THE PORT CITIES' CENTRALITY AND INTERMEDIACY: CONSTANȚA, DÜSSELDORF, LINZ, AND ROTTERDAM

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Abstract

In the 1990s, two ideas emerged regarding cities' centrality and intermediacy. These concepts are still applicable today, particularly for multi-scale analyses of port cities. Due to the ports' connections to more distant regions, port cities are both central and intermediate in their region. Thus, in her dissertation, the author created two indices to assess port cities' centrality (a measure of urban function) and intermediacy (a measure of port function). The European Union (EU) has the most consistent system for classifying regions and sharing data. The indices can, therefore, only be applied to EU port cities.

The author calculated the indices for four port cities in this paper: Constanța, Düsseldorf, Linz, and Rotterdam. All selected cities had the necessary data for calculating the indices, but certain national maritime data only applied to seaport cities. Therefore, the intermediacy index results from the selected riverport cities, Düsseldorf and Linz, were nowhere near accurate.

As evidenced by Düsseldorf, the most central city studied, riverport city data did matter in the normalisation process of the data used to calculate the centrality index. Despite this, Rotterdam was the most important port city among those examined, scoring highly on both centrality and intermediacy due to its status as the EU's largest and most significant port. Consequently, the author confirmed the paper's hypothesis that Rotterdam will be ranked first.

This paper concludes that Rotterdam has experienced greater urban and port growth than Constanța due to its high scores. Even though Constanța is a strategic location, its scores for centrality and intermediacy were low.

Keywords: Urban port network, transport, population, economy, LAU, FUA, NUTS.

1. INTRODUCTION

This article aims to assess the centrality and intermediacy of four EU port cities through a comparative analysis employing the results of two indices[1] developed by the author during her doctoral research. The indices are part of a methodology representing a common methodological framework for the multi-scalar analysis of port cities. Due to the EU's classification of regions as being the most stable in the world [2], the methodology only applies to European port cities. In addition, numerous statistics about all European regions are available on Eurostat and other EU websites.

The author chose to employ the concepts of centrality and intermediacy because, due to the port, the port city (especially the seaport city) is both central[2] and intermediate in its region [4]. On the one hand, the port contributes to the city's and region's economies [5], allowing the city to attain a prominent position among neighbouring urban centres [6]. Thus, the respective centres rely on the city port [7] and are linked to it via a diverse transport infrastructure [8] and a variety of logistics services [9]. On the other hand, the port city is a regional centre due to the port's role as a communication node in the global transport network [10]. In other words, the port city is intermediate because its port provides access to significantly more distant regions [11].

Since centrality and intermediacy also apply to non-port cities that are globally significant due to their transport infrastructure (e.g., airport infrastructure), they must be defined and redefined frequently by researchers based on the context of the analysis [3] [4]. For instance, [12] operationally defined the two concepts applicable to the analysis of port cities. Their operational definition requires the calculation of the following relevant indicators: (1) population to measure centrality and (2) container traffic to measure intermediacy [12]. In addition, researchers can determine the typology of the port city using the matrix depicted in Figure 1. The matrix quantifies the relationship between the two indicator values[4]. Both centrality (a measure of urban function) and intermediacy (a measure of port function) can be interpreted as low, medium, or high. Rotterdam, for example, received a high intermediacy score and a medium centrality score (i.e., gateway typology) based on the data used to calculate the two indicators [13].

[1] An index is helpful because it condenses a multidimensional reality into a single number [1].

[2] Centrality comes from the theory of central places, which states that a port city becomes central in its region due to its port [3].

[3] For example, the way the concepts are defined could be changed by the size of the studied area, changes in technology, transportation policies, and logistics operators [4].

[4] Furthermore, based on the typology obtained, the port city's possible evolution, both past and future, can be deduced [13]. As a result, the current author hypothesises that the matrix can be a handy tool for testing theories (both explanatory and predictive) about the evolution of port cities.

