SIMULATING INDUSTRIAL LOCATION DECISIONS: THE CASE OF THE EMS PORTS IN THE NETHERLANDS AND GERMANY

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ABSTRACT In the period 1993-1995 an EC/INTERREG-funded research project was carried out to identify the industrial development potential of the Ems Dollart region (the northernmost Dutch-German border region). More specifically this concerned the five sea ports which are located in the region along the Ems estuary: Eemshaven, Delfzijl, Emden, Leer and Papenburg. The major part of the project consisted of the development of a dynamic location choice system, the so-called AEGIS system. The core of AEGIS is a matching system which compares locational demands of firms (categorized as two digit ISIC sectors) with locational conditions of the five ports (specified for fifty different location factors, described with approximately 100 indicators). The comparison leads to policy recommendations regarding preferable acquisition strategies and priorities for strengthening location conditions in the region and its ports. Besides that, the supply-side of the AEGIS matching model can be used as a manager information system. The demand-side of the matching system is filled with survey data from firms throughout the Netherlands and Northern Germany. The AEGIS system has the potential of being applied more widely, by using supply side data for other ports, cities or regions. It is also possible to use the system for impact analysis, by using the "what if" options of the model structure. Moreover, location choices for individual companies can be simulated, and different future scenarios have been built in.

1. INTRODUCTION

The goal of this article is to describe a computer model which can simulate industrial location decisions, and thus serve as a basis to support location decisions of firms as well as economic development activities of local governments. The model was a product of the research project "AEGIS", which was carried out in the period 1993-1995 by the Faculty of Spatial Sciences of the University of Groningen in the Netherlands, in cooperation with the Fachhochschule Emden and the Arbeitsstelle DIALOG of the University of Oldenburg in Germany. The project was assigned by the EDR region (Ems Dollart Region) which is one of the official cross-border regions ("Euroregions") of the European Union. "AEGIS" was the abbreviation of the project title in the Dutch language. The central research goal for the AEGIS project was to assess the opportunities for economic development in the EDR region, more specifically for the five seaports situated along the Ems estuary, viz. Eemshaven, Delfzijl, Emden, Leer and Papenburg. The AEGIS research plan consisted of four main

elements:
1. a situation analysis of the regional economy;
2. a SWOT-analysis;
3. the development of a location model; and
4. action plans for local and regional governments.

This article concentrates on the third element, the location model, which is also of general value outside the scope of the AEGIS-study. However, to get an impression of the regional economic context for which the model was developed, a short description of the study region, the EDR, is given. In the subsequent sections the location model will then be presented, and the results produced by its application in the EDR region. Finally, the future development potential of the model will be discussed.

1.1 The Ems Dollart Region

The Ems Dollart Region (Figure 1) combines the Dutch provinces of Groningen and Friesland with Ostfriesland and the Emsland in Germany. It is the northernmost of a series of four Euroregions along the Dutch-German border, and suffers clearly from the well-known general problems of all peripheral border regions, such as low population density, low firm-density, relatively low incomes, high unemployment rates, many branch plants, and little or no economic and social interaction with adjoining regions (Boekema and van Houtum, 1993; COB, 1994). The total population of the region, which occupies 11,184 sq km, is 1.7 million. Unemployment amounts to 10 per cent on the Dutch side and 8 per cent on the German side of the border, in both cases well above the national average. Both in the Netherlands and Germany the EDR has been a target area for regional policy for many decades. Naturally, this policy aims at attracting new industrial establishments to the region, and as the presence of the five ports along the Ems river estuary is one of the natural locational advantages of the region, these ports constitute a logical spear-head for regional development planning.

The five Ems ports are small ports (certainly when compared to the more well-known Dutch and German ports such as Rotterdam, Amsterdam, Bremen and Hamburg) but by no means identical. They are different in character as well as in size (see Table 1). Delfzijl is dominated by a cluster of chemical industries, especially AKZO and her joint ventures (1400 employees). The Eemshaven has no industrial specialisation yet because it attracted very few industries since it was built (in 1971) but its aim is to be a centre of energy-oriented and recycling activities. Emden is dominated by the local Volkswagen production plant (10,000 employees) and shipbuilding. In Papenburg shipbuilding is also dominant (the Meyers ship yard, with 2,000 employees). Finally, the port of Leer is based on the activities of a number of small local industries.

The excentric location of the Ems ports, nationally as well as on the European scale, combined with the weak economic structure of its more direct hinterland, and the vulnerable natural environment of the tidal basin (the "Wadden Sea")

Figure 1(a). The Ems Dollart Region

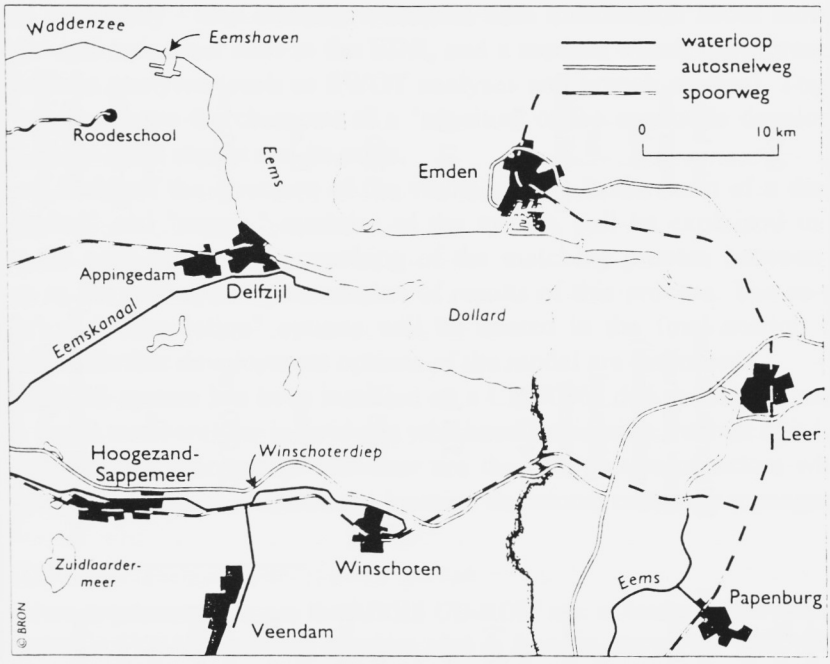

Figure 1(b). The Five Ports Along the Estuary

Source: Witzenburg and Parker Brady (1994a, 1994b)

