walking distance, which is important for a short harbour stop.

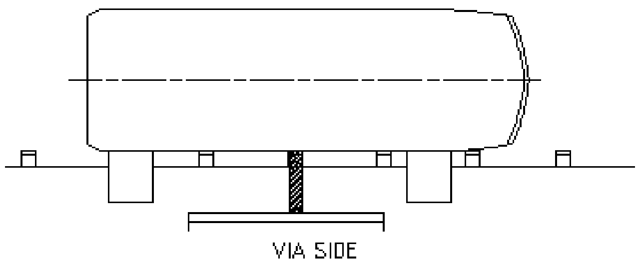


Figure 4.9. A passenger gangway fitted perpendicular to the vessel's centre line

Flexibility is a characteristic that needs to be evaluated when a movable passenger gangway is to be installed. There are three types of interfaces to be considered for an articulated passenger gangway that provides access to a vessel's side: a single point interface; a line interface; or an interface anywhere within a pre-defined rectangle, see figure 4.10. Bow or stern access gangways are more or less tailor made and fall outside these alternatives.

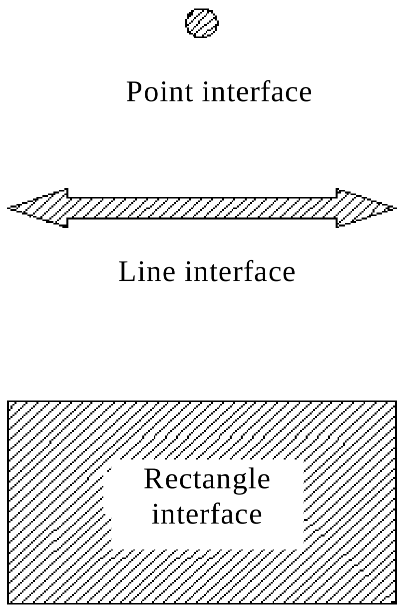
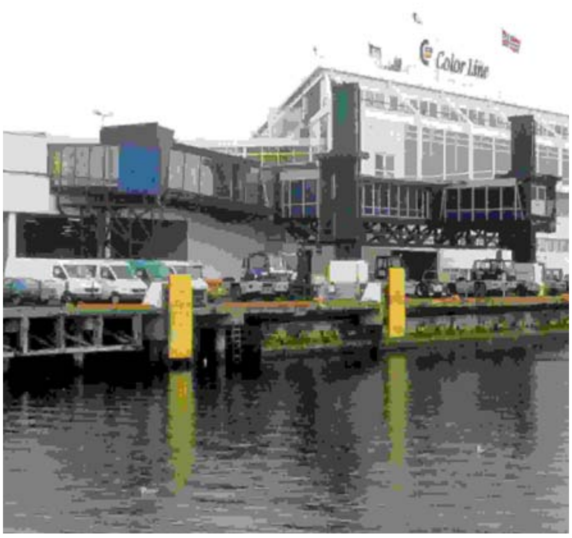


Figure 4.10. The different possibilities for a passenger gangway installation. The point interface fits one vessel type only, the line interface fits vessels with same freeboard height to door thresholds and the rectangle interface fits all vessels for which the system has been planned

A passenger gangway that interfaces with the vessel at a *fixed point* limits the use to one type of vessel when the stern or bow is positioned for unloading/loading in port. It is the cheapest investment, but it can be very costly in the long run. Ship-owners change the transport capacity rather often due to changes in the market.

A passenger gangway that interfaces *along a line* is in principle built in the same way as the fixed-point interface, but it is constructed on a trolley allowing the position along the quay to be changed. The passenger gangway still has a limitation and can only be used for vessels that have side doors fitted to the same height. If the freeboard to main deck distance deviates between two different vessels and if one of the vessels is planned to transport passenger cars and the other one to take coaches other solutions must be used.



A passenger gangway that can interface within a *rectangle* is the most flexible alternative. With this alternative the passenger gangway can be moved along the quay and also hoisted up and down to fit side doors with different elevations. Even if the investment cost is much higher it gives the port the possibility to accommodate different ship owners' requirements, and start up times will be short because existing installations do not need to be modified. See figure 4.1.