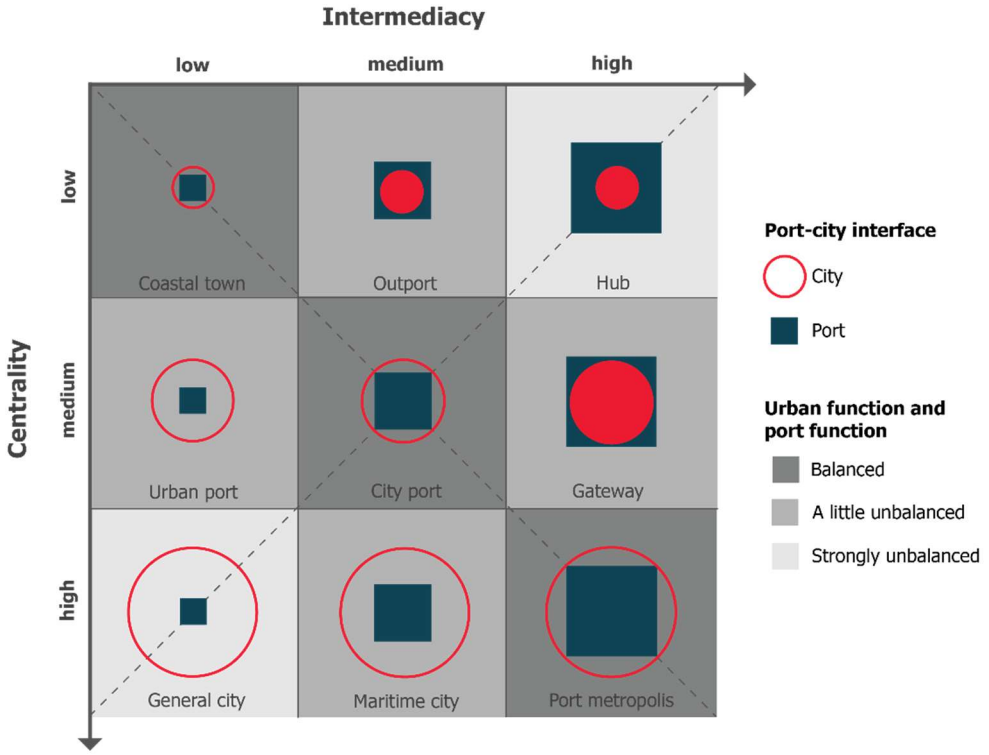

Figure 1. The matrix of centrality (urban function) and intermediacy (port function) of port cities, based on the matrix illustrated in [12, Figure 1]

The author of this paper defined concepts in her dissertation using two indices: (1) the centrality index and (2) the intermediacy index. The indices are able:

- To analyse EU port cities at different territorial scales[5];
- To aggregate the main criteria of analysis using three composite indicators: (1) transport, (2) population, and (3) economy[6];
- To aggregate the main sub-criteria of analysis using individual indicators available at the EU level[7].

The port city of Rotterdam, located in the Randstad urban conurbation[8] [25] is deserving of analysis through the two indices. Rotterdam's port is the largest in the

[5] Due to their dual nature (central and intermediate), [14] recommend such an analysis for port cities.
[6] The author established these three analysis criteria because, in most of the works consulted to measure port function, the most frequently employed indicators referred to the total quantity of goods managed by the port [14], [15], [16], [17], [18], [19], [20], [21]. Gross domestic product (GDP) [16], [17], [18], [19], [22], [23] and population [14], [15], [17], [18], [21], [23], [24] were the most common numbers used to measure how well a city worked.
[7] The author established the main sub-criteria of analysis of port cities using individual indicators selected based on their theoretical relevance, frequency of use in analyses, and the availability of data on Eurostat and other EU websites. Initially, the centrality index had more indicators than it currently has. However, some of the indicators were either too correlated or not correlated after some tests. So, the author decided to eliminate some indicators to solve these problems.
[8] Part of the functional urban area (FUA) of Rotterdam coincides with FUA The Hague. Near the two FUAs, there is also FUA Amsterdam and FUA Utrecht. All four FUAs form the urban conurbation [25].