Table 1. Characteristics of the Five Dutch and German Ems Ports

	DELZFUL	EEMSHAVEN	EMDEN	PAPENBURG	LEER
Total trans-shipment '92 (mill. tons)	4,831	0.631	3,245	0.709	1,289
Transshipment specialisation	bulk products (ind. raw materials forest products)	dry bulk (sugar and fruit)	ore, cereals, transportmeans (parts)	forest products (wood)	bulk, & building materials
Industrial specialisation	chemical industry	no specialisation	automobile production shipbuilding	shipbuilding and repairing	no specialisation
Ind. space, issued (ha.)	414 ha	453 ha	730 ha	150 ha	100 ha
Ind. space, available	314 ha	191 ha	520 ha	100 ha	40 ha
Length of quay (meters)	1943 m.	1320 m.	2641 m. (outer harbour)	1900 m.	500 m.
Depth of entrance (m)	9 m.	11 m.	8.5 m.	5 m.	6 m.
Max tonnage (dead weight)	25,000 dwt	43,000 dwt	40,000 dwt	--	3,000 dwt
Container facilities	no	limited Roro facility	limited (3,000 containers ann.)	no	no
Development plans	multi purpose terminal liquid bulk quay new commercial quay	bulk quay Conro terminal Short sea junction	expansion of terminal output free port	deepening of entrance of the harbour (Ems)	investment in hinterland connections

Source: Witzenburg and Parker Brady (1994a, 1995a)

which separates the estuary from the North Sea, are the main obstacles for transport and industrial development in these ports (Witzenburg and Parker Brady, 1994a). All five of them have their own sad record of abortive development initiatives and countermanded industrial establishments. In spite of that the EDR region and its ports definitely hold certain positive characteristics and opportunities as well, as was demonstrated by the SWOT-analysis of the AEGIS-study. There is a lot of industrial space, absence of congestion, a favourable cost structure, financial incentives and a nice quality of life (Witzenburg and Parker Brady, 1994b). Through a detailed and systematic exploration of these regional and port characteristics, the AEGIS study provides a new framework for the recommendation of feasible industrial development initiatives. The core of this exploration was the development of the location model which was referred to in the introduction. In the next section a short description of this model will be given. For more detailed information, refer to the final report of the AEGIS project (Witzenburg *et al.*, 1995a) and its annexes.

2. THE MODEL: A MATCHING SYSTEM

The "location model" which was produced by the AEGIS study is a system which matches the location demands of industry sectors with the location conditions of places; in this case, the five Ems ports. Next to the *matching system* an *information system* was constructed, which contains the data which are used in the supply side of the matching system. The information system - which can be consulted separately - also contains a module with information about individual companies and industrial sites in the EDR, and a module which shows results of short scientific analyses (such as SWOT analyses and branch studies). Together, the two systems have the character of a "monitor" of the economic development potential of the EDR region and its ports.

Figure 2 shows the structure of the whole system in the form of a diagram. The "demand" and "supply" modules of the system will be explained in more detail in the next section. The working of the matching process between them comes up in the subsequent presentation of results of this process. The so-called "scenario" and "simulation" options will be treated in the final section of the article, where further development options of the model are discussed.

The AEGIS system has been installed on a CD-ROM disk, which is available (albeit in small numbers) for individuals who have a scientific interest in it.[1] More important potential user groups however are the two groups of actors who are most practically involved in industrial location decisions: company managers and

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[1] Hardware requirements to use the AEGIS CD-ROM are: at least an IBM compatible 386 computer; a SVGA compatible graphics card & monitor, supported with VESA; at least 5 MByte of free memory; a harddisk with at least 4 MByte of free space; a Microsoft, Logitech or compatible mouse; MS-DOS or PC-DOS version 3.1 or higher; a CD-ROM player. (Witzenburg *et al.*, 1995b)

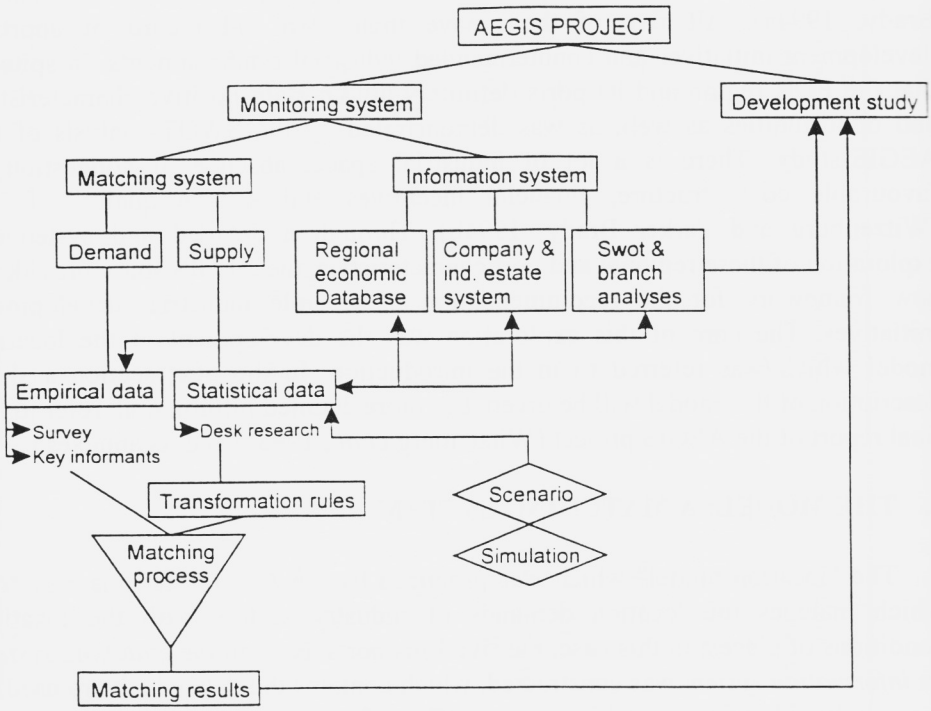

Figure 2. The Framework of the AEGIS Project
Source: Witzenburg and Parker Brady (1994b)

