Mainports as Integrators of Passenger, Freight and Information Networks. From Transport Nodes to Business Generators; the Dutch Case

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In the process of increasing globalization, mainports play an important role. A number of gateways have emerged as transport nodes in the networks of air and sea routes which criss-cross the globe. Here, millions of travellers are transferred and millions of tonnes of freight are transhipped. Both Japan and the Netherlands play an important part in these 'hub and spoke' networks.
In this contribution we will deal with the dynamics of mainports in general, and more specifically with the mainports of the Netherlands. Our argument is that their function goes far beyond that of infrastructure, transport and logistics. Although they started out as transport nodes, the mainports in the Netherlands are now evolving into fully fledged business generators. The economic function of mainports will be strengthened by integrating mainport and brainport functions. It will be further reinforced by seizing the opportunity to combine the traditional mainport functions. This will involve connecting airlines with road and rail transport networks, connecting ocean shipping with inland shipping, cargo trains, trucks and pipelines and connecting transport nodes with an infrastructural node of ICT (information and communications technology) networks. For the Randstad Holland (the Netherlands' economic heartland in the west), we conclude that a stronger integration of gateway Rotterdam and mainport Amsterdam Schiphol could be considered. This could be achieved not only by strengthening their transport infrastructure, but first and foremost by planning, developing and integrating the ICT mainport functions.

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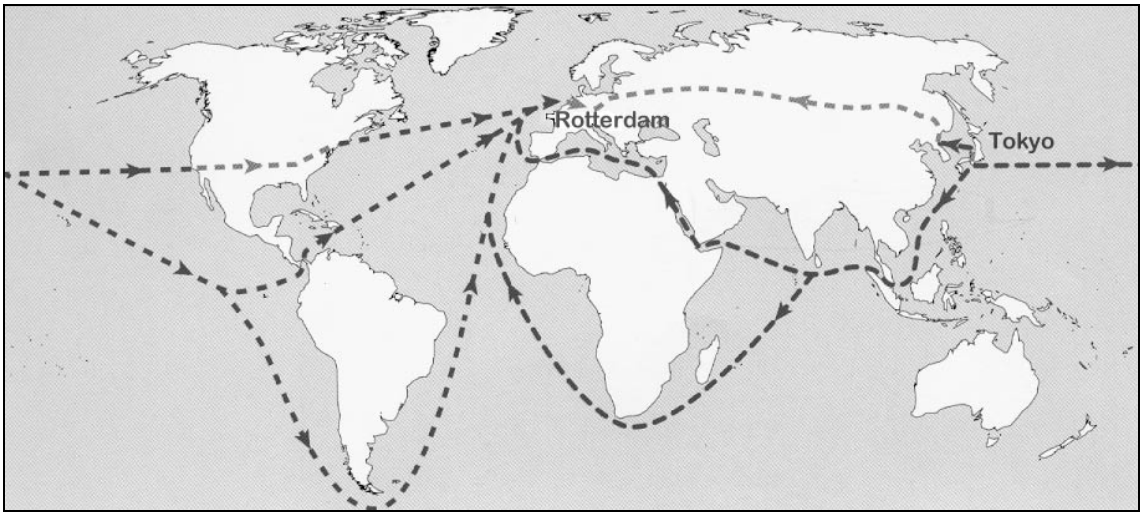
1. Introduction

In the process of increasing globalization, mainports play an important role both for passengers and freight. In the networks of air and sea routes which criss-cross the globe, a number of gateways have emerged as transport nodes where millions of travellers are transferred and millions of tonnes of freight is transhipped.
In this contribution we will deal with the dynamics of mainports in general, and more specifically with the mainports of the Netherlands. Our argument is that their function goes far beyond that of infrastructure, transport and logistics. Initially serving as transport nodes, the mainports in the Netherlands are evolving into fully fledged business generators. The economic function of mainports will be strengthened by integrating mainport and brainport functions. It will be further reinforced by seizing the opportunity to combine the traditional mainport functions. This will involve connecting airlines with road and rail transport networks, connecting ocean shipping with inland shipping, cargo trains, trucks and pipelines and connecting transport nodes with an infrastructure node of ICT networks. As regards the Randstad Holland (the Netherlands' economic heartland in the west), we can further conclude that a stronger integration between gateway Rotterdam and mainport Amsterdam Schiphol could be considered. This could be achieved not only by strengthening their transport infrastructure, but first by planning, developing and integrating the ICT mainport functions.
Intercontinental transport chains connect mainports like Tokyo and Rotterdam (Section 2) by sea, land and air. In Section 3 we give a brief quantitative overview of the performance of Amsterdam Airport Schiphol and mainport Rotterdam. Section 4 characterizes mainports as links between regional economic clusters and international networks. In Section 5 we introduce five functions of mainports in general. Section 6 deals with the infrastructure of networks and nodes in the new economy. We give an inventory of the development of ICT infrastructures in the Netherlands.
Finally, we present some conclusions and recommendations in Section 7.

2. Intercontinental transport chains

Mainports are connected by world-wide intercontinental networks. This can be illustrated by the container routes between Southeast Asia, Europe and America. Figure 1 depicts the main container routes between Tokyo and Rotterdam (Dutch Ministry of Housing, Spatial Planning and the Environment, 1997: 9-10).
Maritime transport between European ports and overseas destinations totals about 1.5 billion tonnes per year. Sooner or later the vast majority of unloaded goods will either be placed on another ship or carried from the ports to their hinterland by truck, rail, barge or pipeline. Continental shipments total about 9 billion tonnes per annum, more than 50% of which is local transport. This implies that maritime flows between ports and their hinterlands represent around 30% of the interregional (non-local) transport volume in Europe. This considerable share is reflected in the enormous organizational and physical efforts required to facilitate such flows of freight through transport chains.

The number of possible routes along which the flows can travel is unexpectedly high. The choice between alternative transport chains is always governed by cost, time and quality. Consider the example of a container shipped from Tokyo to Rotterdam (Figure
1). In Japan, the container will go by lorry or rail from its original location to one of the main harbours. If the plant is not located on Honshu, but on one of the smaller islands, an additional short-sea trip may prove necessary. For centuries, a subsequent long open ocean voyage was unavoidable: the Pacific Ocean, the Indian Ocean, around the Cape of Good Hope and then north towards Europe. The situation first improved in 1869 with the opening (or rather reopening since Roman times) of the Suez Canal and in 1914, almost half a century later, with the opening of the Panama Canal. These two major shortcuts meant that the longer southbound routes were only used for triangular journeys.



Source: Ministry of Housing, Spatial Planning and the Environment, 1997: 9.

Figure 1. Example of container routes between Tokyo and Rotterdam

The next important technical improvement in the area of transhipment has come about in the last three decades: the containerization of load units. The relative cost of transhipment and inland transport (double-stack container trains in the US) has decreased considerably compared to the cost of long sea journeys. This new cost relationship has brought about a major geographic reorientation of transport flows.
The most famous case is the North American land bridge, across Canada and the USA. The Panama Canal can not accommodate ships carrying more than 4,000 boxes (the so-called "Panamax" size), and smaller ships are restricted to daylight sailings. It is therefore cheaper, and sometimes faster, to unload a container from Japan on the US West Coast, between Vancouver and Long Beach (Los Angeles), place it on the double-stack container train to the East Coast, and then reload it onto another ship bound for Rotterdam.
Last, but not necessarily least, there is the Transiberian route. Here, the maritime leg is rather short, and the land leg or legs quite long. From Japan to Rotterdam the sea distance is around 21,500 kilometres taking 35 days. Using a rail connection via Russia shortens the distance to 14,000 kilometres and the time to 24 days. Its development as a viable alternative has been

held up by various difficulties. If conditions improve, however, this route could develop still further. This would have major repercussions for European ports.
As a result of the competition between chains, port competition has also increased – to the benefit of shippers and shipping lines. The situation has become rather volatile, small changes in supply or demand may lead to relatively large shifts of traffic from one port or route to another.