Figure 4.11. A flexible passenger gangway serving a rectangular area on the ship's side

4.4 Automooring

Automooring is a robot system that secures the vessel to the quay without conventional ropes, see figure 4.12. The operation is suitable for quays with a high frequency of calls, since the investment costs are quite large. The costs of the heavy manual work required for conventional mooring can thus be reduced. The safety and cost benefits of an automooring system were assessed in TOHPIC work package 3.

Figure 4.12. Automooring unit in activated position, seen from above

The size of the automooring unit is determined after an evaluation of the physical forces in the harbour basin and depends also on the projected area of the vessel. The number of units depends on the berth, but in most cases two units are used. Figure 4.13 shows some examples of automooring configurations.

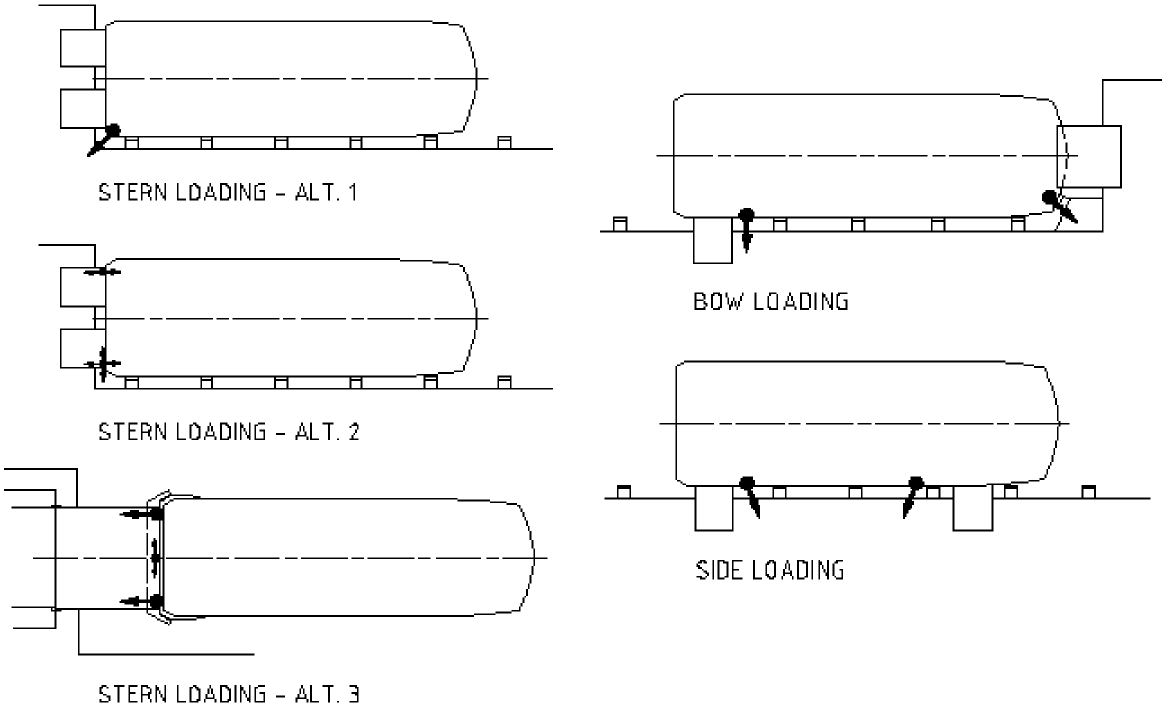


Figure 4.13. Examples of automooring configurations

5. Environmental impact

5.1 Location, Land use and Infrastructure needs

Obviously, a high-speed terminal needs to be located and designed to avoid bottlenecks in the traffic flow and to facilitate short turn around times in the port. Ideally, the terminal should be located close to major roads and public transportation facilities. Unfortunately, such locations are often densely populated, which causes problems due to concerns about emissions and noise from terminal activities.

Another aspect to consider is the length of the voyage approach (speed restrictions). A high-speed craft needs to be operated at high speed for the better part of the voyage in order the reach high efficiency. Therefore, the selected location should enable a short approach as well as be in close proximity to passengers and cargo.

Regarding environmental aspects of land use, normally there are no concerns if the terminal is built in areas that have already been developed. However, if new land is used there are a number of directives to consider, some with very strict requirements. A directive that has caused problems for port developers is the "Birds and Habitat" directive. The directive states: "Since the destruction of natural and semi-natural environments is the most serious threat to birds, the Directive focuses on preserving, maintaining and re-establishing a sufficient diversity and area of habitats. In particular, this includes the creation of protected areas and biotopes and the restoration of destroyed biotopes".