local governments. For them, the system collects and combines a multitude of objective location supply and demand data to support their decisions, viz. the location decisions of company managers and the decisions of local governors involved in acquisition and location preparation. To build the system and load it with information, both these groups had to act not only as information users, but also as information sources. An overview of the demand side of the location problem is first obtained from the managers.

3. DEMAND AND SUPPLY PROFILES

3.1 Location Demands

For the demand side of the matching system, the location requirements of companies were gathered in 1993 and 1994 through an extensive postal inquiry among 5000 firms throughout the Netherlands and Northwest Germany (Niedersachsen), of which 1300 firms responded. Because the matching system was developed and applied for the EDR region and its ports, only firms within (direct or indirect) port-related industrial and service sectors were included in the

inquiry. Small firms (i.e. less than 10 employees) were excluded from the enquiry. For 33 industrial and service sub-branches enough respondents were found to construct demand profiles of statistical significance. The profiles contain 50 different location factors (see appendix) covering four different spatial scale levels (i.e. nation, region, city, site). The factors were chosen on the basis of the international literature, especially descriptions of empirical location studies (Witzenburg and Parker Brady, 1994b).

In the firm enquiry, respondents were asked to give a score (from 1 to 5) to each of the 50 location factors, corresponding to its importance in case of a location decision. Of course this technique is not original (see for instance Dunning and Norman, 1983). In our case, the scores for sectors were calculated as the arithmetic means of the scores given by individual companies in the sectors, under the condition that the dispersion of the individual values was not too big; a skewness of 0.3 was taken as the limit (see Witzenburg and Parker Brady, 1994b). Larger firms were not given more weight than smaller firms, nor was any special weight given to particular industries for particular factors. The latter has certainly been considered, because there is a difference between very important location factors which can or cannot be somehow substituted. In the last case the factor is not only important, but also critical. For instance a study of the NEI (1992) into the location factors for mobile investment in Europe, based on in-depth interviews among ninety managers of multinational firms, has specified the difference between important and critical location factors very clearly. However, in postal inquiries such as we were forced to use in order to get large numbers of respondents, the difference between important and critical factors is difficult to explain and can easily lead to confusion, which was reason to abandon this option.

An exhaustive overview of the results of the firm inquiry, in the form of a matrix showing the scores on all 50 factors for all 33 sectors is beyond the scope of this article. Table 2 gives a selection of these results. It shows the demand profiles of six broad sectors in which the 33 subsectors have been taken together, for the first ten factors of the factor list, under the group headings of market factors, labour market, and infrastructure. Again, in each column the "score" represents an indication of the importance of a location factor. The "rank" in the columns refers to the relative importance of a location factor with respect to the other 49 factors of the list. Clearly, labour mentality (attitudes) is judged of most fundamental importance by all sectors, while for instance proximity to raw materials is much less important. Availability of technically skilled labour is more important for industrial than for service firms and higher educated labour is of great importance (4th rank) for business services. As stated before, the demand profiles were made available for 33 individual subsectors for all 50 location factors. They constitute the input for the demand module of the AEGIS system.

3.2 Location Supply

To describe the supply side of the location problem for the same 50 factors that were used at the demand side, a great number of national, regional and local

Table 2. Relative Importance of Location Factors, by Industry Sector (selection of 10 out of 50 factors, aggregated sectors)

Location factors	Nr.	A(n = 1265) score	ran k	B(n = 574) score	ran k	C(n = 139) score	ran k	D(n = 172) score	ran k	E(n = 116) score	ran k	R(n = 226) score	rank
MARKET FACTORS													
Proximity to markets	(1)	2.09	(05)	2.25	(10)	1.75	(03)	1.90	(03)	2.01	(06)	2.15	(05)
Proximity to suppliers	(2)	3.05	(24)	2.94	(24)	2.94	(21)	3.09	(27)	2.87	(23)	3.57	(30)
Proximity to raw materials	(3)	3.20	(30)	3.12	(29)	3.24	(29)	3.22	(28)	2.98	(29)	4.01	(33)
LABOUR MARKET													
Lower/Medium techn skilled labour	(4)	2.12	(06)	1.84	(03)	1.91	(05)	2.37	(11)	2.34	(11)	3.08	(23)
Higher technically skilled labour	(5)	2.63	(14)	2.46	(12)	2.59	(11)	3.03	(25)	3.02	(31)	2.67	(15)
Labour with lower adminis/commerce sk	(6)	2.50	(12)	2.51	(06)	2.74	(15)	2.36	(10)	2.38	(12)	2.45	(11)
Availability of higher educatn labour	(7)	2.65	(16)	2.68	(15)	3.05	(24)	2.75	(18)	2.72	(20)	2.13	(04)
Workers mentality	(8)	1.40	(01)	1.38	(01)	1.30	(01)	1.42	(01)	1.39	(01)	1.49	(01)
INFRASTRUCTURE													
Connection to internat motorway system	(9)	2.46	(11)	2.28	(11)	2.83	(16)	2.35	(09)	2.08	(07)	3.01	(21)
Connection to national motorway system	(10)	2.05	(03)	1.93	(04)	2.18	(08)	1.96	(04)	1.85	(03)	2.31	(08)

Scores: 1 = very important 2 = important 3 = neutral 4 = not very important 5 = totally unimportant