3. Performances of Amsterdam Airport Schiphol and Mainport Rotterdam

The growth of Amsterdam Airport Schiphol since 1980 and especially since 1990 has been spectacular: the number of passengers increased 5.6% on average in the 1980s, and 9.7% in the period from 1990 to 1998. Even more spectacular was the increase in the number of transfer passengers, with an annual growth of 15.9% in the period from 1990 to 1998. On average, air cargo increased by 6.6% from 1980 to 1990 and by 8.6% from 1990 to 1998. The growth in aircraft movements also accelerated in the 1990s. From 1980 to 1990 this figure was 3.4%. This increased to an average of 8.1% in the period from 1990 to 1998.

Table 1 Development of traffic and transport at Amsterdam Airport Schiphol in the period 1990-1998

	1990	1995	1998	Annual growth in % 1990-1998
Total passenger (mln)	16.2	24.9	34.0	9.7
Transfer passengers (mln)	4.4	9.6	14.3	15.9
Cargo (ton)	604,000	978,000	1,171,000	8.6
Aircraft movements	202,000	291,000	377,000	8.1

Source: Amsterdam Airport Schiphol; Ministry of Transport, Public Works and Water Management, 2000:11.

The accessibility of Amsterdam Airport Schiphol improved considerably in the period from 1990 to 1998. The number of destinations increased by 4.3% annually. The weekly frequency for each destination increased by 8.6% annually in the same period. These figures are more favourable than those for most other West European mainports (Table 2).

Table 2. Network development of Amsterdam Airport Schiphol and competing airports in the period 1990-1998 (direct scheduled-service links passengers and cargo craft)

Airports	Amsterdam	Brussels	Paris (CdG)	Frankfurt	London (Heathrow)
Number of destinations in 1990	140	116	152	183	178
Number of destinations in 1998	196	138	214	248	163
Growth in number of destinations (1990-1998)	4.3%	2.2%	4.4%	3.9%	-1.1%
Average frequency per destination per week in 1990	12.8	11.3	13.8	14.1	20.4
Average frequency per destination per week in 1998	17.6	16.6	18.1	15.1	26.6
Growth in average frequency per destination per week (1990-1998)	8.6%	7.2%	7.9%	4.8%	2.3%

Source: Ministry of Transport, Public Works and Water Management, 2000:11.

Table 3 provides a summary of the passengers passing through Amsterdam Airport Schiphol, per market segment (table 3). Both Amsterdam and Frankfurt can be characterized as transfer hubs.

The domestic market (i.e. that of embarking or disembarking passengers) at Amsterdam Airport Schiphol is smaller than those of the London and Paris airports. Furthermore, the market demand of these airports has more purchasing power. This is because London and Paris are more important financial centres and/or commercial centres than Amsterdam, as a result they attract more business passengers.

Table 3. Passengers of the main European airports, per market segment, 1998

	Passengers embarking/disembarking in 1998 (OD)		Transit passengers in 1998		Total in 1998
London (Heathrow & Gatwick)	64.1 mln	71.8%	25.2 mln	28.2%	89.3 mln
Paris (Ch. de Gaulle & Orly)	43.8 mln	69.1%	19,7 mln	30.9%	64.3 mln
Frankfurt	22.3 mln	53.0%	19.8 mln	47,0%	42.1 mln
Amsterdam	19.7 mln	57.9%	14.3 mln	42.1%	34.0 mln

Source: Arbeitsgemeinschaft Deutscher Flughäfen (ADV, Stuttgart), Ministry of Transport, Public Works and Water Management, 2000: 12.

In the period from 1990 to 1998, direct employment at Amsterdam Airport Schiphol increased by four percent per annum (table 4). The indirect (retrospective) employment effect grew slightly faster, at an average rate of 4.7%. During the same period, the direct added value increased at an annual rate of 5.7%. The indirect added value increased at a rate of 6.1%.

Table 4. Employment and added value at the mainport Amsterdam Schiphol, 1990-1998

	1990	1995	1998	Average annual growth (%) 1990-1998
Direct employment (individuals employed)	38 000	43 000	52 000	4.0
Indirect 'retrospective' employment (individuals employed)	18 000	21 000	26 000	4.7
Direct added value (NLG billion)	3.8	5.3	5.9	5.7
Indirect 'retrospective' added value (NLG billion)	1.5	1.9	2.4	6.1

Source: Netherlands Institute of Economics (NEI): Tussenbalans Economische Effecten Schiphol (Mid-term review of the economic effects of Schiphol).
Ministry of Economic Affairs: Nota Ruimtelijk Economisch Beleid (Regional and Economic Policy Document) June 1999c, The Hague (Ministerie van EZ).

The rapid growth of Amsterdam Airport Schiphol imposed ever greater environmental problems on its immediate surroundings. Although the number of dwellings experiencing noise nuisance decreased by an average of 3.8% per annum between 1990 and 1998 (table 5), the number of complaints regarding noise nuisance increased markedly (17.4% per annum), partly as a result of the increase in night flights (1.5% per annum).
The numbers of takeoffs and landings by noisy aircraft declined rapidly, at an average rate of 25.9% per annum. The net effect of increased growth has been to greatly intensify the debate concerning the environmental effects of Amsterdam Airport Schiphol. The central issue is how long can the airport continue to grow at its present site. One alternative option is the creation of an airport island in the North Sea, linked to the mainland by rapid transit capsules.
The environmental aspects of mainports development are crucial but fall outside the scope of this contribution.

Table 5. Development of noise indicators at Amsterdam Airport Schiphol, 1990-1998

	1990	1995	1998	Average annual growth (%) 1990-1998
Dwellings experiencing noise nuisance within the 35Ke contour	13,900	17,000	10,200	-3.8
Takeoffs and landings by H2 aircraft	55,000	33,000	5,000	-25.9
Night flights between 23.00 and 06.00	12,248	12,171	13,813	1.5
Number of complaints about noise nuisance	55,000	113,000	198,000	17.4

Source: Amsterdam Airport Schiphol; Ministry of Transport, Public Works and Water Management, 2000:16.

The seaport of Rotterdam has not grown as rapidly as Amsterdam Airport Schiphol. Furthermore, it has grown much less rapidly than the major seaports of Southeast Asia and various competing seaports in Europe.