EU. The Port of Rotterdam has access to the EU's most productive river, the Rhine[9] [26], and the North Sea, which connects it to the Atlantic-United States route, one of the busiest trade routes in the world. Moreover, the Rhine-Main-Danube canal connects the port of Rotterdam to the Black Sea, a body of water with few outlets from which ships must travel great distances to reach the world's major trade routes [27]. Consequently, Constanța, whose port is the largest in the Black Sea basin, is another port city that merits analysis. Due to its direct connection to the Danube-Black Sea canal, the port of Constanța is both riverine and marine [28]. As a result, Constanța's port competes with Rotterdam's port[10]. It has a strategic location [30], an adequate regional multimodal infrastructure[11] [31], and a high potential to attract cargo flows from the port of Rotterdam, originating in Asian nations[12], such as China. In addition, the hinterlands of Rotterdam[13] and Constanța[14] overlap, creating competition between the two ports. The hinterlands of the ports of Rotterdam and Constanța, for example, overlap in Hungary and Austria. These two nations have a superior connection (e.g., higher quality transport infrastructure) to the port of Rotterdam compared to the port of Constanța [30].

Due to the location of the port of Linz, which is roughly in the middle of the Rhine-Main-Danube canal [32], Austria has greater potential than Hungary to be studied in this paper. Düsseldorf (Germany) should also be taken into account. The author of this paper chose these two cases for the following primary reasons:

- Due to their location on the Rhine-Main-Danube canal, these ports facilitate the direct or indirect transport of goods between the ports of Constanța and Rotterdam.
- Germany and the Netherlands work together through cross-border shipping. German ports import more than they export, while Dutch ports export more [26].
- The Rhine-Ruhr region, which includes Düsseldorf, is one of the world's most populous polycentric regions, containing approximately ten million people. Furthermore, Düsseldorf's FUA is the most important in the region and one of the most important in the world for the knowledge economy, as it is home to many companies specialising in high technology and advanced services for manufacturers [33].
- Unlike the other Danube countries, Austria is primarily a destination for goods rather than a transit nation. Austria imports ca. 49% of the raw materials for the steel industry. Before being transported upstream on the Danube to Austria, these materials arrive in Black Sea ports on ships [26].

[9] It has an approximate productivity of 84% [26].
[10] The two ports compete but also cooperate. Rotterdam is in sixth place on the list of partners of the port of Constanța. The relationship between the two ports is predominantly one-way. Namely, the port of Constanța transports almost all the quantity to the port of Rotterdam [29].
[11] Some examples of transport infrastructure are the highway connecting Bucharest and Constanţa, the airport, the railroad for goods distribution, and the Danube-Black Sea canal [31].
[12] The port of Constanța is easily accessible from Asia Minor due to its location [28], [31].
[13] Western Europe and a portion of Southern Europe, Northern Europe, and Eastern Europe constitute the hinterland of Rotterdam's port [30].
[14] Romania, northern Bulgaria, Serbia, Hungary, and Austria constitute the hinterland of Constanța's port [30].

- The region that includes Linz, Oberösterreich, has highly developed logistics services [34]. In addition, Linz-Wels ranks second in the Austrian logistics activity index, trailing only Vienna [35].

Based on the information presented briefly in this section, this author hypothesises that Rotterdam is the most important city between Constanța, Düsseldorf, and Linz because it should score highly on both the centrality and intermediacy indices. Rotterdam has the largest port in the EU, so it should be the most intermediate port city among those analysed. In terms of centrality, Düsseldorf will likely rank highest. To test this research hypothesis, the author aims to answer two questions: (1) Is Rotterdam the most important of the four studied port cities? (2) Is it possible to determine typologies for each analysed port city?

