Strategies and innovations to improve the performance of barge transport

Bart W. Wiegmans* and Rob Konings**
Delft University of Technology
OTB Research Institute for Housing, Urban and Mobility Studies
P.O. Box 530
2600 GA Delft
The Netherlands
* tel: +31 (0)15 278 3005
fax: +31 (0)15 278 4422
e-mail: B.Wiegmans@otb.tudelft.nl

** tel: +31 (0)15 278 7669
fax: +31 (0)15 278 4422
e-mail: R.Konings@otb.tudelft.nl

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The extended competitive forces model is a tool for analysing the barge transport market in Europe. This paper examines several sub-sectors in the barge transport market with the aim of identifying potentially successful innovations and strategies for improving competitiveness. Barge transport faces some tough challenges if it is to significantly enhance its competitive position.

1. Introduction

Freight transport by barge is growing in a modest way. However, it is perceived of considerable societal importance to achieve sustainable mobility. The European Commission sees barge transport as an important mode in the overall transport system. Given the huge congestion problems on the European road network, it might be useful to explore the possibilities of transporting freight by barge instead of by road. Much of the capacity of inland waterways is still unexploited, thereby suggesting that there is scope for more freight transport. The aim of this paper is to ascertain the potential of barge transport as an alternative to road transport. As this potential might need new concepts in order to be realised, we shall concentrate our attention on strategies and innovations which might improve the competitiveness of barge transport. Section 2 addresses the barge transport sector and the innovations. Section 3 deals with the extended competitive forces model. Section 4 analyses the competitive position of the different barge transport sub-sectors and the respective innovations. Section 5 presents the conclusions.

2. The barge transport sector and innovations

2.1 The barge transport sector

Most of the freight in the barge system is transported between seaports and the hinterland. Thanks to its extensive network, barge transport is ideal for carrying sea-borne cargo on the next stage of its journey to inland destinations. This applies almost invariably in the case of liquid cargo (such as crude oil), dry bulk (grain, ore) and containers. Hence, barge transport is indirectly, but strongly involved in large worldwide flows of bulk transport. The importance of barge transport varies widely from continent to continent. For example, in Europe, it has evolved mainly in the north west (the Netherlands, Belgium, Germany and France) (Wiegmans, 2005). The current important role played by barge transport may be largely attributable to the large capacity and relatively high quality of the inland waterway network. There is, however, also plenty of potential for barge transport in Eastern Europe, so – all in all – we can expect Europe to form the stage for key innovations in barge transport in the future. It is with this in mind that this paper will also focus on Europe (see figure 1).

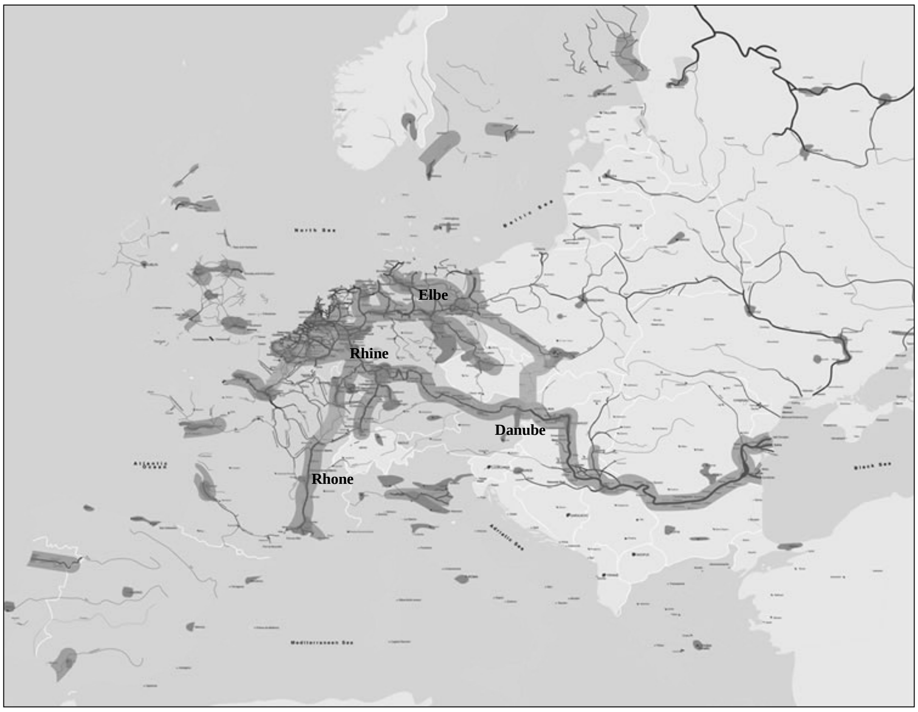

Figure 1. Inland waterways in Europe
Source: based on www.inlandnavigation.org (2004)

The European inland waterway network stretches for around 30,000 kilometres, almost 20,000 of which are in Western Europe (Germany, Belgium, France, Austria and the Netherlands). There are wide variations in the conditions of the waterway network. Only 50% is accessible to 1,000-ton vessels. The network is a mix of large, high-capacity rivers such as the Rhine and Danube with excellent links to seaports and small-scale waterways. As barge transport is generally long-distance and the load capacity is determined by the worst bottleneck on the route, competitiveness is undermined by differences in the quality of the infrastructure. In other words, competitiveness is inhibited by the draught (particularly important for bulk goods) and bridge clearances (particularly important for container traffic) on the weakest stretch of the route. The European waterway network has some well-known missing links, which are difficult to fill by the construction of new waterways because of high investment requirements and budget constraints. However, one of the ambitions of the EU Trans European Network Programme is to solve the major missing links and bottlenecks in the infrastructure. Probably the most prestigious project in barge transport is the Schelde-Seine connection in France, which is due for completion in 2012. Meantime, national and regional governments are working on the removal of local bottlenecks (raising bridges and dredging river and canal stretches).