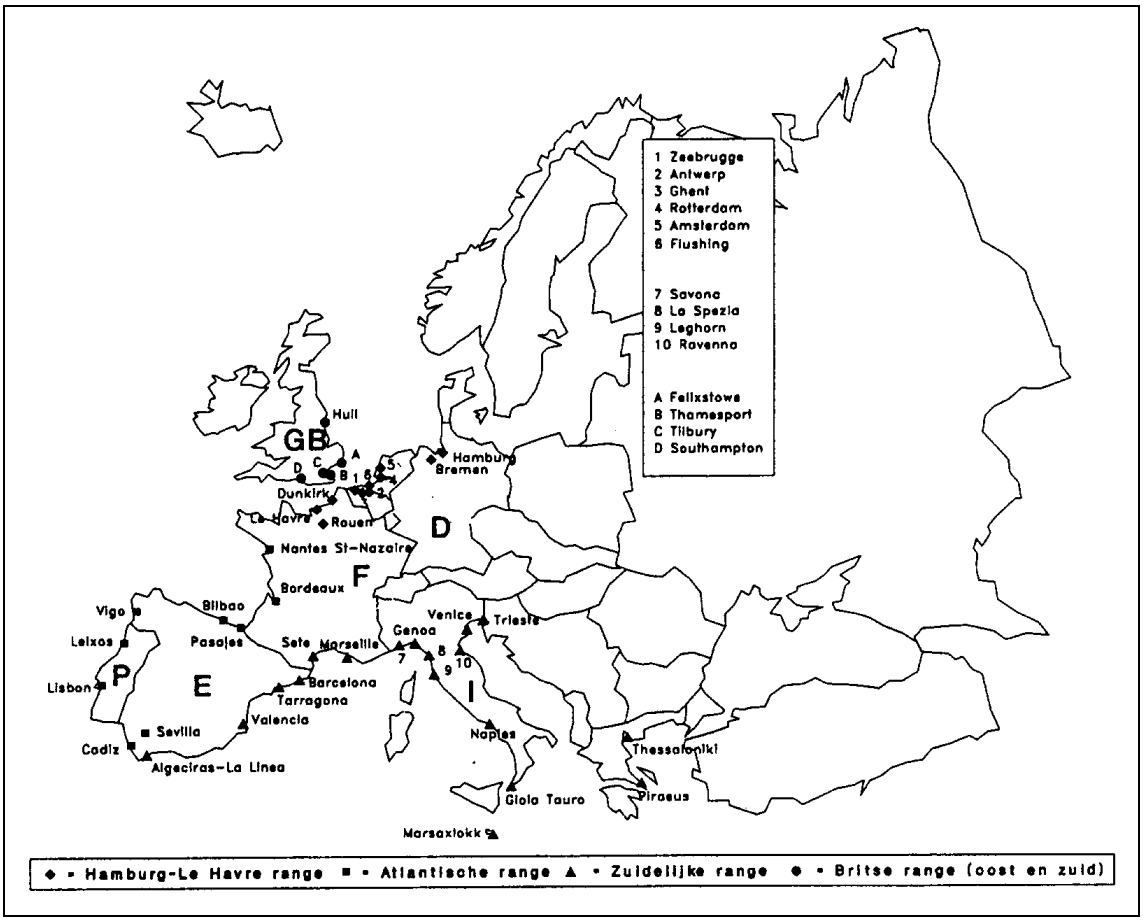
Table 6 provides an overview of the largest European container ports in 1975, 1985, 1996 and 1997 in terms of container transfer, measured in TEU (Notteboom & Winkelmans, 1998: 382).

Table 6. The ten largest European container ports, measured in TEU container transfer (1975, 1985, 1996)

----------1975----------			----------1985----------			----------1996----------		
Port	**Container transfer in 1000 TEU**	**% in port system**	**Port**	**Container transfer in 1000 TEU**	**% in port system**	**Port**	**Container transfer in 1000 TEU**	**% in port system**
Rotterdam*	1079	25.2	Rotterdam*	2655	21.1	Rotterdam*	4936	18.0
Bremen*	410	9.6	Antwerp*	1243	9.9	Hamburg*	3054	11.1
Hamburg*	326	7.6	Hamburg*	1159	9.2	Antwerp*	2654	9.7
Antwerp	297	7.0	Bremen*	986	7.9	Felixstowe	2065	7.5
Tilbury	232	5.4	Felixstowe	726	5.8	Bremen*	1543	5.6
Le Havre*	231	5.4	Le Havre*	566	4.5	Algeciras	1307	4.8
Felixstowe	230	5.4	Marseilles	488	3.9	Le Havre*	1020	3.7
Southampton	199	4.7	Leghorn	475	3.8	La Spezia	971	3.5
Zeebrugge*	184	4.3	Tilbury	387	3.1	Genoa	826	3.0
Genoa	162	3.8	Barcelona	353	2.8	Southampton	808	3.0
Top ten	**3351**	**78.4**	**Top ten**	**9037**	**72.1**	**Top ten**	**19184**	**70.0**
Port system (43 ports)	**4273**	**100**	**Port system (43 ports)**	**12539**	**100**	**Port system (43 ports)**	**27395**	**100**

Note: * = port within the Hamburg – Le Havre range.
Source: based on statistics from the port authorities concerned.
Source: Notteboom & Winkelmans, 1998: 382.

Table 6 clearly shows in each period the dominant position of Rotterdam, although container transfer there accounts for only a modest share of the total. The ten largest container ports are the leaders of a group of 43 European container ports in four areas: see figure 2.



Source: Notteboom & Winkelmans, 1998: 381.

Figure 2. Location of the European container ports

The emphasis is on the Hamburg - Le Havre range (11 ports), the Atlantic range (9 ports), the southern European range (18 ports on the Mediterranean Sea) and a limited British range (5 ports on the Eastern and Southern coasts of the United Kingdom). The ports along the Baltic Sea have been omitted, as have the Scandinavian ports. Total container transfer within the European port system under consideration amounted to 27.4 million TEU in 1996, compared with 4.3 million TEU in 1975. The Hamburg - Le Havre range accounted for 14.1 million TEU in 1996, more than half the total transferred (Notteboom & Winkelmans, 1998: 380).

The growth of container transfer in the European ports under consideration has been spectacular, as table 7 makes clear. It has to be said, however, that these growth figures cannot compete with the even stronger growth of the large container ports in Southeast Asia.

Table 7. Average annual growth of container transfer in 43 European container ports throughout five separate periods between 1975 and 1996

Period	Annual growth of container transfer	
	in 1000 TEU	As a percentage
1975-1982	834	13.10
1982-1987	770	6.66
1987-1991	1121	7.21
1991-1994	1509	7.59
1994-1996	2212	9.21

Source: Notteboom & Winkelmans, 1998: 384.

Within the European system of container ports, Rotterdam's market share decreased from 25.2% in 1975 to 18.0% in 1996.

Table 8 illustrates that the transhipment of containers at Rotterdam (45.7 million tons in 1993) has a dominant share of the mixed cargo sector (63.9 million tons in 1993). It also shows that container transhipment still only accounted for a modest share of the total transhipment of 282.2 million tons in 1993. Traditionally, wet and dry bulk commodities had a large market share at Rotterdam. This all serves to give Mainport Rotterdam its rather traditional image. In financial terms, the added value associated with the transport and transhipment of bulk goods is somewhat limited, there has only been modest growth in these types of freight and the environmental effects associate with the transport of bulk goods are relatively detrimental.