2. METHODOLOGY

A multi-scalar approach to the analysis of port cities should involve analysing the port city at multiple territorial scales, such as the regional scale, where the city is central, and the global scale, where the port connects to other ports. For such an analysis, the concept of an urban network is the most useful tool. According to some theorists who attempted to define the concept, the urban network would be composed of a hierarchical grouping of cities connected at varying territorial scales [36], [37], [38], with a single city at its centre. Due to its large population, numerous employees, and diverse economic activities [36], the central city influences the network's structure [39]. Given that the concept of urban networks encompasses a variety of cities, it is necessary to operationally define the urban networks being analysed. There is, thankfully, a method for defining urban networks. The method defines nodes according to three levels (micro, meso, and macro) and three territorial analysis scales (local, regional, and global) [40]. Table 1 defines the examined urban port networks based on (1) four networks deemed highly relevant for port city analysis[15] [24], [41] and (2) the EU territorial units and their relevant and accessible data.

Table 1. The nodes of EU urban port networks

Types of connections	**Internal connections (EU regions)**		**External connections (global regions)**
Levels/ scales of analysis	**Local**	**Regional**	**Global**
Micro	Population, including employees	FUA	Ports
Meso	Companies, including port operators	Nomenclature of territorial units for statistics (NUTS) 2[16]	Port cities

[15] The first is the port network, followed by the network of port cities [41], the network of port city metropolitan areas [24], and the network of port city extended areas [41].

[16] In this comparative study, the NUTS 3 region was not included in the EU's operational definition of urban port networks, as NUTS 3 regions differ from case to case. In the case of the city of Constanța, NUTS 3 is larger than FUA and smaller than NUTS 2. As for the city of Rotterdam, NUTS 3 coincides with

Types of connections	Internal connections (EU regions)		External connections (global regions)
Levels/ scales of analysis	**Local**	**Regional**	**Global**
Macro	Local administrative units (LAU) – port cities	NUTS 0	Countries

Table 2 contains the previously defined nodes and the connections between them for which data is available to calculate the indices. Both indices are synthetic indicators. Each synthetic indicator is made up of three composite indicators. Each composite indicator represents an essential criterion for port city analysis. Multiple individual indicators (the sub-criteria of the three analysis criteria) also contribute to the computation of each composite indicator.

On the one hand, the author downloaded the necessary 2019 data to calculate some individual indicators. On the other hand, to calculate the other individual growth rate indicators, the author downloaded the necessary data for 2000-2019. The downloaded data were then normalised for both the centrality and intermediacy indices using the Python programming language[17].

Table 2. The centrality index (urban function) and the intermediacy index (port function)

Synthetic indicator	Composite indicator	Individual indicator	Data source
The centrality index (C)	**Transport (C_1)**	The density of highways in NUTS 2, km/1,000 km^2/year (C_{11})	[42]
		The density of railways in NUTS 2, km/1,000 km^2/year (C_{12})	
	Population (C_2)	The city's population, no./year (C_{21})	[43]
		The city's population growth rate, % (C_{22})	
		FUA personnel, no./year (C_{23})	[44]
		The growth rate of FUA personnel, % (C_{24})	
		Employees from companies in NUTS 2 that carry out economic activities in industry, manufacturing, logistics, communications, and other related activities, no./year (C_{25})	[45]
	Economy (C_3)	The NUTS 2 GDP, euro/year (C_{31})	[46]
		GDP per capita in NUTS 2, euros/capita/year (C_{32})	[46], [47]
		Gross value added (GVA) in the NUTS 2 region from industry, manufacturing, logistics, communications, and other related activities, euros/year (C_{33})	[48]
		Companies from NUTS 2 that carry out economic activities in industry, manufacturing,	[49]

FUA. Furthermore, in the case of the city of Düsseldorf, NUTS 3 coincides with the city limits (LAU), and in the case of the city of Linz, NUTS 3 is smaller than the FUA.