There are two main types of barge: i) self-propelled vessels; and ii) push boat-push barge formations. The wide scale of barge transport (loading capacities ranging from 350 to over 11,000 tons) makes it an all-round mode on the one hand (through the use of many small waterways) and a cost-efficient mode on the other (through large-scale operations). The diversity of the vessels means that many different kinds of products can be transported efficiently. Most vessels can transport different types of products and can therefore be flexibly deployed. A clear distinction exists, however, between vessels for dry cargo and liquid cargo. The fleet is dominated by vessels for dry cargo (see table 1). The average age is fairly high, because of the long life expectancy (50 years). This long life expectancy hampers speedy adjustments to changing market circumstances and innovation in the fleet.

Table 1. Characteristics of the inland shipping fleet in the EU-15 (2003)

	Number of units	Total capacity (1000 tdw)
Dry cargo		
self-propelled vessels	6788	6062
push barges	2593	3307
towing barges	273	235
Liquid cargo		
self-propelled vessels	1375	1615
push barges	164	244
towing barges	21	6

Source: Buck Consultants International et al. (2004)

In 2000 a grand total of 438 million tonnes of cargo was transported by barge in the EU, 215 million and 223 million of which were domestic and intra-EU-15 freight respectively. These volumes represent modal shares of 3.5% of the total freight volume, only 1.8% of the domestic freight for all 15 EU countries, but 26% of all freight crossing EU-15 borders (Buck Consultants International et al., 2004). These figures plus the fact that 97% of all international freight stems from traffic between just four EU countries (the Netherlands, Belgium, Germany and France) underscore the distinctive role of the barge sector at regional level, but also suggest room for growth.

The sector can be mapped out in greater detail by splitting it into four commodity groups, defined as sub-sectors. Dry bulk transport, i.e. unpacked goods, is the sub-sector with the highest share in terms of overall transport volume (59%). In 2002 dry bulk transport accounted for around 265 million tonnes. By far the most important product in this category is construction materials (about 37% of all freight shipped on inland waterways). Other important dry bulk products are ore, metals, coal, and cattle feed. The shipments in this group are usually large. As economies of scale and low-cost operations give barge transport a competitive edge over road transport, barge transport has a relatively large share of this sub-sector. As far as structural changes in the commodity structure are concerned – a shift from raw materials to semi-manufactured and manufactured products – growth expectations are modest. This sub-sector has many large and even very large customers, e.g. the coal-processing industry, and has always been characterised by a wide diversity in the types and sizes of vessels. Push boat/push barge formations with six push barges is the most significant increase in scale that can be encountered.

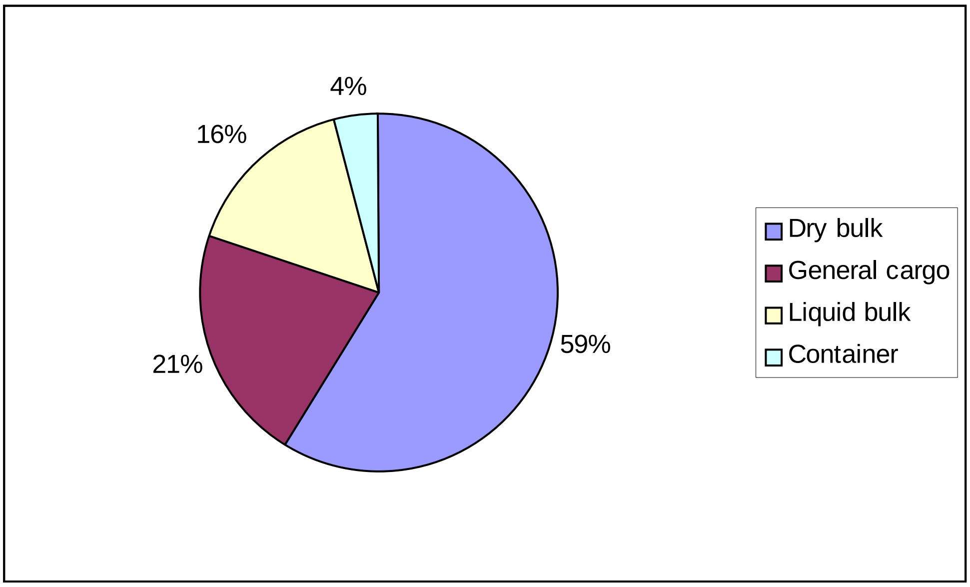

Figure 2. Importance of barge sub-sectors in Europe
Source: European Commission (2002)
Note: dry bulk is the main commodity group with 264.6 million tons, general cargo accounts for 95.7 million tons, liquid bulk for 72.1 million tons, and containers for 18 million tons.

General cargo is the second largest sub-sector, accounting for 96 million tonnes. The freight consists mainly of large components and semi-manufactured goods. This sub-sector is too diverse to include in the analysis.
In the liquid bulk sector the main products are fuels and chemicals, with a total volume of 72 million tonnes. Petroleum products are particularly important as they represent about 25% of the total freight transported on inland waterways. Barge transport also has the highest share for these products in the modal split of inland modes (Buck Consultants International et al., 2004). There are dedicated vessels for the transportation of liquid products. Small tankers with a loading capacity of several hundred tons are used for transportations from factories situated on small waterways. Push-barge combinations of 4,500 tons are also operated. One notable vessel in this sector is the parcel tanker, which originated in the chemical industry as a result of a growing demand for the dedicated transport of high-value products. As the vessels are equipped with several tanks, they can transport large and small batches of different products at one and the same time. This creates economies of scale, which make barge transport more competitive than road transport in this sub-sector. The liquid bulk

segment is much smaller than the dry bulk segment, but there is a greater degree of specialisation. This may be partly due to the fact that many of the goods in this sub-sector are classified as hazardous and are therefore subject to prescribed transport conditions and stringent regulations. The barge transport of liquid bulk and fuel in particular is dominated by a fairly small number of large companies. The demand is likewise dominated by a small contingent of large firms.