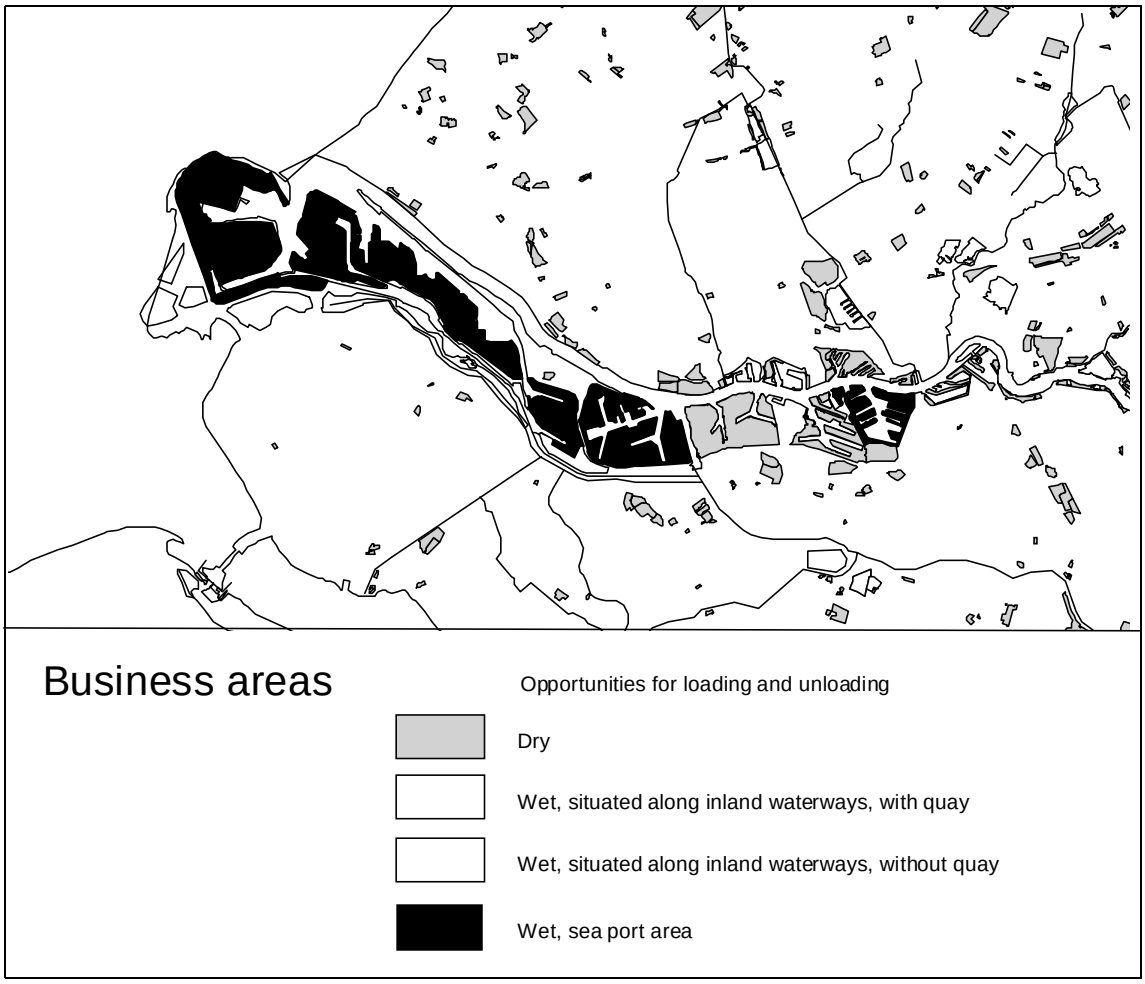
Table 8. Transhipment by type of goods in the port of Rotterdam, from 1990 to 1993 (in million tons gross weight)

	1990	**1991**	**1992**	**1993***
Agribulk	20.3	17.9	16.8	17.3
Ores and scrap	41.8	42.7	40.8	38.1
Coal	21.4	23.7	23.0	19.5
Other bulk goods, dry	11.5	7.9	7.1	8.3
Total bulk goods, dry	**95.0**	**92.2**	**87.7**	**83.2**
Crude oil	88.5	96.6	102.3	97.2
Petroleum products and petcokes	29.3	25.2	20.4	20.2
Other bulk goods, wet	16.7	18.1	19.3	17.6
Total bulk goods, wet	**134.5**	**139.9**	**142.0**	**135.0**
Total bulk goods	**229.5**	**232.2**	**229.7**	**218.3**
Roll-on-Roll-off	7.3	7.1	7.2	7.2
Containers, flats	39.3	40.3	44.3	45.7
Other mixed cargo	11.7	12.5	12.2	11.0
Total mixed cargo	**58.3**	**59.9**	**63.7**	**63.9**
Total	**287.8**	**292.0**	**293.4**	**282.2**

* Provisional figures.

Source: Rotterdam Port Authority, 1994, in: Priemus, Konings & Kreutzberger, 1995: 127.

Figure 3 is a summary of industrial sites in and around the mainport of Rotterdam. Rijnmond has the greatest concentration of industrial sites in the Netherlands. A strip of
land to the south of the Nieuwe Waterweg (New Waterway) is almost entirely used for industrial sites. There is generally no room for new initiatives in this area. It is therefore not surprising that industrial sites are springing up all along the Nieuwe Waterweg (both in the immediate vicinity and further away), all of which derive from the mainport role of Rotterdam Rijnmond.



Source: OTB calculations of IBIS, in: Priemus, Konings & Kreutzberger, 1995: 128.

Figure 3. Companies in and around mainport Rotterdam

With the future in mind, the flow of containers would seem to be of special significance. This is, after all, the most rapidly growing form. Table 6 shows that Rotterdam is by far the largest container port in Europe (albeit with rather modest growth figures). World-wide, only four other ports are larger than Rotterdam. These are Hong Kong, Singapore, Kaoshiung (Taiwan) and Pusan (South Korea), and all have higher growth figures than Rotterdam.
The prognoses presented in August 1990, which were based on Goods Flow Model 6 (GFM 6), show that over the next 20 years annual transhipment in the port of Rotterdam will increase by approximately. 100 million tons to reach almost 400 million tons in 2010

(according to the most optimistic variant). The Rotterdam Port Authority (RPA) wants to anticipate this developments and presents a vision of how the further development of mainport Rotterdam can be stimulated in cooperation with industry, local governments and other involved parties. This involves the enhancement of industry and commerce on one hand and appropriate compliance with environmental policy by all involved on the other. Some key figures are shown in Table 9.
The principal variant, which is based on GFM 6, assumes a rate of economic growth equivalent to the upper estimate of the Central Planning Office, which is slightly less than the European Community estimate. By way of comparison, a reference variant has been calculated, based on the (adverse) assumption that the requisite port sites will not be available.

Table 9. Key figures of the 2010 Port Plan of Rotterdam

	1990	**2010**
Total transhipment (mln tons)	288	400
Employment in transhipment, storage and distribution activities (jobs)	12.800	17.800
Direct added value (NLG bln)	10	14
Area required (in hectares)	5.250	6.700

Source: Rotterdam Port Authority, 1991, in: Priemus, Konings & Kreutzberger, 1995: 129.

Since 1990, the actual growth figures for the port of Rotterdam have fallen well short of the prognoses published in 1991.
Priority is given now more and more on increasing the added value and the transformation of the mainport into a brainport. A brainport is a mainport in which knowledge-intensity has increased, as a result of which the added value of transport and logistics has increased considerably.