Sectors: A = all firms, B = manufacturing industry, C = building industry, D = wholesale, E = Transport & communication, F = banks, insurance firms and other business services

Source: Witzenburg *et al.* (1995a)

statistical data sources were used, both from the Netherlands and Germany. Wherever necessary, local and regional administrators were asked for additional information, and key-informants were used to check certain data. To get comparable data many problems of differing statistical definitions had to be tackled. The use of Eurostat data (Nuts regions) was only a partial solution for these problems. Much of the data needed for the factors and spatial levels as specified in the AEGIS matching system were not available, which made the use of indicators and transformation rules indispensable (Witzenburg and Parker Brady, 1994b). Eventually, a number of 92 indicators were used to describe the 50 location factors. In the appendix the entries after the two digit numbers describe the indicators which were used. Using this approach, the determination of scores on the supply side of the matching system on each of the 50 factors for each of the five Ems ports proved to be a very labourious task. For several indicators various average values had to be calculated as a basis for comparison, and also a transformation from the original statistical figures to scores between 1 and 5 was needed, to be able to match the supply scores with the demand scores. As an example, the calculation of the first supply factor (F1: proximity to clients/ markets) for the port of Delfzijl is given as follows:

> F1 = 0.2 x [population density (inhabitants/km^2) of the northern part of the Netherlands and the Weser Ems area compared to the average population density of the Netherlands and Germany] + 0.2 x [firm density (excluding sectors 0, 8 and 9) within 1 hour travelling time by road from an Emsport compared to the national firm density averages (number of firms per capita)] + 0.6 x [the average travelling times by road from an Emsport to economic core regions (Randstad Holland, Ruhr area and Hamburg) compared to the travelling times to these core regions from the ports Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining Emsports].
> The indexed outcome of this calculation is then transformed into a score from 1 to 5 by means of the transformation rule 2 x (0.2Xi1+0.2Xi2+0.6Xi3) : 100 (Xi1=index indicator 1; linear interpolation).
>
> (Witzenburg *et al.*, 1994b)

As can be observed from the example, the calculation of the individual score on factor 1 for Delfzijl does not simply take the Delfzijl values for the three indicators (1.1 population density, 1.2 firm density - both measured, in this case, not for the city alone but on a regional level - and 1.3 distance to core regions) but relates it to average values at the national level for 1.1 and 1.2, and for 1.3 to the travel times for all other ports along the coast of the Netherlands and Northern Germany, which are, in this case, the proper basis for comparison. Many of the individual factors/indicators imply such an implicit comparison with the other ports in the Netherlands and Germany. Clearly, the supply side of the model is not just loaded with local and regional figures, but also uses information about ports and regions elsewhere in both countries to find an objective basis for the valuation of the location conditions, relative to competitive port locations. So, the

supply side module of the AEGIS model in fact involves a real benchmarking exercise.

4. RESULTS OF THE PROFILE MATCHING

4.1 Suitability of ports and sectors

A detailed description of the matching of location supply and demand data is given in the official reports about the AEGIS project (Witzenburg and Parker Brady, 1994b, 1995a; Parker Brady and Witzenburg, 1995). In the matching process a suitability matrix for the five ports or 33 branches is constructed on the basis of decision rules. Two options can be chosen for the matching process, i.e. a selection by port and a selection by branch. In the first case the output of the matching process will be a list of 33 branches for each port, in order of a decreasing suitability-potential of the port for firm settlement. This serves as an indication, for local governors, of the sectors which are the most promising candidates for a promotion and acquisition strategy, and can support decisions as to what kind of sites and locations to develop. In the second case, a ranking of the five ports for each industrial branch is produced, which can serve as a short list of location alternatives for companies that might consider the ports as possible locations.

In Table 3, the result of the matching process for all five ports and 33 branches (industrial subsectors) is presented. The first impression is of course, that the figures indicating the suitability for industrial location are not very different for the five ports. Certain differences are observable, for instance (reading from the top) Leer is the best port for the location of waste recycling firms, Emden and Eemshaven are the best locations for food industry, Eemshaven for wood and paper industry, Leer for printing, Delfzijl for oil industries, etc. The differences however are remarkably small. This is explained by the small differences in the locational climate of the ports, which - as noted above - is valued in comparison with all fifteen ports along the Dutch/German coast including Rotterdam, Amsterdam, Hamburg and Bremen. With this frame of reference it is only natural that the five Ems ports appear as group of ports, a "port region", with very comparable location conditions and, as a result, comparable suitability for firm location.

Quite contrary to the matching result per port, the matching result per subsector shows remarkable differences. Obviously, some sectors are much more suitable for firm location in the Ems ports than others. Table 4 lists the top-12 of branches which have a positive score for (almost) all five Ems ports.

4.2 Evaluation of results

The results of the matching process certainly hold an answer to the original question about the suitability of the Ems ports for firm location, but at the same time they give rise to new questions. One rather crucial question concerns the

Table 3. Results of the Matching of Location Demand and Supply Data for the Five Ems Ports and 33 Industrial Subsectors

Subsector/Port	Eemsh	Delfz	Papenb	Emden	Leer
Waste recycl.	113	118	111	117	120
Food prod.	153	148	144	153	145
Timber ind.	140	136	129	133	133
Paper ind.	140	137	136	137	138
Printing	88	86	87	85	92
Oil industry	129	136	135	134	139
Chemical ind.	131	143	135	134	136
Rubber, plast.	116	118	114	114	118
Building ind.	124	122	125	123	125
Metallurgy	114	111	114	115	118
Construction	92	86	88	83	90
Metal ind.	97	93	99	88	104
Engineering	129	127	125	123	130
Electrotechn.	115	112	115	114	113
Motorcar ind.	129	124	131	125	126
Shipbuilding	153	148	146	150	142
Energy works	66	67	69	68	68
Building	95	94	93	92	95
Civil works	85	84	87	81	92
Agr.wholesale	140	139	133	149	135
Wholes. food	109	108	100	104	104
Wholes. chem	122	118	113	118	117
Wh. building	91	92	90	90	94
Wholes. paper	105	103	96	100	104
Road trans	130	128	125	130	131
Sea shipping	149	147	150	154	150
Logistic act.	154	150	154	159	149
Other transp.	138	131	131	131	136
Banks	79	78	71	74	72
Insurance	60	58	58	57	60
Adm. offices	85	83	81	82	80
Eng. offices	83	81	86	83	84
Econ. consult.	72	69	69	68	68

Note: The higher the score, the greater the suitability of the port for location of the subsector.