Barge container transport has evolved into a mature business in a relatively short period of time (see Konings, 2003). This sector is regarded as the most promising growth market for barge transport in the near future, but it represents only a small percentage of the total freight transported by barge in Europe (Wiegmans, 2005). It has carved out a role for itself in hinterland transport in particular, i.e. in the transport of maritime containers between seaports and inland destinations. In 2002 the container freight transported along the Rhine corridor exceeded 1.3 million TEU (Notteboom and Konings, 2004). The total container volume transported by barge in Europe in 2002 has been estimated at over 3 million TEU, including a flow of about 1 million TEU of so-called 'feeder traffic' between the ports of Rotterdam and Antwerp (A&S Management et al., 2003). The growth figures have continually surpassed expectations. Low operational costs and high reliability have enabled the barge sector to capture a substantial share of the transport market. At the moment, barge transport accounts for around 35% of the transport between the ports of Rotterdam and Antwerp and their hinterlands. Governments have introduced a number of policies to encourage the development of container barge transport, which is regarded as a promising option for moving freight transport from the roads (reducing congestion and pollution) to more sustainable modes (inland shipping and rail transport). The market for transporting continental container cargo by barge has considerable potential for growth and is still to be opened up. The sector consists of around 30 barge operators, who are responsible for the organisation of container barge services. These operators act as shipping agents and charter vessels and crew from skippers. The number of vessels used for container barge transport is estimated at 200. There are numerous customers of all sizes. Most of the large customers are shipping lines and forwarders. They have a strong bargaining position.

2.2 Barge transport innovations

This section will discuss barge transport innovations gleaned from Internet and literature searches. In recent decades, cost-effectiveness has been a major driver of developments in barge transport (Macharis and Verbeke, 2004; Konings, 2004). An important aspect of this has been a continuous increase in operations in order to create economies of scale. This trend will continue in the future, although there are still infrastructural constraints (river depth, locks) on many routes. These constraints and the legal regulations will determine the sizes of vessels on the waterways in the future. In Western Europe the *push boat/push barge-formation* (1) with six barges on the Rhine seems to be the largest conceivable unit (Filarski, 1989). Two- or four-barge formations are more common, but the barge fleet is dominated by motor vessels. Developments in size may be expected in the latter category in particular. Incentives for upgrading the vessel size have been induced, mainly from the container transport market, because of the growing barge transport volumes. This has led to wider regulations on the Rhine and the introduction of mega vessels (134 metres long and 17 metres wide with a loading capacity of 400 – 500 TEU). This type of vessel will not set a trend for the whole European barge transport market as it can only be accommodated on the lower reaches of the Rhine. European barge transport policy (market liberalisation and demolition rules) has led to the withdrawal of many small vessels from the market. A very limited number of new small vessels has been added. The introduction of a dedicated small type of container vessel (Neokemp) fell short of expectations. In addition to developments in the size of vessels, the degree of s*pecialisation* (2) is gradually increasing. An interesting example is a vessel of Dutch design – the River Hopper – to transport palletised goods between distribution centres and supermarkets. The River Hopper can transport 520 pallets (1.20 x 1 metre) and thereby match the capacity of a 20-truck combination. The plan (known as *Distrivaart*) is to develop a national network for this type of barge service. The ideal configuration would consist of 40 barges transporting pallets between 17 distribution centres. This would take 43 million pallets off the roads and could cut costs by 20%. Similar, road-based network initiatives claim to improve lead times and to lower transport costs (Kia et al., 2003). Other examples of innovation are a dedicated barge (the Mercurial-Latistar) for wheat transport between Wormerveer and Nijmegen in the Netherlands (Van Rulo, 2003) and for the temperature-controlled transport of bananas from Antwerp to Duisburg. Meantime, the ever-increasing logistical demands of shippers, with reliability and transport time as the key criteria, have prompted the barge transport sector to keep pace with new demands. Some *organisational solutions* (3) have been implemented to meet these demands; for example, regular services have been introduced in container barge transport and additional services, such as pre- and end-haulage, have been made available. Technological innovations will also improve transit times. One possible option is to introduce *fast barges* (4) but these would have to cope with infrastructural constraints, emission norms and fuel efficiency. Fast vessels have a larger engine capacity and are likely to produce more emissions (CO_2 and NO_2) (GEM/Haskoning, 1996). Then there are the economic barriers: high investment costs, high fuel consumption and limited carrying capacity (GEM/Haskoning, 1996). At present, most of the plans for fast vessels focus on sea transport (Lagoudis et al., 2002). In barge transport they are still in the awareness stage. One of the most obvious ways to improve the performance of barge transport is to change the technical design of vessels. Several innovative concepts have emerged in this area. *Double-hull barges* (5) can absorb collisions, thereby enhancing the safety of barge transport and creating more scope for cargo space (Van de Kar, 2002). Another idea is to use four tanks instead of six, thus reducing the cleaning costs. The downside of this proposal is that the barge will be heavy, repairs will cost more, and fuel consumption will rise. Fossil fuels, such as gasoline and fuel oil, are the main *energy sources* (6) for diesel engines. Though diesel engines are being constantly improved, the results are not regarded as innovative or revolutionary. One major innovation is the use of fuel cells and solar cells as propulsion systems for electricity. The use of fuel cells may dramatically reduce emissions and noise compared with current motor technologies, (Van der Laag and Mallant, 2002), but they present certain problems in terms of costs, weight, size and storage (in the case of H2 or methane). In any case, the performance of diesel is hard to beat. All of this will hinder commercial operation in the short term. Solar energy is already being used in barge transport on an experimental scale, and could conceivably become a satisfactory energy source if solar panels can become part of the construction. A study on the potential for an all-electric barge (Prins, 2002) concluded that 8-30% more cargo could be transported, fuel consumption could be reduced by between 10% (upstream) and 40% (downstream), emissions could be lowered and a 15% reduction in transport costs per unit transport could be realised compared with the current situation. One drawback is the higher costs of installing the motor (2.5%). Electric propulsion may be especially interesting for tankers (Bouw, 2003). Most barges, however, operate in other sectors. The *performance of the barge motor* (7) (in terms of energy consumption and exhaust gases) is influenced by depth, streamway, the speed of the current, and the loaded cargo (Dalpis, 2002). Many of the improvements to barge engines have concentrated on reducing emissions. European policy has tightened the regulations for the performance of barge motors and will continue to do so in the years ahead. A significant step forward may come from the SCR catalyst, which can cut NOx emission to less than 3 grams/KWH (http://www.innovatie.binnenvaart.nl). Marked improvements have been achieved in propellers and propeller traction. Take, for example, the recently introduced Z drive (special wheels at the transfer point and two propellers instead of one), which was built to improve manoeuvrability and motor-energy performance (5%-8% has been quoted). Another advantage of the Z drive is that it does not emit a lot of noise (Laros, 2003). No barges with a Z drive have been built so far in the Netherlands. They have been introduced in Belgium, but the results in terms of motor performance and noise level have not been published. A few years ago, Technofysica developed an advisory 'tempomaat' (http//www.technofysica.nl/tempomaat.htm), which calculates the most efficient motor usage on the basis of a set of variables (fuel consumption, tides, current speeds). Tempomaat provides advice on the route and speed so that the barge arrives at the agreed time. This innovation might cut fuel consumption by 4 -12% and lower costs and emissions at the same time. Air lubrication under the barge is another innovative way to cut fuel consumption. Reductions as high as 20% (VNSI, 2003) have been claimed. Overall, the fuel efficiency that might be realised by air lubrication is in the region of 6% (Van Heerd and Thill, 2002). The last development is the use of *new materials in vessel construction* (8), aimed at reducing weight (by, for instance, using lightweight metals and synthetic materials). Since weight reduction makes for a smaller draught, it will enhance the carrying capacity of the vessel. The aim of all these changes in vessel design is to make sailing more economical, but some of them will also help to improve the environmental performance of barge transport. The competitiveness of inland waterway transport could be enhanced by extended use of information and telecommunication technology. This would reduce costs directly and indirectly by, for instance:

- higher levels of automation and standardisation to improve the administrative processes;
- planning systems to improve the load factor;
- Vessel Traffic Management Systems to improve 'just in time' (JIT) deliveries.

Vessel Traffic Management Systems (9), which are currently used only for safety reasons, will increasingly support logistical goals as well. There are several initiatives which aim to improve ICT systems (communication, navigation). Communication systems facilitate the immediate availability of information on the loaded cargo on barges (e.g. in emergencies). ICT may also enhance communication between barge crews and between barges and the quay. On a European scale, the *River Information System (RIS)* (10) is probably the most important initiative in the navigation sector. RIS contains information on loading and unloading timetables, lock planning management, customs formalities, and water police. The costs of transhipment in barge transport are relatively high compared with the costs of sailing. The competitive edge derived from being a cheap mode is therefore seriously undermined: these costs can endanger the chances of barge transport in the logistical and

multi-modal transport chains. Containerisation has vastly improved handling efficiency, but transhipment costs are still relatively high compared with sailing costs and other modalities.
Different techniques and concepts have been and still are being studied to improve the transhipment process (TRAIL, 1995; TERMINET, 1997; GEM Consultants et al., 1998; Van Klinken, 2004). On the one hand, innovation is geared to improving the handling efficiency of large container volumes (11). This has been necessitated by fast-growing volumes in the mainports and the problems encountered by barge transport in attempts to gain a larger share of the growing hinterland transport. Designs have been produced for horizontal transhipment techniques (such as Rollerbarge*)* and for advanced vertical transhipment techniques with a high level of automation and robotisation (such as Barge Express). The feasibility studies on Barge Express were promising (TRAIL, 1996). The transhipment technology was based on proven technology, but the concept has not been implemented yet. The Rollerbarge system has not been introduced to the market either.
Besides large-scale systems, innovation efforts are focusing on improving the transhipment costs of small container flows, with self-unloading container vessels and self-service terminals as the most notable achievements (GEM Consultants, 1996; Ministerie van Verkeer en Waterstaat, 1998). These transhipment techniques should also enable barge transport to penetrate the market for small-scale container distribution which, being characterised by small flows and relatively short distances, is still dominated by road transport. Under the current market conditions the economic barriers for these techniques are greater than the technical ones. Another interesting option is to deploy river-sea transport to reduce the number of transhipments in the chain (12). The distinguishing feature of river-sea transport is that a sea-going vessel can sail through inland waterways to its inland port of destination. As there is no need for transfer or transhipment at the seaport, savings are realised on transport costs and time. New technologies are being studied with a view to increasing the performance and the geographical scope of the river-sea transport system (see e.g. Konings and Ludema, 2000; Janssen, 1997).

3. Competitive forces in the barge market

3.1 The competitive forces model

In this paper we use the competitive forces model (rivalry among industry competitors, bargaining power of buyers and suppliers, threat of substitutes, potential entrants and regulators) to construct an analysis of the barge sub-sector markets. This model enables the position of the different players in a particular market to be determined. Basically, what the model does is link a company to its industry competitors and its 'wider' environment. Hence, a 'competitive force' is defined as 'the degree of competitive pressure influencing the profit potential of a company' (adapted from Porter, 2001). If it is strong enough, the competitive force can exert a major influence on the competition and the response strategies of the businesses (Porter, 2001).
The competitive position of the different transport operators in the barge sub-sectors can be determined by analysing the strength of the competitive forces in the market. If, for example, the competitive forces 'surrounding' the skippers are strong, there will be less profit potential for industry competitors in that particular market. Competition exerts pressure on every company in every market. A company that understands the factors that underlie the

competitive forces will be better equipped to respond strategically to market challenges. The aim of the model is to facilitate the strategy-making process, not to replace it.