4. Mainports serving as links between regional economic clusters and international networks

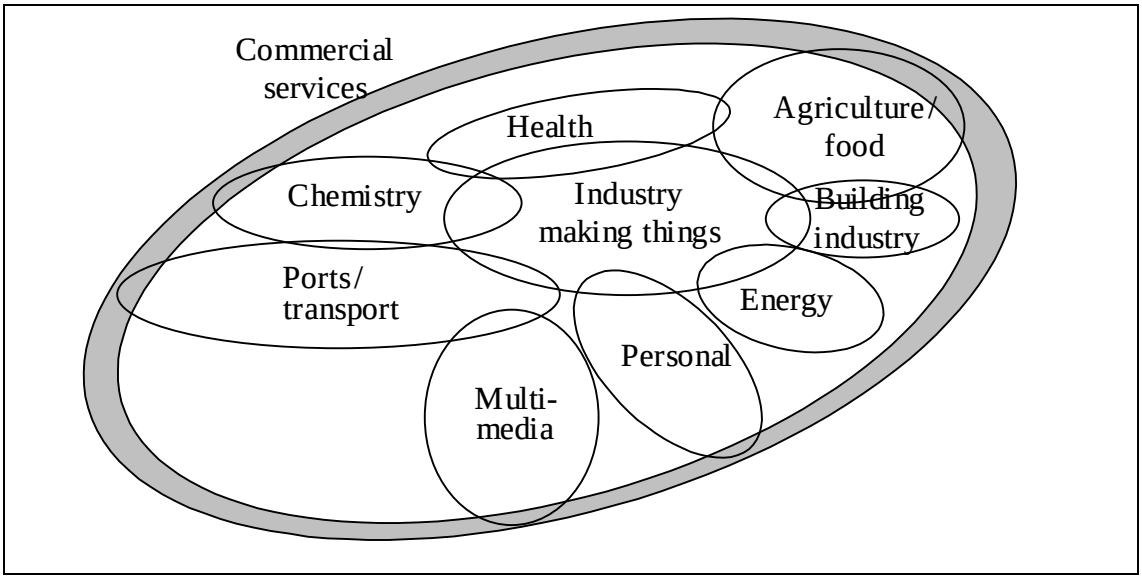
The mainports of Rotterdam and Amsterdam Schiphol have an international transport function, both for passengers and freight. Whereas Rotterdam is primarily concerned with freight transport, Amsterdam Airport Schiphol transports both goods and passengers. Both are vital to the functioning of the Dutch economic clusters. A study carried out by Buck Consultants in 1997, in collaboration with NEI, supported the view that the mainports have an important part to play in the Dutch economy. The study's authors concluded: 'Adequate frequency and quality of transport links with other countries and continents are essential preconditions for a very internationally oriented economy. This particularly applies to the development of international business services, as well as trade and distribution facilities.'

4.1 European Distribution Centres

The Netherlands likes to refer to itself as 'the Gateway to Europe', a direct reference to the country's logistical and distribution facilities. The Netherlands' position as market leader in the field of European Distribution Centres (EDCs), is largely due to the strong positions of Amsterdam Airport Schiphol and Rotterdam. A study commissioned by the Holland International Distribution Council has shown that 57% of the 611 American EDCs are based in the Netherlands, as are 56% of the 344 Asian EDCs. This market share has grown rapidly during the 1990s, from just 40% in 1990 to 55% in 1997 (for American and Japanese EDCs). American EDC companies represent a wide variety of sectors: computers, medical equipment, office equipment, machinery, the chemical, fashion and textile industries, cosmetics and household items. Japanese EDCs primarily distribute office equipment, chemical products, machinery (heavy equipment), automotive items, consumer electronics and instruments. Two thirds of the Taiwanese EDCs are active in the computer and electronics cluster (Ministerie van Economische Zaken, 1999b).
Most of the EDCs (53%) are located in the Randstad Holland. Of these, 28% are in the region of Rotterdam while 26% are situated in and around Amsterdam. The majority of American companies are based around Amsterdam Airport Schiphol, but most Japanese companies have a preference for Rotterdam. This concentration in the west is the result of a development that started in the latter half of the 1980s. This was an increase in the share of metropolitan business sites for EDCs due to the popularity of Amsterdam Airport Schiphol. This share has declined in the 1990s as American and Japanese companies have increasingly opted for sites throughout the connecting corridors in the hinterlands of the Rotterdam and Amsterdam Schiphol mainports. The position of Rotterdam has been most affected by this development (Buck Consultants, 1998).

4.2 Economic clusters

A country may contain several economic clusters, each consisting of numerous companies and industrial sectors forming a critical mass of networks (production, market or expertise). From within the Dutch clusters, the constituent sectors maintain their links with international networks.
In his book, 'Competitive Advantage of Nations' (1990) Michael Porter emphasizes the interweaving of several sectors, companies and centres of expertise to create added value.
Porter (1990) argues: 'A nation's successful industries are usually linked through vertical relationships (buyer/supplier) or horizontal relationships' (common customers, technology channels, etc). This interweaving occurs through personal contacts, goods flows, information and individuals with particular expertise. The Dutch mainports are typical links, places where various flows merge. Both the Port of Rotterdam and Amsterdam Airport Schiphol serve as links, connecting Dutch clusters to international networks (Technopolis & Dialogic, 2000: 12).
Figure 4 shows clusters in which the Dutch economy enjoys a pre-eminent position.



Source: Ministerie van Economische Zaken, 1999b.

Figure 4. Dutch economic clusters

In the Netherlands, as elsewhere, clusters have become the object of policy. The Dutch government defines clusters as networks and chains of suppliers, customers and/or individuals with particular expertise, focusing on the innovative creation of added value.
A study commissioned by the Ministry of Economic Affairs (Ministerie van Economische Zaken, 1999b: 20) emphasized the strategic importance of the mainports for Dutch clusters within international networks. Rather than being restricted to a single area or country, entire value chains for most products and services are increasingly likely to be spread across all parts of the global economy. The mainports are essential links in these international networks and are critical to the controlling function of the Dutch clusters.

4.3 ICT mainport

The concept of a 'gateway' is not restricted to the dimension of transport alone. Increasingly, people refer to the knowledge-intensive brainport. The Gigaport project cited the requirements imposed on an ICT mainport, as part of the mainport of Greater Amsterdam (Ministerie van Economische Zaken, 1999b: 19). The Gigaport project (set up by the Ministry of Economic Affairs, the Ministry of Education, Culture and Science and the Ministry of Transport, Public Works and Water Management), which includes a number of companies and Amsterdam Airport Schiphol, concerns the development of the world's most advanced communications networks.

5. Mainports: five functions

Five distinct functions of mainports can be identified: freight transport node, passenger transport node, cluster magnet, business generator and signboard. Each of these functions is

further elaborated in the brief descriptions given below (Ministerie van Economische Zaken, 1999b: 23-25).

5.1 The Mainport as 'Goods node'

This is the classical function of the mainports, the physical transport of goods. Both mainports play an important part in the transport of goods and can also enhance this with Value Added Logistics services.
This function can be subdivided into the following three aspects:

- import node for raw materials, materials, components and semi-finished products for Dutch production clusters;
- goods transit node, with the facility for simple processing within the Netherlands (assembly, packaging, bundling);
- export node for semi-finished products and finished products manufactured in the Netherlands.

Factors such as accessibility, connections to the hinterland, intermodality and network development, all help to determine the competitive position of the mainports as goods node.