These measures primarily concern vulnerable and rare species and those in danger of extinction. Such species shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction. A list of 181 such species and sub-species is presented in the Directive.

5.2 Emissions from vessels

Vessel emissions are probably the most important environmental issue with HSC. Short approach, quick turn-around, the possibility to shut down machinery at quay side, shore connection (electricity), fuel quality, and easy manoeuvring in port, are just some factors affecting vessel emissions in the port.

EU Air Quality Directive 1999/30 will give the authorities an instrument to prevent operations that contribute to exceedances of limits set for ambient concentrations of specific air quality parameters. The EU member states are now successively implementing this Directive, with full implementation expected before 2010. In that perspective, it is essential not to allow unnecessary emissions due to bottlenecks, long turn-around times, etc.

Concerning air pollution, the surrounding infrastructure should also be considered. Stena Line have, for example, experienced situations where their efficient operation is stalled by municipal traffic lights outside the terminal area, which creates queues that lead all the way back to the vessel. This is both a logistical and an environmental problem to watch out for.

5.3 Emissions from vehicles

A ferry operation will hopefully attract many vehicles. Since a terminal often is located in a (densely) populated area, problems can arise regarding emissions and noise from vehicles and goods transport.

It would be advisable to look at the anticipated flow of vehicles to and from the terminal and try to identify potential bottlenecks and adjacent neighbourhoods along the routes that may be affected. Some types of cargo require that engines be kept idling (frozen goods and air-conditioned carriers). Make sure that these carriers are stored remotely on the quay and that connection to a power grid can be provided.

5.4 Hydrodynamic effects influencing environmental impact and operational safety

Wash waves, Squat effects and Interaction effects between ships are all hydrodynamic effects that influence the environmental impact and/or the operational safety. The magnitude of these effects depends partly on the ship's speed and partly on the relative areas of the underwater cross section of the ship and the water through which it is moving. Speed, beam, draught, channel width and water depth are important parameters.

The influence from these effects needs to be assessed if the HSC is going to be operated in narrow passages and relatively shallow water. The hydrodynamic effects are further explained in TOHPIC report D1.4.

6. Safety aspects

In order to plan and implement HSC service in a new area it is necessary to carefully assess the risks thisit may imply to the surrounding activities and environment. In the planning phase a preliminary risk assessment should identify problems that have to be solved. Typical items could be:

- Hazard recognition and control, e.g. handling of dangerous goods in the port area.
- Operational risks in the specific port, traffic density, pleasure craft, currents, wind and wave protection.
- Safety procedures when refuelling
- Emergency vehicle access to the pier
- Security problems

6.1 Preliminary risk assessment

One method that could be recommended for this risk analysis is "Structured What If Technique" "SWIFT". In this method, originally developed for process industries, risks can be identified and analysed. Potential risks connected with a system are investigated by posing questions in a systematic manner. For the analyses of the ferry system the method will be adopted accordingly.

Several risk analysis methods take an approach that requires a system or a procedure to be investigated step-by-step or part-by-part. Although these methods are time consuming, they provide complete and detailed coverage. On the other hand the overall view may be lost. The SWIFT method is more system oriented; the whole system, parts of the system or operational procedures are analysed at the same time. This means that the analysis goes faster and time-consuming discussions about questions of little consequence can be avoided. The coverage is guaranteed by conducting the analysis according to a fixed scheme. The analysis is carried out as a structured brainstorming by a group of specialists with theoretical and practical experience from the actual operations and systems.

6.2 Ship/shore information exchange

An efficient ship/shore information exchange that provides details on specific constraints and requirements is needed during the port approach phase. These requirements generally apply in areas where the traffic is heavy, the geographical features are complex and the environment is sensitive.