One major competitive force is the buyers (or the customers). The buyers of barge transport are shipping companies, deep-sea transport carriers, or intermediaries. The competitive force of buyers depends – amongst other things – on how well they are organised and whether they can represent a sales volume high enough to negotiate discounts (Ministerie van Verkeer en Waterstaat, 2001). The producing company (the skipper) is also dependent on the loyalty of the buyers. The threat of (new) substitutes consists of products or services that (may) offer an alternative to the current product. For example, barge transport might be replaced by unimodal road transport. Amongst other things, the strength of this competitive force depends on (Ministerie van Verkeer en Waterstaat, 2001):

- Barriers that prevent access to the market;
- the growth potential in the market;
- the nature of the market (oligopoly, monopoly).

Suppliers are players that provide a sector with goods or services. For example, in the barge transport sector, the suppliers provide the barges and equipment that are needed for transporting and handling the freight. The competitive force of suppliers (as opposed to the industry competitors) depends – amongst others – on (Ministerie van Verkeer en Waterstaat, 2001):

- The producing company (the skipper), which depends on its suppliers and the price they want for their products. If supplies are scarce, suppliers may demand higher prices, which may then push up the price of the product;
- the degree to which agreements have been reached between the producers and the suppliers.

There is a constant threat that new or improved products (potential entrants) will appear with the ability to displace the current product (barge transport service).

Regulators are found in all tiers of government, from local to European. Incorporated in this competitive force are transport infrastructure, load units, means of transport, transport networks, the environment and – especially – the respective regulations.

The last competitive force is the industry competitors (in this case the skippers). The competition between the producing companies leads to fierce rivalry and creates high dependence among the competing firms. Each action triggers a reaction from the other companies (Ministerie van Verkeer en Waterstaat, 2001).

For an overview of all the competitive forces see figure 3.

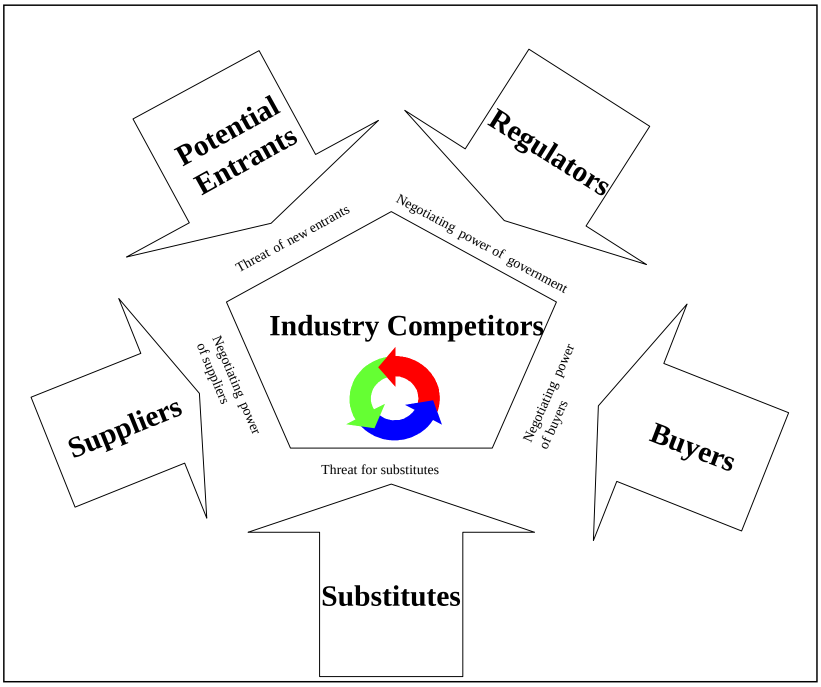

Figure 3. The competitive forces model
Sources: based on Porter (2001) and Wiegmans (2003)

4. Analysis of the barge sub-sectors

In this section we analyse the innovations with the greatest impact on the different barge transport sub-sectors (based on interviews with experts and literature research). We also suggest strategies to improve the competitiveness of barge transport.

4.1 Competitive forces in the dry-bulk sub-sector of the barge transport market

This sub-sector can be characterised by scale economies and cost control that might enable skippers to (at best) retain their profits. One threat to the dry-bulk sub-sector is the anticipated decline in the European cattle stock. Building materials also represents an important non-growth area. The skippers focus on customer relationships and prices. When there is excess capacity, they immediately resort to price competition. The suppliers and buyers have a strong position in this sub-sector. The buyers have considerable power which they can increase still further by combining their orders and negotiating lower prices. The skippers therefore depend on the loyalty of the buyer. The suppliers also have considerable power because of the high investments that are needed. The individual power of the skippers (industry competitors) is limited because of the many relatively small companies that operate in this sub-sector. This results in high dependence among competitors. The threat of new entrants is marginal as market opportunities and growth are limited. One access barrier is the high investment required for the barge. On certain routes, road and rail are substitutes for barge transport. The threat of substitutes in dry-bulk is fairly low due to the limited scope for growth in this sub-sector. The impact of the regulators is also of little consequence as governments do not interfere all that much in the barge market (see figure 4).