5.2 The Mainport as a 'Passenger node'

For all clusters the main node for business air traffic is Amsterdam Airport Schiphol, even though its importance for some sectors is waning. In this context, the mainport fulfils a primarily logistic role in giving travellers access to a large number of (mainly foreign) destinations. This involves the transport of:

- staff of Dutch companies who are involved in overseas projects, who conduct international acquisitions, meet with members of the company's branches abroad, attend international conferences, trade fairs or other informative occasions;
- staff of foreign companies who have been seconded to the Netherlands, who conduct acquisitions in the Netherlands and hand out work assignments, inspect work in progress, visit a subsidiary/parent company and attend trade fairs and conferences that take place in the Netherlands;
- people participating in international meetings and conferences that take place in the vicinity of the mainport.

Amsterdam Airport Schiphol is to be linked to the European high-speed train network, which further enhances its function as a passenger node.

5.3 The Mainport as a 'Cluster magnet'

The geographical surroundings of the mainports act as a magnet for industries. In some cases, the companies involved tend to display a degree of clustering. This is where companies from the same sector or value chain establish themselves in close proximity to one another in order to gain a competitive advantage. This advantage derives either from such mutual proximity or from the specific advantages offered by the site itself.
This initially involves several companies establishing a physical presence in the vicinity of the mainport. In addition to activities that are directly associated with the airport (logistics

and distribution), these include companies that are located in the value chains of the various clusters.

The synergism generated by the cluster is further enhanced by the concentration of expertise in the vicinity of the mainports, primarily embodied in the individuals employed in the cluster. Clustering promotes the development of a specialized labour market. Accordingly, for the information technology (IT) cluster, one of the most attractive features of Amsterdam (and other areas of the Randstad Holland) is the presence of a relatively large labour market for IT specialists. Process technicians are easier to find in Rotterdam than in other parts of the country. Know-how can be exchanged via informal networks, the labour market, links to training institutes, mutual collaboration and specialized service providers.

Two examples of this are the financial cluster that has developed in the southern and south-eastern districts of Amsterdam ('Zuid' and 'Zuidoost') and the chemical industry cluster that has established itself in the port of Rotterdam. Expertise is also concentrated in the logistical know-how that is associated with the physical flows of goods. This can generate additional services such as the tele-auctioning of flowers that have not yet been transported. This logistical know-how is partly stored in IT systems. This transforms the mainport into an expertise node, in the broadest sense of the term. During discussions of such issues, the mainport is often referred to as a brainport.

Another step in the formation of clusters occurs when specialized resources are shared. Some examples would be shared services such as Safety, Health and Welfare services, safety facilities, distribution channels, pipelines etc.

This bundling of activities can also result in the creation of relationships between different clusters. A large number of (European) head offices are located around the Amsterdam Schiphol mainport. The presence of such large potential customers tends to attract other companies, primarily from the service sector. One of the clearest examples of this is the interweaving of the IT cluster with the head offices of other clusters that have been established in the area.

5.4 The mainport as a 'Business Generator'

The mainports do much more than simply provide services to industry. Their roles as an infrastructure company and as a transport and distribution cluster make them important potential customers for local clusters. In this context, both mainports are large-scale users of computer systems and software needed to manage logistical flows. The large sums invested in physical infrastructure generate work for construction companies and for engineering firms involved in the construction projects. These relationships serve to enhance the strategic importance of the mainports.

5.5 The mainport as a 'Signboard'

One of the 'softest' factors making up the strategic importance of the mainports is the image of Amsterdam Airport Schiphol and, more especially, that of the city of Amsterdam, together with Rotterdam's reputation as a world port. In the case of Amsterdam, the city's reputation for culture and tourism makes it easier for Dutch companies to persuade foreign customers and business partners to come to the Netherlands to discuss an acquisition, or to attend trade fairs or conferences. It can even influence decisions on whether to set up overseas offices in the city. This favourable image can also serve as a business image. Companies that have

carried out work for one of the mainports (Amsterdam Airport Schiphol or Rotterdam Port Authority) can gain benefits overseas from the prestige associated with these infrastructural projects. Amsterdam Airport Schiphol itself has profited from this by being selected for major projects, for example, the construction and management of terminals at JFK Airport (AAS, 1998) and the development of the Airport City formula.
When dealing with the 'softer' mainport functions, it is better to use the term 'mainport Schiphol/Amsterdam' rather than to limit the concept to the airport itself. The same is true of Rotterdam, since the area of the mainport extends well beyond the harbours themselves. The mainport and the city centre are deeply interwoven, forming an integral unit.
Policy documents relating to the Rotterdam mainport tend to focus on:

- the creation of a second Maas Area to avoid a situation in which logistics and industry will run out of space;
- tying the logistic flows of the port itself into other transport modalities such as road, inland waterways and rail, especially the links to the Ruhr and to the Antwerp port area;
- enhancing local know-how and the mainport's level of computerization by boosting activities associated with added value.

In terms of passenger numbers, Amsterdam Airport Schiphol ranks fourth in Europe behind London, Paris and Frankfurt. In terms of air cargo it ranks third, ahead of Paris. Nearly half of those using scheduled services are transit passengers. A major issue for the future is whether Amsterdam Airport Schiphol will be able to continue to develop within the environmental limits that have been imposed. The clustering of companies around Amsterdam Airport Schiphol as well as in Hoofddorp and Amsterdam Zuid (EDCs, Dutch head offices, European head offices and the associated service industries) has a certain geographic element. For many companies, the key factor for success is the proximity of the airport. The central thrust of policy for Amsterdam Airport Schiphol is meeting the environmental preconditions and the option of an airport on an island in the North Sea.

5.6 Conclusions

Mainports are much more than transport and logistics nodes. Mainports should not be defined merely in physical terms since they have already become major centres of expertise and information. The ability to direct flows of goods and passengers is critical to the future developments of both mainports.
The mainport Rotterdam is, nevertheless, primarily concerned with freight transport. This virtually eclipses the region's relatively minor role as a passenger transport node (Rotterdam Airport, Rotterdam Central station and the high-speed railway, motorway connecting point and node). While mainport Amsterdam Schiphol is primarily a mainport for passenger transport, freight transport is also important both at Amsterdam Airport Schiphol and in the port of Amsterdam. The relationship between the port of Rotterdam and Rotterdam Airport is extremely weak. The same is true of the relationship between Amsterdam Airport Schiphol and the port of Amsterdam.
The essential difference between Amsterdam and Rotterdam at this stage centres on the IT node function. While Amsterdam is rapidly progressing towards an IT mainport status, Rotterdam is lagging behind. It might be worthwhile to develop a cohesive, urban, Randstad Holland network. This could encompass cities such as Amsterdam, Rotterdam, The Hague

and Utrecht, as well as medium-sized towns such as Almere, Haarlem, Leiden, Delft, Zoetermeer and Dordrecht. The mainport function of Rotterdam and Amsterdam would then need to develop into a mainport function for Randstad Holland (see figure 5).
Such a step would require significant improvement of public transport at the level of Randstad Holland, recently by central government renamed as Deltametropolis. In addition, the accelerated informatization and computerization of this Deltametropolis is of strategic importance. The ongoing ICT revolution is transforming the economy such that service industries would become dominant and greatly increasing the concentration of expertise.