6.2.1 Importance of Vessel Traffic Systems (VTS)

The port operator should be considered as a service provider, considering that it has to organize a safe operation and, to that effect, make specific rules or procedures and also to play its part in implementing national and international rules. The presence of an effective Vessel Traffic Systems (VTS) is a primary requirement. This seems rather obvious, but it is not always present in ports that operate high-speed services. In an ideal situation, the VTS should be able to cover the following functions:

- Cover areas where radar coverage is hardly feasible, like rivers and archipelagos
- Identify radar blips on the VTS radar automatically
- Interrogate ships for information regarding type of cargo
- Continuously track, with a high update rate, the risk generating targets
- Determine the size and draught of ships in the vicinity
- Detect in real time a change in a ship's heading
- Allocate priorities dealing with COLREGs and port regulations

6.2.2 Vessel Traffic Systems (VTS) and Automatic Identification Systems (AIS)

The AIS (Automatic Identification Systems), is soon going to optimise to a great extent the safety of navigation as well as its management, both for vessels and for maritime traffic control services. The establishment of global AIS in general, or a land-based AIS reception network in particular, may actually reduce the need for VTS in many areas. The cost of installing and maintaining an AIS network is minute compared with a VTS radar network.

6.3 Port regulations and procedures

Requirements for safe navigation of high-speed craft within the local context are defined within the international framework of the IMO Collision Regulations (COLREG 1972), local regulations, and to a large extent by regulations by port authorities. Port authorities are entitled to regulate the speed limits, the routes and the need for pilots. It is recommended to take the following observations into account:

Route and speed regulations need to be tailor-made, taking specific features of each location and each individual hull into consideration when specifying speed limits along the route. Corresponding requirements should be carefully targeted, in order to make them effective and to fit each situation. As an example, the application field of such regulations should not necessarily refer to the definition of a high-speed craft in SOLAS Chapter X, but should rather refer to a maximum operational speed.

Pilotage is impractical for vessels that operate under tight time constraints, and the most common response to this restriction is issuing restricted pilot licenses to fast shipmasters. Shore based pilotage is an alternative to be contemplated. The main requirement for its safe and efficient operation is to have an extremely close link between the VTS operators and the pilots. The most strongly recommended solution is to locate the shore based pilot in the VTS control room itself.

An obvious danger in certain ports is the allocation of **priorities for port entry**. Priority should never be the stake for a dangerous competition between arriving vessels. One mission of the VTS, not the least in terms of safety, is to be the referee in such issues, which is effective only through its early intervention, on the basis of a well-established code of practice.

7. Checklist

The functionality and efficiency of the HSC operation is clearly depending on a number of critical parameters. The proper consideration of these factors will form the requirements for a successful establishment of an HSC line.

Many of the parameters were discussed in the previous chapters and the following could be seen as a checklist in order to ensure essential factors are not forgotten. Depending on your specific establishment some questions could be crucial while others could easily be checked off.

7.1 Market needs and business opportunities

Main parameter	*Specific considerations*	*Comments*
Passengers	High season, average, low season	The basis for passengers often fluctuates through the seasons. A careful market evaluation is needed.
Cars	High season, average, low season	
Rolling goods	High season, average, low season	
Need of regular daily time schedule	High season, average, low season	
Competition	Other shipping lines, land transport, air transport	
Level of efficiency	Will the HSC run on a tight timetable	
Level of comfort		This could be a tool to be competitive.
Cheaper alternatives		
External factors	Fluctuations of the bunkering market People’s long-term preferences Seasonal variations in cargo and passengers Political decisions	
Permission to operate HSC	Environmental impact EU directives Local regulations	In addition to a number of EU environment directives there may be local restrictions and regulations pertaining to HSC operations. It is necessary to check with the authorities at an early stage.

7.2 Location

Speed restrictions	Inbound and outbound routes and speeds. Length of passages with speed	

	restrictions	
Weather conditions and protection	Tide, wind, waves	The harbour should be weather protected to facilitate a fast and safe mooring. Statistics and local experience need to be assessed.
Physical requirements	Draught Air draught Beam LOA	An HSC has often a small draught however the squat effect is limiting high speed in shallow waters (See Chapter 5).
Distance between ports	Distances at open sea Distances with speed restrictions	More than 4 hours in open water is normally not recommended. In areas with frequent rough sea conditions the time that is considered comfortable is shorter.
Flexibility		Equipment for high efficiency in port may decrease the flexibility for different ship types etc.
Port connections	Roads, traffic jams, busses, trains	
Available facilities, need for investments	Terminal Equipment Restoration	Compare with “on board and on shore” below