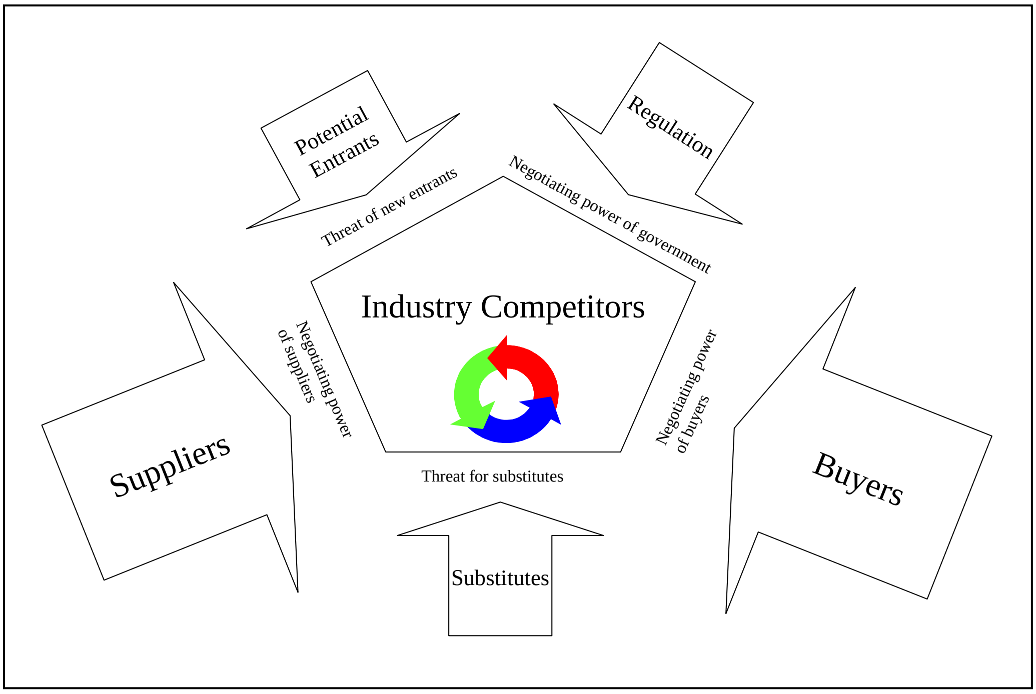

Figure 4. The competitive forces in the dry-bulk market
Sources: based on Ministerie van Verkeer en Waterstaat (2001), Porter (2001) and Wiegmans (2003)

The innovations in this sub-sector are geared mainly to improving the motor performance and enhancing the opportunities for reducing empty transport, i.e. raising the performance of logistical organisation. Cost-control is absolutely vital in the dry-bulk sub-sector, which is faced with only limited growth in relevant freight flows, mounting competition from road transport, and a tendency to overcapacity. But, increasing the scale of operations is no driver for cost savings: the vessel sizes in this sector are attuned to the freight flows on the one hand and the constraints of the waterway infrastructure on the other. Innovations in transhipment and river-sea transport might present opportunities to improve the competitiveness of barge transport through raising quality and lowering costs.

4.2 Competitive forces in the wet-bulk sub-sector of the barge transport market

This sub-sector is characterised by an increase in scale. It runs some risk of getting into a declining market, as the demand for products seems to be waning (for the time being). The oil transport might, however, disappear in the long run if oil is displaced by another fuel. Profits are kept intact by cost reductions. Price competition plays an important role in this sub-sector. The competition may be described as ‘almost perfect’ by virtue of the fact that there are many skippers (industry competitors). One competitive advantage of this sub-sector – compared with road and rail – is safety. The buyers are in a position to wield considerable competitive power. The suppliers also exert a strong influence, but they interfere in the business developments as well. This implies that the suppliers of, for example, barges and financial resources, are dependent on the skippers’ earnings for their income. The threat of potential entrants is reined in by the low rate of growth. The threat of substitutes is also limited as transport by barge is safe; other modalities would have difficulty matching this safety level. The regulators have considerable power. Governments do not interfere all that much in the barge market, but given the increased emphasis on safety and sustainability, a more pressing policy might be on the cards (see figure 5).

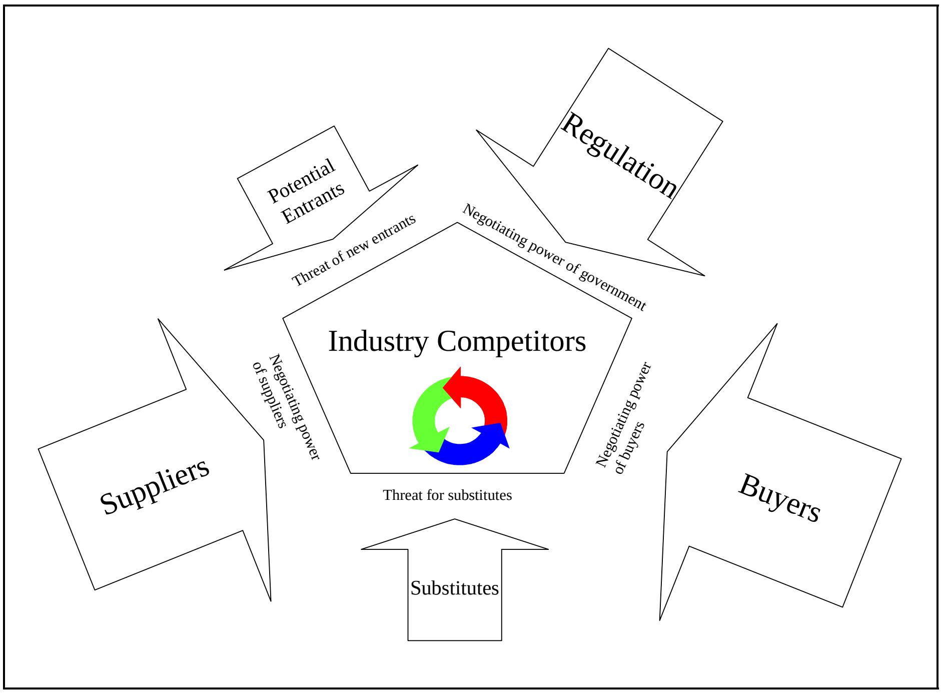

Figure 5. The competitive forces in the wet-bulk market
Sources: based on Ministerie van Verkeer en Waterstaat (2001), Porter (2001) and Wiegmans (2003)