[17] The programme used the method of linear data normalisation according to the minimum and maximum values to result in values between [0;1]. The method's code lines are as follows: for column in tabel.columns: tabel[column] = (tabel[column] - tabel[column].min()) / (tabel[column].max() - tabel[column].min())

Synthetic indicator	Composite indicator	Individual indicator	Data source
		logistics, communications, and other related activities, no./year (C_{34})	
The intermediacy index (I)	**Transport (I_1)**	The annual tonnage of goods handled by the port, tonnes/year (I_{11})	[29], [50]
		The growth rate of the cargo handled by the port, % (I_{12})	
	Population (I_2)	Employees from NUTS 0 in the maritime sector (port activities, maritime transport, and ship construction and repair) from the total number of employees in the blue economy, %/year (I_{21})	[51]
	Economy (I_3)	GVA of the maritime sector in NUTS 0 (port activities, maritime transport, and ship construction and repair), euros/year (I_{31})	
		The growth rate of the GVA of the maritime sector in NUTS 0 (port activities, maritime transport, and ship construction and repair), % (I_{32})	

After normalising the data, the author calculated the two indices using the following mathematical formulas[18]:

$$\mathbf{C} = \frac{\sum_{i=1}^{3} \mathbf{C_i p_i}}{\sum_{i=1}^{3} \mathbf{p_i}} = \left[\frac{\sum_{i=1}^{2} \mathbf{C_{1i} p_i}}{\sum_{i=1}^{2} \mathbf{p_i}} \mathbf{0,2} + \left(\frac{\sum_{i=1}^{5} \mathbf{C_{2i} p_i}}{\sum_{i=1}^{5} \mathbf{p_i}} + \frac{\sum_{i=1}^{4} \mathbf{C_{3i} p_i}}{\sum_{i=1}^{4} \mathbf{p_i}}\right)\mathbf{0,4}\right]$$

$$C_1 = \frac{\sum_{i=1}^{2} C_{1i} p_i}{\sum_{i=1}^{2} p_i} = (C_{11} + C_{12})0{,}5$$

$$C_2 = \frac{\sum_{i=1}^{5} C_{2i} p_i}{\sum_{i=1}^{5} p_i} = (C_{21} + C_{22})0{,}286 + (C_{23} + C_{24} + C_{25})0{,}143$$

$$C_3 = \frac{\sum_{i=1}^{4} C_{3i} p_i}{\sum_{i=1}^{4} p_i} = (C_{31} + C_{32})0{,}333 + (C_{33} + C_{34})0{,}167$$

$$\mathbf{I} = \frac{\sum_{i=1}^{3} \mathbf{I_i p_i}}{\sum_{i=1}^{3} \mathbf{p_i}} = \frac{\sum_{i=1}^{2} \mathbf{I_{1i} p_i}}{\sum_{i=1}^{2} \mathbf{p_i}} \mathbf{0,539} + \frac{\sum_{i=1}^{1} \mathbf{I_{2i} p_i}}{\sum_{i=1}^{1} \mathbf{p_i}} \mathbf{0,164} + \frac{\sum_{i=1}^{2} \mathbf{I_{3i} p_i}}{\sum_{i=1}^{2} \mathbf{p_i}} \mathbf{0,297}$$

$$I_1 = \frac{\sum_{i=1}^{2} I_{1i} p_i}{\sum_{i=1}^{2} p_i} = (I_{11} + I_{12})0{,}5$$

$$I_2 = \frac{\sum_{i=1}^{1} I_{2i} p_i}{\sum_{i=1}^{1} p_i} = I_{21}$$

$$I_3 = \frac{\sum_{i=1}^{2} I_{3i} p_i}{\sum_{i=1}^{2} p_i} = (I_{31} + I_{32})0{,}5$$

[18] The author created a hierarchical decision tree for each index in a programme that employs the analytic hierarchy process. All analysis criteria and sub-criteria were entered into the programme. The author specified the more important or equally important criterion or sub-criterion for each pair of criteria or sub-criteria. The indicators frequently used in port city analyses and those theoretically relevant and available at the EU level have the highest weight (importance) within the index.