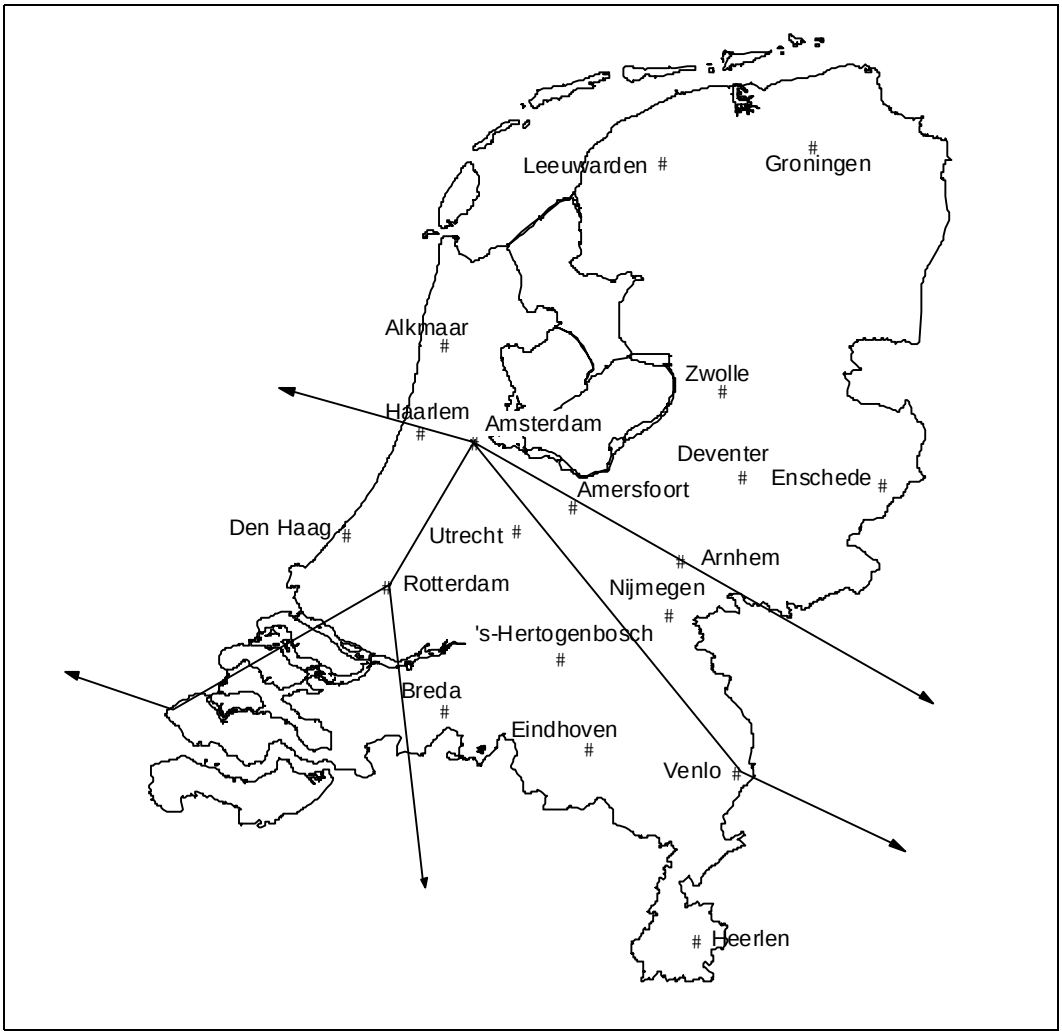
Figure 5. Mainport functions of Randstad Deltametropolis

The Netherlands mainports are links where flows of freight, passengers and information come together. The harbour of Rotterdam and airport of Amsterdam Schiphol connect the Dutch clusters with international networks.
Figure 4 indicates which *mega clusters* put the Netherlands economy in a strong position. These mega clusters can be further subdivided into several *meso clusters,* such as the dairy industry in the agricultural-food cluster and truck construction in the port transport cluster.

The clusters shown in figure 4 are formed by industrial firms in the Netherlands: they have developed a critical mass of their production, market, and information networks, so that from here they can maintain their connections with international networks.
Porter (1990) stresses the importance of thinking in clusters, which emphasize the importance of the intertwining of sectors, firms and knowledge institutes in the creation of added value: 'A nation's successful industries are usually linked through vertical (buyer/supplier) or horizontal (common customers, technology channels, etc.) relationships.'

6. ICT networks and nodes of the new economy

Mainport policies are still disproportionately focused on seaports and airports, and on connecting intercontinental ocean networks and airlines with regional, national and international multimodal networks of roads, rails, inland waterways and pipelines.
This is all related to physical transport. However, electronic highways are developing much more rapidly. Electronic mainports are gaining ground, increasingly eclipsing traditional infrastructural functions. Many policymakers find it difficult to grasp the development of virtual mobility and the concept of the new economy. They do not understand issues such as the location and the significance of IT networks.



Source: Ministerie van Economische Zaken, 1999a: 30.

Figure 6. Footprint across the Netherlands

DDV (1999: 27-34) has mapped out the current telecommunications infrastructure of the Netherlands. The primary infrastructure of most operators (the 'backbones' or transport nets) all have more or less the same footprint across the Netherlands (figure 7).
Following a phased development starting in Randstad Holland, the mobile nets have also acquired a common characteristic, namely national coverage. They differ only in terms of the numbers of transmitter masts.
This section contains an overview of the location of telecommunications infrastructure in the Netherlands and a summary of the most important players responsible for developing this new infrastructure (DDV, 1999: 27-34).

6.1 International access networks

- *KPN.* KPN is energetically working on its future and KPN/Qwest is making rapid progress in constructing the so-called Eurorings, which link the Netherlands to most other western European states. The aim of this project is to establish a private infrastructure capable of handling large volumes of cross-border traffic for international customers. The Eurorings are linked to KPN/Qwest's own transcontinental infrastructure and to those of other providers.
- *Global Crossing.* The Global Crossing company builds fixed infrastructures throughout the world. It is presently working on a new transatlantic connection (Atlantic Crossing 1) with branches to European capitals. This connection will roughly double current transatlantic capacity.
- *Viatel*. This new player is also constructing a European infrastructure, thereby opening up the Dutch market.
- *Worldcom/MCI.* Within a short space of time, Worldcom has grown (partly by means of a series of take-overs) to become one of the most important telecommunications operators in the world. Worldcom has traditionally focused on high volumes and on data traffic. However, the company cannot afford to ignore the rapid development of the mobile market and will have to reorient its focus in this regard. Worldcom's Network Operations Centre for the European market is located in Amsterdam.

6.2 Places where undersea cables come ashore

Undersea cables fulfil a major role in world-wide telecommunications networks. They link up countries and continents.
Some enterprises are truly global in scope. One example is Fiber Link Around The Globe (FLAG). This is made up of a large number of participants, such as Atlantic Crossing and Pacific Crossing. The transatlantic routes usually enter Europe via Britain (Lands End) and France (Brittany). The cable routes pass through Britain to reach the Netherlands, Germany and Belgium.
In addition to the transatlantic cables, there are also undersea cables linking the Netherlands and Britain, such as the Rembrandt 1 and Rembrandt 2 cables.
As has already been pointed out, the Netherlands has a part to play in the connections between the United States and Europe since various undersea cables come ashore in this country. There are six sites at which undersea cables come ashore, these are located in Alkmaar, Beverwijk, IJmuiden, Zandvoort, Katwijk and Domburg.
From these sites, the connections link up with the main routes to European cities. They connect the Dutch networks to international gateways. The fact that such networks come ashore in the Netherlands has a certain economic significance. The construction of such networks requires involves enormous sums of money, in the region of several hundred million Dutch guilders. Furthermore, the fact that these cables come ashore in the Netherlands regularly leads to the creation of Network Operations Centres (NOCs), each providing from several dozen to a couple of hundred high-quality jobs. Operators such as WorldCom/MCI, Global Crossing and Versatel have either already set up NOCs in the Netherlands or are in the process of doing so.