Source: Witzenburg *et al.* (1995a)

nature of the selected sectors, in relation to their actual presence in the Ems ports. The twelve best suited industries of Table 4 can be divided into the following three, rather different categories:

1) Four sectors are so-called "basic" industries which are already represented in (some of the) Ems ports, i.e. shipbuilding, oil refining & chemical industry, car assembly, and metallurgy.

Table 4. Most Suitable Subsectors for the Five Ems Ports

1.	Wholesale activities, esp. agriculture and chemical products
2.	Logistic sea port activities
3.	Sea shipping
4.	Food and beverages industry
5.	Shipbuilding and -repairing
6.	Oil refineries and chemical industry
7.	Wood processing industry
8.	Paper industry
9.	Other transport ind. (forwarders, shipbrokers, warehouses)
10.	Car assembly, coach work, car parts
11.	Waste recycling
12.	Metallurgy and related activities

2) Four other sectors are what one could call "margin" or "related" industries which are also already present in (some of the) Ems ports: sea shipping, other transportation, logistic activities, and wholesale. These are sectors which are not basic, but related to the demand of other industries in the port regions.
3) Finally, four sectors are selected which are basic in character but thus far *not* (at least not strongly) represented in the Ems ports: food and beverages, wood processing, paper industry, and waste recycling.

Clearly, eight of the twelve selected industries are already present in the five Ems ports. On the one hand this proves the suitability of the ports for these sectors. On the other hand one could ask why the EDR region is so depressed if so many of the theoretically best suited industries are already located there. Theoretically, one explanation might be that the selected sectors are depressed, or that the firms located there are depressed representatives of these sectors. Neither explanation is true however, leaving aside exceptions. The real problem is that industrial establishments in the sectors concerned are still too small in number, and sometimes restricted to only one of the ports whereas others could support them just as well. This calls for more activity from local planners to attract firms in the existing industrial sectors, and of course the same holds even stronger for those four industrial sectors that proved to be feasible but are not currently represented.

The official AEGIS-reports discuss these and other results of the matching process at greater length, entering into details such as the contribution of the separate location factors to the matching result for individual ports (which may very well uncover why certain industries well suited to the region are nevertheless not represented, such as those under the heading 3: food, wood, paper and recycling). For each port, an action plan was then constructed, with a list of concrete recommendations for the local governments and port authorities about useful further actions. Such actions can take the form of targeted marketing activities, but also concern infrastructural or other shortcomings shown by the matching results, and contain ideas about cooperation in certain fields with the other Ems ports. For the EDR region as a whole such an action plan was also made. The content of all these action plans will not be discussed in this article

however, because it is less essential in view of the more general question of interest here, i.e. how can we offer information, on the basis of economic-geographical analysis, which can support the decisions of company managers and local governments with respect to the industrial location problem. For this, we consider, in the final section, the future development potential of the AEGIS-system.

5. PROSPECTS FOR FURTHER DEVELOPMENT

5.1 Similarities and Differences with Existing Systems and Models

Certainly, the AEGIS-system is not a totally new concept. The idea of combining location demand and supply data to outline development possibilities for places and regions has been the core of many so-called "feasibility studies", especially in the nineteen sixties and seventies. Although most of these studies have been carried out by private consultants and for that reason have not always been openly published, a number of them have become known, such as the comprehensive study of the European Economic Community into the industrial development possibilities of the Bari-Tarente region in Southern Italy (EEG, 1966) and a comparable study for Central Lancashire in the UK conducted by Luttrell (Livesey, 1972). For the Netherlands several smaller scale feasibility studies are known (see Pellenbarg, 1985), among others for the industrial region between Amsterdam and IJmuiden (Bureau Beerenschot, 1970), the small ports of Medemblik and Harlingen (Pellenbarg *et al.*, 1974; Aenea Venema, 1983) and the textile town of Enschede (Bakker, 1980). All of these studies cope with the same problem, viz. a lack of sound and detailed demand profiles of industrial sectors. The first to provide a comprehensive overview of such demand profiles was Schilling (1968) with his "Standortfaktorenkatalog" (they were used, among others, in the studies for Medemblik and Harlingen), but since its publication these profiles have become outdated.

The AEGIS-system may be regarded as an updated and dynamised (computerised) version of Schilling's Standortfaktorenkatalog of 1968. The number of industrial sectors for which AEGIS has demand profiles is smaller than Schilling had, but the number of location factors going into the matching process is twice that of Schilling's list. Judged by the same points of reference - number of sectors and number of factors - the AEGIS system is superior to the computerised site-selection programs set up by some consulting firms - as far as we know them. Private location consultants sometimes use location-selecting models as a part of their service to clients. In Europe, Plant Location International (now part of the international accountancy company Price Waterhouse) operates such a model, and its smaller competitor in the Netherlands, BCI (Buck Consultants International), has one as well (the SILOC model). Such models work however with no more than a dozen sectors and factors, and cannot reach the degree of detail of a true feasibility study. Moreover, they seem to be more firm than region-oriented, mainly serving as indicators for possible location alternatives for individual

companies. The AEGIS system also offers this option of an individual location advice, but there are more possibilities, which will now be discussed.