This sub-sector invests heavily in safety and environmental performance, a classic example being the double-hull barges. In terms of safety this sub-sector has a competitive advantage over road and rail transport. Its safety performance (and the perception and valuation thereof) might even improve further, now that transport safety is gaining in importance and looks set to play a more decisive role in the choice of transport mode in the near future. The introduction of the parcel tanker is offering interesting prospects for developing new markets, thus confirming the theory that markets need to diversify when product development reaches maturity. There are only limited openings for improving the competitiveness of liquid bulk barge transport. Innovations that seem (or are) promising for this sub-sector lie in energy sources, motor performance, and new materials for vessel construction. However, these innovations might only improve the performance of the existing sector.

4.3 Competitive forces in the container sub-sector of the barge transport market

The container sub-sector is still growing. Product development and process improvements are gaining in importance as growth slows down. Obviously, product differentiation is difficult when a homogeneous object like containers is being transported, so barge operators distinguish themselves through (geographical) market segmentation and the level of (additional) services. The buyers are in a particularly powerful position resulting in transport being a marginal business. Dependence among industry competitors (skippers) will be low as long as there is enough scope for everybody. The industry competitors depend to a small extent on the loyalty of buyers. One access barrier for skippers is the high investment required for the barge. Potential entrants in this sector might be deep-sea transport companies, logistic businesses and skippers from other sub-segments. The power of the suppliers is restrained but is gradually increasing because suppliers see the growing profits and want to safeguard their interests. The threat of substitutes comes from the road transport sector, which has a large share of the market. Competition with rail transport is low-key. The strength of the regulators is contained, as governments do not interfere all that much in the barge market (see figure 6).

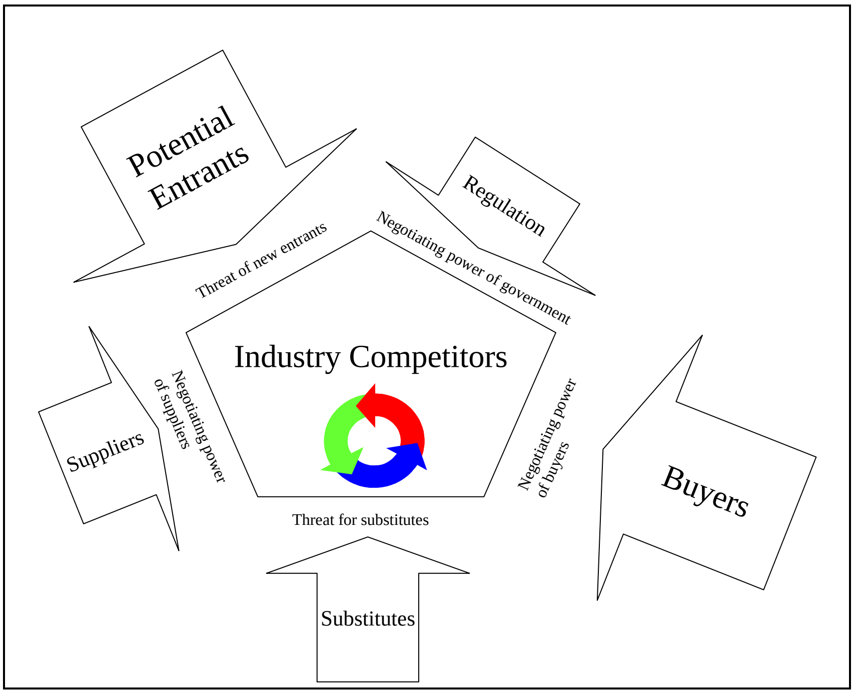

Figure 6. The competitive forces in the container market
Sources: based on Ministerie van Verkeer en Waterstaat (2001), Porter (2001) and Wiegmans (2003)

There is a pressing need in this sub-sector to improve handling processes via new transhipment concepts and technologies. The heavy congestion that barges face at seaport terminals is a threat to the low costs and reliability of container barge services. In the hinterland, existing terminals need to be upgraded or redesigned to accommodate growth. Additionally, new low-cost transhipment concepts could help broaden the geographical scope of container barge transport. New terminal concepts have not been widely adopted yet, but significant R&D efforts are underway. ICT innovations are directed at improving the efficiency of barge services, since the dynamics of container logistics require up-to-date information on cargo and containers. Furthermore, new logistical services are being introduced in this sub-sector so that barge operators can distinguish themselves from each other. One element in this strategy is to increase the scale of operations, i.e. deploy larger vessels in an attempt to become more cost-efficient than the rest.

4.4 Competitive forces in the new barge transport market

The need for reliable alternatives to road transport seems to have created (significant) growth potential for new barge services (or new sub-sectors). The barge sector offers a range of alternatives (express barge transport, small barges, large barges, pallet transport, milk transport, big bags, ‘freezing’ barges, and port hoppers). All of these initiatives require high start-up investments. Promotion and marketing can prove costly at first: campaigns need to be organised to obtain access to the logistics and transport channel. In addition, the parties need to work together to increase the prospects of a successful market launch.

The potential buyers are the freight owners and the intermediaries. At first sight, these players are not interested in risks and prefer a waiting game. Buyers can join forces to increase their purchasing power. Competition is limited, it is more important to successfully introduce the new barge service. Competition exists between the new initiatives. The main barrier is investment in new technology. The power of the suppliers is limited because the success of the new initiative takes precedence in the beginning. The regulators exert considerable influence as governments do interfere in the barge market (see figure 7).