6.3 Main international routes

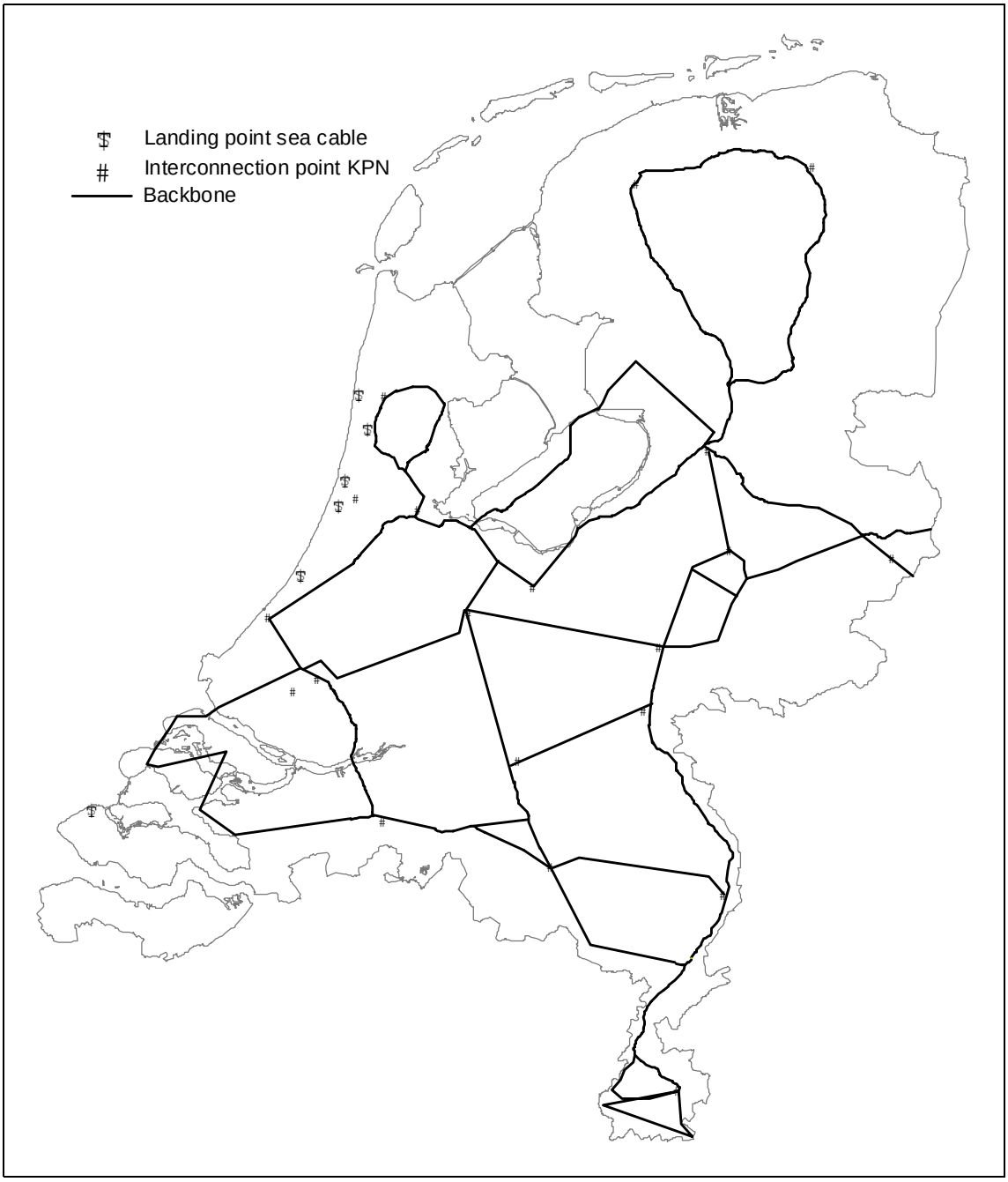
Laying undersea cables up onto the shore is usually part of the construction of main international routes, and these almost always follow the same fixed pattern. The routes run from the coast to Amsterdam where they are connected up to various optical fibre rings. Any companies wishing to be connected up to these main routes should establish a physical presence as close as possible to a network node, for example a KPN interconnection point. This confers considerable advantages, both in terms of cost and time.
From the point at which they link into the Amsterdam infrastructure, the main routes follow three paths.

- To the south, past Amsterdam Airport Schiphol to Rotterdam where they connect up with the pipeline complex to Antwerp
- To the south-east, towards the Ruhr, either via Zevenaar or via Venlo.

Bottlenecks are always developing, due to underestimates of the numbers of new users entering the market for the first time and requiring space for cable routes. One example is the pipeline complex between Rotterdam and Antwerp. This had to be expanded in a hurry, adding several dozen extra ducts in order to meet the requirements of telecommunications providers.

6.4 Main infrastructure, transport nets

Figure 7 displays the routing used by KPN and the new users of main infrastructure in the Netherlands. The map image derived from this is reasonably clear. There is a clear link between the presence of telecommunications links and centres of economic activity and population centres.
In the figure, the infrastructures of alternative providers is depicted as well. This stock-taking exercise reveals that some cities have several providers.



Source: Ministerie van Economische Zaken, 1999a: 30.

Figure 7. Main ICT-infrastructure in the Netherlands

A larger role of the ICT infrastructure in the mainports and urban networks may also introduce some problems: the higher energy demand (often underrated), the increasing vulnerability for system breakdowns and the growing dependency on foreign companies which control the ICT-networks.

When economic policy strives to transform the mainports into brainports, a synergy is needed between the ICT-mainport and mainports like Rotterdam and Amsterdam-Schiphol. Although the mobility of persons and the mobility of freight are largely separate domains, it

is worthwhile to promote the synergy between the Rotterdam harbour, Amsterdam-Schiphol, and the urban networks in the Randstad, for instance by improving the accessibility of urban nodes and mainports by car and high speed public transport (Deltanet).
It is important for policy makers to be aware of the development and significance of the new ICT infrastructures. Only then will they be able to evolve strategic plans for the backbone and to coordinate the development of these networks' strategic nodes with that of the traditional sea mainport and air gateways. Randstad Holland should get the message and endeavour to integrate ICT-mainport with mainport Rotterdam and mainport Amsterdam Schiphol.

7. Conclusions

Mainports are much more than mere transport nodes that serve to connect transport networks by sea, land and air. We have identified the following five mainport functions:

- freight transport node;
- passenger transport node;
- magnet for economic clusters;
- business generator;
- signboard.

The economic function of mainports can be enhanced by linking regional economic clusters and international networks. The development of infrastructural networks for ICT is of strategic importance when coupled to the economic restructuring involved in switching from industrial activities to knowledge-intensive business services. Mainports can be transformed into brainports by improving connections between the nodes for freight transport (like Rotterdam) and passenger transport (Amsterdam), and by integrating these with the mainports' ICT function (Gigaport). Randstad Holland is a polycentric urban configuration with a variety of city centres. It could be developed into a coherent urban network, where local governments cooperate to improve accessibility and interconnections. This would create an integrated mainport Randstad Holland, which would be capable of handling passengers, freight and information in a competitive and sustainable way.

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