5.2 Present and Potential Uses of the AEGIS System

From the explanation of the AEGIS system in the preceding pages, two options for use of the system come to the fore:

- *support of managerial location decisions*
- *support of governmental locational policy and marketing*

To this we may add two possibilities which have not yet come up for discussion, but nevertheless are inherent qualities of the AEGIS system:

- *future-oriented industrial location planning*
- *simulation of the effects of investments in infrastructure*

The future-oriented use of AEGIS is related to the built-in possibility to attune the matching process to one of the four growth scenarios which are used by the Dutch national planning institute (Centraal Planbureau, 1992). Normally the matching system uses the *Balanced Growth* scenario (a long term scenario assuming multipolar economic growth), but it is also possible to run the matching system under the assumptions of the scenario *Global Shift* (also a long term scenario, assuming a worldwide shift of economic core areas), *Cautious* (a medium-term scenario expecting continuing vulnerability of the OECD economies) and *Positive* (medium term, assuming a positive development of OECD economies without structural bottlenecks or fluctuations). These scenarios have been "translated" from the national to the regional level, where they affect the supply side of the AEGIS-system, with various effects on the outcome of a matching with sectoral demand profiles (Witzenburg and Parker Brady, 1994b)

A second possibility to bring more dynamism in the model is to use its "what if" options. This is one of the greatest improvements that come into existence by using a computerized model instead of the more static supply-demand comparisons of the older feasibility studies or Schillings catalogue. One of the modules of the AEGIS system is a "simulation module" (Figure 2) which enables the user to alter the entries of the supply side module, for instance by supposing changing distances to clients and suppliers as a result of new railways or highway improvements, or changing labour market conditions as a result of new educational facilities. The comparative shift in the model results is a clear indication of the effect which such improvements in the location conditions may have on firm establishment in the port region. This simulation option of the AEGIS system can even be used as an instrument to evaluate *investment* plans, more specifically investments in local, regional or national *infrastructure* (roads, railways, industrial sites, logistic facilities, or even institutional infrastructure such as educational facilities) by comparing the possible effects of alternative investment schemes on the local regional suitability for industrial location.

In addition to the four options enumerated thus far, further development possibilities include:

- *Location advice for individual companies*

For this, the demand module has to be reconstructed in such a way that instead of the "average" location demands of industrial subsectors, individual demands of separate firms can be loaded. The matching system would then provide a short list of the "best" possible locations, which may then be subjected to closer inspection. Of course, this procedure would only be possible if the number of locations/ supply profiles in the system is much greater than the present five, representing the Ems ports in the EDR region. Therefore one of the first developments of the AEGIS system is to fill the supply module with profiles of many more cities and regions, beginning with the whole of the Netherlands. This will then enable:

- *Evaluation of local and regional economic development potential*

For the EDR region, the AEGIS matching system delivers, as a unique product, the basis for local and regional action programs. If the procedure were to be regularly repeated, for the same region, the system will work as a regional-economic monitor for this region. If however the supply module of the AEGIS system were loaded with data for a greater number of places and/or regions, more comprehensive comparisons of the economic development potential of regions within a broader geographical context would become possible, which could form a basis for regional and spatial policies within such broader, for instance national, contexts. Again, one of the first priorities of the AEGIS system will have to be its equipment with supply data for more places and regions. The same holds true for the demand side of the system; to produce comprehensive regional economic evaluations as envisaged here, the number of subsectors in the demand module will have to be expanded (on the basis of new extensive industry inquiries) beyond the present 33 more or less port-related sectors.

With the widening of the scope of the AEGIS-applications, the circle of potential users of the system may grow as well. Up till now the use of the system is limited to the EDR officials who commissioned the study, and the regional authorities who gave financial support, such as the Chambers of Commerce of Groningen and Emden, the Port Authority of Delfzijl and Eemshaven, the province of Groningen, and the Bundesland Niedersachsen. Utilisation of the other potential uses indicated in this section may broaden the group of users to individual companies seeking a new location, intermediaries (consultants) between such companies and local/regional authorities, and to national planning institutions. Finally, there may be a group of scientific users wishing to apply the model in their more fundamental economic-geographical and regional-economic studies. It is to this group that this article is addressed in the first place, asking for discussion about the significance of the AEGIS-approach, for possibilities to improve the system and for suggestions about how to proceed with its further development.

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APPENDIX. Location Factors

(Representing both demand and supply; the second digit lists the indicators used to describe the demand side profiles)

1. PROXIMITY TO MARKETS

1.1 Population density of the Northern part of the Netherlands and the Weser Ems area compared to the average population densities of the Netherlands and Germany (in population per km^2).

1.2 Firm density (except branches 0, 8 and 9) within 1 hour travelling time by road from an Emsport compared to the national firm density averages of firms per capita.

1.3 The average travelling times by road from an Emsport to weighted economic core regions (Randstad Holland, Ruhr area and Hamburg) compared to the travelling times to these core regions from the following ports: Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

2. PROXIMITY OF SUPPLIERS

2.1 Industrial firm density (number of employees of industrial firms) within 2 hours travelling time by road from an Emsport compared to the industrial firm density within 2 hours travelling of Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

2.2 The average travelling times by road from an Emsport to weighted economic core regions (Randstad Holland, Ruhr area and Hamburg) compared to the travelling times to these core regions of the following ports: Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

3. PROXIMITY TO RAW MATERIALS

3.1 Distance by road to raw material sites in the region.

3.2 Distance (as the crow flies) to the nearest power plant.

3.3 Capacity of nearest power plant in megawatts.

4. AVAILABILITY OF SUFFICIENT LOWER/MEDIUM TECHNICALLY SKILLED LABOUR

4.1 Regional number of employees in the industrial branches with a lower/medium technical education compared to Dutch-German national averages.

4.2 Regional unemployment-quotes of lower/medium technical educations compared to the Dutch-German average.

4.3 Regional number of school-leavers per year (lower/medium technical skilled) compared to Dutch-German average.

5. AVAILABILITY OF SUFFICIENT HIGHER TECHNICALLY SKILLED LABOUR

5.1 Regional number of employees in the industrial branches with a higher technical education compared to Dutch-German national averages.