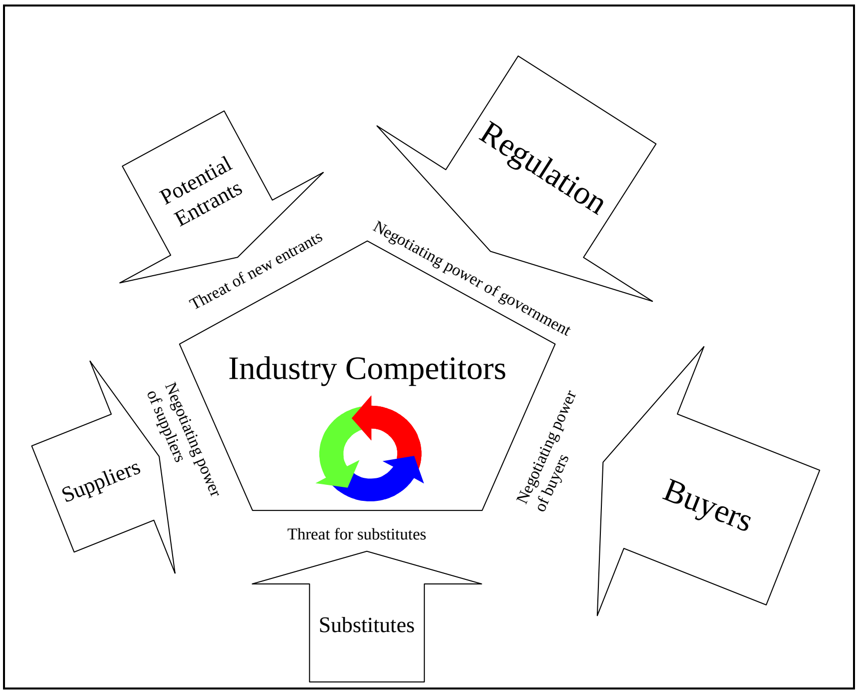

Figure 7. The competitive forces in the ‘new barge services’ market
Sources: based on Ministerie van Verkeer en Waterstaat (2001), Porter (2001) and Wiegmans (2003)

Usually, new initiatives require financial and other support from the government. Very characteristic of the innovations in this sub-sector is the level of specialisation in vessel design and market and product orientation. Striking examples are the dedicated vessels for pallets, and the transport of wheat and bananas (see section 2.2). Close attention is also paid to the logistical organisation so that the customer gets a service with added value. As the theory suggests, the quality of services – which is largely determined by the technical performance of all the system components – needs to be excellent in this early stage if it is to win over prospective customers. The (pilot) introduction of the dedicated vessel for pallet transport showed that the unsatisfactory performance of a new transhipment technique adversely affected the interest of barge customers in this transport concept.

5. Conclusions

This paper has focused on innovations and strategies in barge transport and their implications for the performance of each sub-sector. It addressed the question of which strategies and innovations might improve the competitiveness of barge transport. We have analysed these two elements in relation to four sub-sectors (dry-bulk, wet-bulk, containers, and new barge transport services).

The analysis uncovered significant differences between the sub-sectors. Each sub-sectors is in a different phase of its product life cycle and therefore needs different market strategies and product developments.

The dry-bulk sector has reached maturity. The suppliers and buyers have considerable power. The power of competitors in this sector, the potential entrants, the government and the threat of substitutes are limited. The strategy should concentrate on market penetration and market development.

The wet-bulk sector is in an early stage of maturity and therefore largely comparable with the dry-bulk sector. The preferred strategy for this sector is market penetration and market development.

The container barge sector is still in the growth phase. There is a clear threat of potential entrants and the customers have considerable power. The competition in this sector is still substantial. The strategy should focus on product development and diversification: the development of new services for existing and new markets.

New barge transport services are still in the introductory phase. The customers have considerable power, as their behaviour is a determining success factor. The strategy for this sector should focus mainly on diversification.

Looking over the current innovations in barge transport, it would be fair to say that many of them could be adopted in all the sub-sectors. This applies particularly to innovations for vessel design and vessel components. Indeed, all sub-sectors could benefit from developments that improve navigation efficiency.

One striking exception is the increase in vessel size. Though there is a general trend towards larger vessels, it is not the same in all sectors. The container barge is pioneering this trend, but it is being tempered by physical constraints and the need for flexibility (accessing locations on small waterways). Even so, sustainable large volumes will continue to encourage the deployment of vessels with a size that is (almost) optimally adapted to the waterway infrastructure. A typical example is the mega container vessels that sail mainly on the Rhine. That said, the existing medium-sized and small vessels will remain in use.

A more general development in vessel design is the increasing level of specialisation. The next generation of inland vessels will be designed for one or only a few types of freight. The driving forces behind specialisation are the need to improve efficiency and the ever-increasing quality demands of barge customers. Specialisation offers opportunities to cut costs by improving the loading and unloading process. This trend is already discernible in the sub-sectors, despite significant differences. Improvements to transhipment efficiency (the loading/unloading process) can also act as an incentive for innovations in vessels.

The need to improve the handling process is greatest in the container barge sector, given the overall cost structure of container transport. Substantial R&D efforts are taking place in this field.

Barge transport may get cheaper in the near future as result of the reduction in ship resistance, more efficient propulsion systems, new energy sources and the use of lightweight materials in vessels. The extended use of existing ICT systems and the introduction of sophisticated new ones will make sailing more efficient. Some of these technical improvements will help to raise the economic performance of the *existing* fleet and hence can increase competitiveness and the market share of the barge transport sector as a whole. However, several innovations can only be implemented in new constructed vessels. As a result of the long life expectancy of vessels the effects of these innovations will emerge only in the long term.

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