3. RESULTS

3.1. Composite Indicators

3.1.1. Transport

As shown in Table 3, Rotterdam was the most central port city in terms of transportation among the studied port cities due to the Zuid-Holland region's highest railway density. In contrast, the density of highways was greatest in the region surrounding Düsseldorf. Moreover, despite having a relatively high density of railroads, Oberösterreich had four times fewer highways than Zuid-Holland. Thus, Linz ranked third, with a value considerably lower than that of Düsseldorf. As for the South-East, its highway density was approximately five times lower than that of Oberösterreich. Despite having a moderate density of railways, roughly half that of Düsseldorf, Constanța ranked last due to its low density of highways (ca. 2 km per 1,000 km^2) [42].

According to the same table, Rotterdam was the most intermediate in terms of transportation among the studied port cities. With a growth rate of +45%, Rotterdam was the port that handled the most cargo. The second-placed city, Constanța, handled twelve times fewer goods than Rotterdam but had a respectable growth rate (+33%). Despite handling twice as much cargo as the port of Düsseldorf, the port of Linz ranked last because it had the lowest cargo growth rate (-31%) among all studied ports. Likewise, Düsseldorf experienced negative growth (-19%) [29], [50].

Table 3. The results of the composite indicators for transport

Urban port network	The analysed nodes NUTS 2	Transport (C_1)	The analysed nodes Ports	Transport (I_1)
Constanța	South-East	0.000	Constanța	0.462
Düsseldorf	Düsseldorf	0.875	Düsseldorf	0.079
Linz	Oberösterreich	0.270	Linz	0.002
Rotterdam	Zuid-Holland	0.926	Rotterdam	1.000

3.1.2. Population

According to Table 4, Rotterdam was the most central port city in terms of population because it had the most residents, employees, and significant growth. Third-placed Linz and last-placed Constanța followed second-placed Düsseldorf. First, Rotterdam had the largest population (ca. 645 thousand), while Düsseldorf had a slightly smaller population (ca. 620 thousand). Linz had the fewest inhabitants (ca. 100 thousand fewer than Constanța), while Constanța had roughly half the population of Düsseldorf. The only city in the study with a negative population growth rate was Constanța (-8%). The rates in the other cities were comparable, with population increases of roughly 10% [43].

Second, at the FUA level (ca. 845 thousand) and the Zuid-Holland region level, Rotterdam had the most employees (ca. 500 thousand employees worked in

companies with economic activities in industry, manufacturing, logistics, communications, and other related activities). Furthermore, FUA Düsseldorf employed many individuals (ca. 745 thousand), whereas the Düsseldorf region employed a negligible amount (ca. 1,200 employees in the examined economic activities). FUA Linz recorded nearly twice as few employees as FUA Düsseldorf, but the region of Oberösterreich employed significantly more individuals in the examined economic activities (ca. 360 thousand people). FUA Constanța registered nearly twice as few employees as Linz, and the South-East region registered nearly 100 thousand fewer workers than Oberösterreich. FUA Constanța (+12%) and FUA Rotterdam (+36%) experienced greater employment growth than FUA Düsseldorf (+9%) and FUA Linz (+9%) [44], [45].
As shown in Table 4, Düsseldorf was the most intermediate in terms of population because Germany had the most significant number of employees (ca. 275 thousand), followed by the Netherlands, which had a value three times lower[19]. In addition, Romania had a substantially lower value (ca. 35 thousand employees). Austria ranked last (ca. 3,700 employees) [51].

Table 4. The results of the composite indicators for population

Urban port network	The analysed nodes			Population (C_2)	The analysed nodes	Population (I_2)
	LAU	FUA	NUTS 2		NUTS 0	
Constanța	Constanța		South-East	0.085	Romania	0.117
Düsseldorf	Düsseldorf		Düsseldorf	0.807	Germany	1.000
Linz	Linz		Oberösterreich	0.342	Austria	0.000
Rotterdam	Rotterdam		Zuid-Holland	0.881	The Netherlands	0.297