5.2 Regional unemployment-quotes of higher technical educations compared to the Dutch-German average.

5.3 Regional number of graduates per year compared to Dutch-German average.

6. AVAILABILITY OF SUFFICIENT LABOUR WITH LOWER ADMINISTRATIVE/COMMERCIAL SKILLS

6.1 Regional number of employees with a lower administrative/commercial education compared to Dutch-German national averages.

6.2 Regional unemployment-quotes of lower administrative/commercial educations compared to the Dutch-German average.

6.3 Regional number of school-leavers per year (lower commercial skilled) compared to Dutch-German average.

7. AVAILABILITY OF SUFFICIENT HIGHER EDUCATED LABOUR

7.1 Regional number of employees with higher education (college & academic degree) compared to Dutch-German national averages.

7.2 Regional unemployment quotes of college/academic educations compared to Dutch-German average.

7.3 Regional number of graduates per year (college & university) compared to Dutch-German average.

8. WORKERS MENTALITY

8.1 This factor is given a provisional fixed value of 2.5 because of the difficulties in making this factor operational.

9. CONNECTION TO THE INTERNATIONAL MOTORWAY SYSTEM

9.1 Total length of the international motorways per region (in kilometres per capita) compared to the Dutch-German average.

9.2 Shortest distance by road from an Emsport to the access of an international motorway compared to similar distances from the ports of Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

9.3 The average travelling time by road from an Emsport to weighed economic core regions (Randstad Holland, Ruhr area, Hamburg, Paris and Munich) compared to the travelling times to these core regions from the following ports: Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

10. CONNECTION TO THE NATIONAL MOTORWAY SYSTEM

10.1 Total length of the national motorway system per region (in km/capita) compared to Dutch-German average.

10.2 Shortest distance by road from an Emsport to the access of a national motorway compared to similar distances from the ports of Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

11. CONNECTION TO THE REGIONAL ROAD SYSTEM

11.1 Total length of regional roads (in km/capita) compared to Dutch-German average.

12. QUALITY INLAND-SHIPPING INFRASTRUCTURE

12.1 Distance by inland waterways from an Emsport to worlds largest seaport (Rotterdam) and worlds largest inland port (Duisburg) compared to similar distances from Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

12.2 Length of the regional inland waterways (weighed according to the CEMT classification) compared to the Dutch-German average.

13. QUALITY OF RAIL-INFRASTRUCTURE

13.1 Distance by rail from an Emsport to weighed economic core regions (Rotterdam, Hamburg and the Ruhr area) compared to similar distances from Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

13.2 Distance by road to nearest inland rai/road terminal compared to similar distances from the ports of Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

14. PROXIMITY TO INTERNATIONAL AIRPORT

14.1 Travelling time by road from an Emsport to the international airports of Amsterdam, Hamburg and Bremen.

14.2 Facilities of the nearest international airports (Amsterdam, Hamburg and Bremen) in transfer/transshipment figures.

15. PROXIMITY OF REGIONAL AIRPORT

15.1 Travelling time by road from an Emsport to the nearest regional airport.

15.2 facilities of the nearest regional airports (transfer/transshipment figures, length of runway and the number of regular services).

16. PROXIMITY TO SEAPORTS/HARBOUR FACILITIES

16.1 This factor is the average of the scores on the factors 37 through 50.

17. BASIC LAND PRICE (WITHOUT FACILITIES)

17.1 Average price of land per square meter and land rent (long and lease) per year, without facilities and VAT, compared to the ports of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

18. PROXIMITY AND COST OF PROCESS WATER

18.1 The cost of tap water in ECU per cubic meter in the harbour regions, compared to the national averages.

18.2 The presence of process water facilities (plants) on the industrial estate.

18.3 The quality of surface water (percentage of salt and lime).

19. AVAILABILITY OF LAND/INDUSTRIAL ESTATE LOTS FOR EXPANSION

19.1 The direct available industrial estate area divided by the total (gross) industrial estate area (in hectares) compared to similar shares in the ports of Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

20. REPRESENTATIVENESS/IMAGE OF THE LOCATION

20.1 Condition of the buildings and prestige of surrounding area.

20.2 Equipment of industrial estate (signposting, infrastructure, neatness).

21. CONNECTION TO MODERN COMMUNICATION SYSTEMS (ISDN NETWORK)

20.1 This factor is given a constant value of 2.75.

22. PROXIMITY TO CHEMICAL INDUSTRY

22.1 Share of the chemical industry (employment) in the total industrial employment of the Emsport, compared to similar shares in Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

23. PROXIMITY TO METAL INDUSTRY

23.1 Share of the metal industry (employment) in the total industrial employment of the Emsport, compared to similar shares in Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

24. PROXIMITY TO TRANSPORT INDUSTRY

24.1 Share of the transport industry (employment) in the total industrial employment of the Emsport, compared to similar shares in Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

25. PROXIMITY TO CERTIFIED SUBCONTRACTORS

25.1 The number of certified subcontractors (ISO-9000) in the surrounding region of an Emsport compared to similar figures in regions surrounding the ports of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

26. PROXIMITY TO TRANSPORT COMPANIES

26.1 Number of employees in transport companies in the Emsport, divided by the total industrial employment in the Emsport, compared to similar shares in Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

26.2 Employment in transport companies within 1 hour travelling time from an Emsport compared to the Dutch-German average.

27. PROXIMITY TO BUSINESS SERVICES

27.1 Regional share of employment in business services compared to Dutch-German average.

28. PROXIMITY TO UNIVERSITIES/RESEARCH INSTITUTES

28.1 College student density in the Northern part of the Netherlands and the Weser Ems area (number of college students per capita) compared to the Dutch-German average density.

28.2 University student density in the Northern part of the Netherlands and the Weser Ems area (number of university students per capita) compared to the Dutch-German average density.