7.3 The ship

Need of capacity	Confirm with market needs	
Operational limitations	Wave height	
Weather statistics	Wave height Weather conditions	Since high-speed craft are more vulnerable to bad weather conditions than conventional vessels, it is important to evaluate the number of cancelled journeys and find out how you will be able to decrease them.
Efficiency and flexibility requirements, level of technical sophistication	Specific requirements on manoeuvrability. Onboard ramps and gangways. Technical equipment onboard	Onboard ramps and gangways make the ship more autonomous however HSCs are very sensitive to weights and the onboard equipment will cost in load capacity or fuel consumption.
Level of comfort	Suitable for first class customers, commercial	

	drivers, etc.	
Loading capacity	Number of passengers Number of vehicles (cars and lorries)	
Turn around time	Facilities Flexibility	

7.4 Port layout

Need of berth length and layout	Own berth or shared with others	
Need of port area	Marshalling and terminal area Additional storage area for goods Parking area Turn around time	Order in the loading of goods/vehicles/passengers, identification of bottlenecks.
Port gate	Security control Secured / restricted areas Check in gate Ticketing facilities (automatic device) Access to the port and terminal facilities with / without vehicles Timing Port dimension	
Port surroundings	Infrastructure Bottlenecks in surrounding city traffic system Timing Community response	
Need for terminal facilities	Terminal building/ weather shelter Ticket office Ticketing facilities (automatic device) Check in desk (including customs if applicable) Waiting area (depending on the ticket class) Catering storage Secured / restricted areas, risk control. Toilets Cafeteria Fencing and gates Catering storage	
Storage and marshalling area	Size of the marshalling area	

	Need for storage	
Need for onshore equipment	Linkspan Gangways Mooring control Remote control Sewage reception Garbage reception Fuelling	The level of ship to shore equipment depends on the need for high efficiency and flexibility. Dedicated pontoons, ramps, infrastructures for simultaneously loading / unloading increases the efficiency for one specific ship, however this reduces the flexibility to receive different ship types.
Flexibility	Alternative use of the berth and the port facilities	

7.5 The logistic flow in the port

Ship to shore	Vehicle position in the ship Dimension of gateways, number of gates	
Vehicles, passengers	Separation of the flows of cars / lorries / coaches / motorcycles Identification of bottlenecks Passenger gangways Handling of luggage Waiting area (depending on the ticket class) Access to the port and terminal facilities with / without vehicles Path / sequence for leaving through the loading area Check-in time Walking distances	
Cargo	Path / sequence for leaving through the loading area	
Catering	Automatic loading and unloading of catering supplies, Timing	
Wastes	Versatile ship system simultaneously discharging sewage systems and wastes Management of wastes, separately from the other goods	
Booking service	Internet	Extensive possibilities for

	Telephone Mail Travel agency In terminal	booking can speed up the check-in process and avoid bottlenecks and delays

7.6 Ship operation

Arrival and departure: Manoeuvrability of the ship at terminal approach	Simulation of harbour approach and mooring manoeuvres. Characteristics of the vessel for enhancing the approach procedure efficiency.	Simulation is often a safety requirement when new ship types are introduced to a port. It can also help the owner to decide on the proper thrusters capacity etc. For further information about simulations, see WP4.
Procedures for the approach of the HSC in the terminal	Control from the shore: need for reporting to VTS, route planning	
Efficiency requirements	Critical time Timing of the entire approach Turn around time Time schedule	
Wash waves, squat effects and interaction effects		Influencing the environmental impact and/or the operational safety

7.7 Onboard and onshore

Procedures and operations for mooring/unmooring	Role of the onboard crew and onshore assistance. Need for staff onshore.	Control from the shore. Responsibilities: who is in charge of monitoring the mooring/unmooring procedures, onboard / onshore? Reliability of the system in adverse weather conditions. Timing of the procedures
Preliminary risk assessment	Hazard recognition and control, e.g. dangerous goods in the port area Operational risks in the specific port Safety procedures when refuelling Emergency vehicle access to the pier	Some countries have restrictions or laws that forbid simultaneous loading and discharging
Preliminary environment	Land use	EU directives and local

impact assessment	Emissions, from ship and vehicles Noise Wash waves Sewage and waste discharging	regulations.
Vessel Traffic control	Existing VTS and need for improved VTS. Radar coverage Surrounding Ships info. Remote piloting Priorities	
Automatic Identification Systems (AIS)		
Port regulations	Speed limits Routes Pilotage requirements Port entry priorities	Local regulations and requirements