3.1.3. Economy

According to Table 5, Düsseldorf was the most economically central port city studied. This region had the highest GDP (ca. 220 million euros), GVA of economic activities related to industry, manufacturing, logistics, communications, and other related activities, and number of companies engaged in the examined economic activities (ca. 113 thousand). Its per capita gross domestic product was not the highest, however. This sub-criteria was topped by Zuid-Holland (ca. 48 thousand euros per capita), followed by Oberösterreich (ca. 46 thousand euros per capita). The South-East region's per capita GDP was significantly lower than that of Düsseldorf, which was three thousand euros less than that of Oberösterreich [46], [47]. Oberösterreich ranked second in terms of the GVA of the examined economic activities, followed by Zuid-Holland and the South-East [48]. In terms of the number of companies involved in the examined activities, Zuid-Holland ranked second (ca. 103 thousand), followed by the South-East (ca. 52 thousand) and Oberösterreich (ca. 29 thousand) [49].

[19] The number of Dutch maritime industry employees has decreased due to automation [52].

Regarding the economy, Düsseldorf was the most intermediate of the port cities studied, as shown in the same table, because the GVA of the maritime sector in Germany had a very high value (ca. 22 million euros). The Netherlands ranked second, with a value three times lower than Germany's. Romania ranked third (ca. 650 thousand euros), trailing Austria (ca. 300 thousand euros). Among the countries studied, Austria had the highest GVA growth rate (ca. +57%), followed by the Netherlands (ca. +30%), Germany (ca. +20%), and Romania (ca. -5%), the only nation with a negative growth rate [51].

Table 5. The results of the composite indicators for economy

Urban port network	The analysed nodes NUTS 2	Economy (C_3)	The analysed nodes Ports	Economy (I_3)
Constanța	South-East	0.046	Romania	0.008
Düsseldorf	Düsseldorf	0.955	Germany	0.700
Linz	Oberösterreich	0.460	Austria	0.500
Rotterdam	Zuid-Holland	0.588	The Netherlands	0.446

3.2. Synthetic Indicators

Based on the obtained scores, Düsseldorf was the most central (high centrality), and Rotterdam was the most intermediate (high intermediacy) among the analysed port cities, as shown in Figure 2. Regarding the centrality of port cities, Rotterdam came in second (also with high centrality), Linz came in third (medium centrality), and Constanța came last (low centrality). Furthermore, regarding the intermediacy of port cities, Düsseldorf came in second (medium intermediacy), Constanța came in third (low intermediacy), and Linz came in last (low intermediacy).

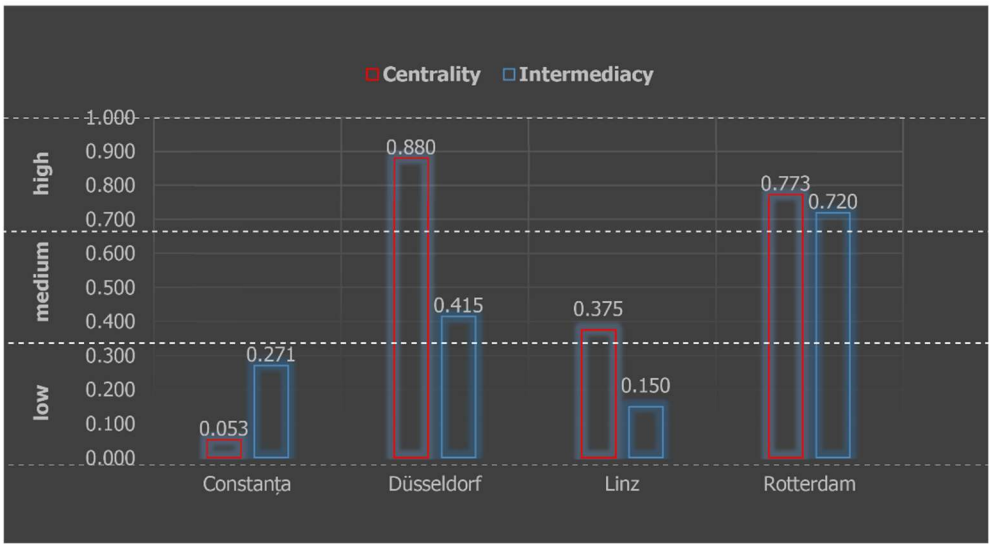

Figure 2. The results of the synthetic indicators for centrality and intermediacy