29. REGIONAL FINANCIAL INCENTIVES

29.1 Net effect of a financial incentive per port (fixed and variable incentives).

30. FREE ENTERPRISE ZONES

30.1 Net effect of free enterprise zones (free writing off of fixed assets permitted).

31. ABSENCE OF RESTRICTIONS CONCERNING WASTE WATER DISPOSAL

31.1 This factor is given a constant value of 3.5. Because of the location of the five Ems ports near to the Wadden Sea, many entrepreneurs experience this region as "environmentally sensitive". Despite this negative image no striking differences from the national averages have been found.

32. ABSENCE OF ENVIRONMENTAL IMPACT ASSESSMENT OBLIGATION

31.1 The factor is based on the list of company activities (with hazardous side effects) on the regional level which are obliged to carry out an environmental impact assessment (new location or expansion).

33. SOCIAL CLIMATE: HOUSING AND SHOPPING FACILITIES

33.1 Average price of owner occupied houses (in ECU) on the regional level, compared to Dutch-German average.

33.2 Average price of rented houses (in ECU) on the regional level, compared to Dutch-German average.

33.3 Regional number of employees in the retail trade per capita, compared to the Dutch-German average.

34. CULTURAL FACILITIES

34.1 Number of cinemas per capita (municipality) compared to the Dutch-German average.

34.2 Number of theatres per capita (region) compared to the Dutch-German average.

34.3 Number of art galleries per capita (region) compared to the Dutch-German average.

35. AVAILABILITY OF LEISURE TIME FACILITIES

35.1 Surface area per region, allocated to recreational purposes (amusement parks, playgrounds, zoos, camping sites etcetera), in square kilometre per capita, compared to Dutch-German average.

35.2 Surface area forest per region, in square kilometre per capita, compared to Dutch-German average.

35.3 Surface area inland open water per region, in square kilometre per capita, compared to Dutch-German average.

36. DEPTH OF HARBOUR ENTRANCE

36.1 Depth of the harbour entrance in metres of an Emsport, compared to the average depths of the entrances of the following ports: Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining four Emsports.

37. LENGTH OF THE QUAYS

37.1 The total length of the quays of an Emsport compared tot the average quaylength of the ports of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

37.2 The average depth along the quays in an Emsport compared to the average depth along the quays of the ports of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

38. CAPACITY OF TRADITIONAL TRANSSHIPMENT FACILITIES

38.1 Lifting capacity of cranes in tons (floating cranes included) of an Emsport, compared to the average capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

38.2 Capacity of loading bridges in tons per hour of an Emsport, compared to the average capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

39. PRESENCE AND QUALITY OF CONTAINER TRANSSHIPMENT FACILITIES

39.1 Capacity of container terminal(s) in tons of an Emsport compared to the average capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

39.2 Length of the quays dedicated for container transshipment compared to the average length in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports .

39.3 Specialization index container transshipment for an Emsport (share of container transshipment in the total transshipment in tons) compared to the average of similar indices for Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining Emsports.

40. QUALITY OF DRY BULK CARGO TRANSSHIPMENT FACILITIES

40.1 Capacity of dry bulk cargo facilities per hour for an Emsport, compared to the average capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports .

40.2 Specialization index dry bulk cargo transshipment (share of dry bulk cargo transshipment in the total transshipment in tons) for an Emsport, compared to the average of similar indices for Hamburg, Bremen, Bremerhaven, Nordenham, Brake, Harlingen, Amsterdam, Rotterdam, Vlissingen, Terneuzen and the remaining Emsports.

41. QUALITY OF DRY BULK CARGO STORAGE FACILITIES

41.1 Capacity of covered storage in cubic metre for an Emsport, compared to the average covered storage capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports .

41.2 Capacity of open storage area in square metre for an Emsport, compared to the average open storage capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

42. QUALITY OF TANKSTORAGE INSTALLATIONS

42.1 Capacity of storage facilities for wet bulk cargo in the Emsport (in cubic metres) compared to the average tankstorage capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

43. QUALITY OF COLDSTORAGE FACILITIES

43.1 Capacity of refrigerated storage facilities (in square metres) for an Emsport, compared to the average coldstorage capacity of Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

44. QUALITY OF FLOATING DRYDOCK FACILITIES

44.1 Number of drydocks in an Emsport, compared to the average number of drydocks in Brake, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

44.2 Capacity of drydocks in length, width, depth (in metres) and dead weight tonnage, compared to the average capacity of drydocks in Brake, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

44.3 Maximum lifting capacity of drydocks compared to the average lifting capacity of drydocks in Brake, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

45. QUALITY OF LOGISTIC SERVICES

45.1 Employment in logistic services in an Emsport, compared to similar figures for Brake, Nordenham, Harlingen, Terneuzen and the other Emsports .

46. PRESENCE OF REGULAR SERVICES

46.1 Number and frequency of regular services from an Emsport, compared to the number and intensity of regular services in the remaining Emsports.

47. PRESENCE OF ENTREPOT FACILITIES

47.1 Capacity of entrepot facilities in an Emsport, compared to the capacity of similar facilities in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

48. TURN AROUND TIME PORT

48.1 Unfortunately figures about the speed of transshipment per type of cargo and the congestion in ports are not available. As an alternative, the distance from the port entrance to the main North Sea shipping routes (in seamiles) is taken, compared to similar distances from Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

49. PORT'S RELIABILITY

49.1 This factor is given a fixed score of 2.5 because of the lack of valid data about strikes in transshipment companies, and other relevant data.

50. HARBOUR COSTS

50.1 Harbour dues in an Emsport, compared to harbour dues in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

50.2 Quaydues in an Emsport, compared to quaydues in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

50.3 Pilot dues in an Emsport, compared to pilot dues in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

50.4 Towage dues in an Emsport, compared to towage dues in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.

50.5 Mooring and unmooring dues in an Emsport, compared to mooring and unmooring dues in Brake, Nordenham, Harlingen, Vlissingen, Terneuzen and the remaining Emsports.