4. CONCLUSIONS

The findings confirmed the study's hypothesis, allowing the author to answer the primary research question: Is Rotterdam the most important of the four studied port cities? Yes, because Rotterdam was the only one to have both high centrality and intermediacy. Rotterdam was the most intermediate but not the most central port city compared to the others. Instead, the most central city was Düsseldorf, followed by Rotterdam. The centrality of Linz was moderated, while that of Constanța was reduced. The intermediacy of Constanța was also reduced. This study determined that Düsseldorf is a more intermediate port than Constanța; however, this is not the case because the port of Düsseldorf handles significantly fewer goods. Düsseldorf obtained an unrealistic result because this research used NUTS 0 data[20] in the population and economic analysis criteria. Due to Germany's other major ports, such as Hamburg[21], Düsseldorf's score was significantly higher than it actually was. As a result, the author has also addressed the second research question: Is it possible to determine typologies for each port city studied? No, it was not possible to determine the typologies for Düsseldorf and Linz because their intermediacy is undeniably much lower (they are exclusively riverport cities) than the values obtained in this study.

However, the author only established the typologies for the selected seaport cities (i.e., according to Figure 1, Constanța is a coastal town, and Rotterdam is a port metropolis). The current study generates new hypotheses as a result of these findings. Based on the centrality and intermediacy matrix, one hypothesis suggests that urban and port functions have increased in both cities over the past two decades. Therefore, the author should respond to the following research question: Did increases in urban and port functions prevail in both Constanța and Rotterdam's recent evolution?

During the evolution of the two cities, some global causes specific to the maritime sector (such as the transition from bulk cargo to containerized cargo [7]) may have stimulated the growth of the ports and, by extension, the growth of the regions. Increases in urban and port functions most likely dominated Rotterdam's historical development but not that of Constanța. Most likely, local and regional factors caused decreases in Constanța. Consequently, a potential research question could be: How have the port cities of Constanța and Rotterdam developed? This author will test these hypotheses using a multi-scale approach similar to the one presented in this article. First, the author will comprehensively analyse the paper's calculated indicators. Second, the author will evaluate additional pertinent indicators. More likely than Eurostat, their data will be available on the official pages of national statistics.

Regarding the two indices' configuration, the three criteria for analysis established following the theoretical analysis—transport, population, and economy—in both indices exceptionally captured the reality of the chosen port cities, especially Constanța and Rotterdam. Even though relevant and available data at the EU level

[20] The data available for NUTS 0 on [51] are relevant for the largest port in the country, which contributes the most to the country's economy and has the most employees in port activities, maritime transport activities, and shipbuilding and repair. Such examples are the ports of Rotterdam and Constanța.

[21] Hamburg is the third-busiest port in the EU, handling many containers. It was also ranked 20th worldwide [53].

are still scarce (particularly data for measuring port function), the hierarchy resulting from the calculation of the two indices confirmed the hypothesis stated at the start of the paper. Nevertheless, riverport cities' data may have distorted seaport cities' data during normalisation. The author would therefore continue to test the two indices to validate the centrality and intermediacy indices for additional seaport cities in the EU. To represent the different types of port cities proposed in the matrix of centrality and intermediacy, the cities chosen should be as dissimilar as possible (e.g., in terms of population, economic profile, and history).

In future studies, the data collected in this study for Constanța, Rotterdam, and the other seaport cities will be normalised once more. The author will then remeasure the two indexes for Constanța and Rotterdam, evaluate the new results critically, and answer the following research questions: Are the typologies of the two port cities identical to those found in this paper? Is it necessary to include additional sub-criteria for analysis? Perhaps more relevant data will be available at that time (e.g., data related to maritime employees and companies valid on a regional or local scale). In addition, the new normalisation procedure may produce situations in which the correlation between variables is excessively high or low. In both scenarios, the index would be reconfigured.

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