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THE COMPETITIVENESS OF EGYPT'S COMMERCIAL PORTS: A REGIONAL-LEVEL ANALYSIS

Mohammed NAGAH
Regional Urban Development Department, Faculty of Urban and Regional Planning, Cairo University, Giza, Egypt.
abdelhamed.m.n@furp.cu.edu.eg

Ebtehal Ahmed ABDALMOITY
Regional Urban Development Department, Faculty of Urban and Regional Planning, Cairo University, Giza, Egypt.
ebtehala@furp.cu.edu.eg

Mosatafa MONIR
Regional Urban Development Department, Faculty of Urban and Regional Planning, Cairo University, Giza, Egypt
mosta_fa@cu.edu.eg

Muhammad A. SEDDEEK
Regional Urban Development Department, Faculty of Urban and Regional Planning, Cairo University, Giza, Egypt
muhmad.abdulrhman@cu.edu.eg

Abstract
Ports are critical drivers of globalisation, influencing trade, economic systems, and urban development. OECD studies show that ports handle nearly 70% of global trade. Consequently, foreign direct investment in ports and their hinterlands rose from 17% in the 1980s to 43% in the early 21st century, highlighting the link between port expansion, population growth, and urbanisation. Egypt's strategic location contributes significantly to global trade, handling approximately 22% of global container tonnage and 10–12% of world trade. This research analyses Egypt's commercial ports using key clusters of indicators: shipping and inland networks, the logistic chain, port efficiency, urban-economic performance, and hinterland elements. Findings reveal Alexandria Port as Egypt's most globally competitive port. The study aims to assess the effects of this competitiveness on two levels. First, changes in the city-port interface of Alexandria and its expansion trends, evaluated through indicators such as port area, storage capacity, transit zones, berth depth and length, container volume reliability, and inland networks. Second, regional-level changes in Alexandria Port's surroundings are statistically analysed across five elements: land uses, economic structures, transportation networks, logistics networks, and special economic zones. The study anticipates identifying the relationship between port competitiveness and urban spillover, offering a foundational basis for sustainable urban development and planning in port regions.
Keywords: Port competitiveness, ports regions, urban spillover, logistics services.

1. INTRODUCTION

Ports are considered one of the most significant elements that have experienced substantial development due to globalization and the subsequent technological advancements in production, manufacturing, and especially maritime transportation. These advancements have had a profound impact on economic development, urban development, and maximizing development gains within port areas. This evolution has transformed the spatial scope of ports from the concept of a "city-port" to a "port region" (Ducruet and Lee, 2006). A port region is now defined as a functional area comprising two main parts: the port hinterland and the port foreland. The port foreland is responsible for servicing the internal markets of the port region through maritime shipping routes. The second part, known as the port hinterland, refers to the land area that supports the port. This hinterland experiences various economic interactions due to the presence of the port, such as storage, packaging, manufacturing, repurposing, and distribution of goods. These activities serve consumers in regional and local markets or suppliers in global markets (Rodrigue and Notteboom, 2010).

These global developments have led to the creation of global competitiveness among port regions. Shippers, logistics providers, and shipping line operators do not necessarily choose a specific port; instead, they select a supply chain in which the port is merely a node or gateway to meet the demands of international trade and integrated supply chains (Rodrigue and Notteboom, 2009). Therefore, we can say that ports and their urban hinterlands are two sides of the same coin and must be addressed together. They must have sufficient flexibility to handle and accommodate more goods, especially from large vessels, and to provide suitable transport modes in hinterland areas more rapidly. This makes these regions more responsive to the needs of all participants in global trade passing through the ports, thus making the ports more competitive. The global competitiveness of port regions and their urban hinterlands can increase the added value of port-related activities and services. For instance, an average of one million tones of port productivity generates about 800 direct and indirect jobs. The larger the port, the greater the added value generated by the port and its related sectors. On average, one tone of port productivity is associated with $100 of economic added value, including both direct and indirect port-added value. This information is based on studies conducted by the Organisation for Economic Co-operation and Development (OECD) (Merk, 2013).

This global competition among port regions has impacted the spatial, functional, and economic dynamics between ports and their urban hinterlands. These dynamics can manifest in changes in land use, economic activity structures, transportation and movement networks, logistics systems, and networks of special economic zones. Consequently, there is an increasing need for logistical integration and the expansion of port-related areas, such as waterfronts and hinterland zones, in response to these changes.

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This has redefined and reshaped the functional role of ports and their regions within the global supply chain (Akhavan, 2020).

Due to the lack of urban studies on the global competitiveness of Egyptian port regions and its impact on the urban dynamics of these regions, it was necessary to direct part of the research studies through statistical and spatial analyses. Therefore, the main aims of this research are:

- To identify the most globally competitive Egyptian ports based on a set of indicators derived from a literature review, including shipping networks, inland networks, logistic services, inland terminals and ports, urban-economic performance, and port performance. Through statistical analysis of these indicators, it was found that the Port of Alexandria is one of the most globally competitive Egyptian ports.
- To analyze the impact of the global competitiveness of the Port of Alexandria region on the spatial, functional, and economic dynamics of its urban hinterland during two different periods (2010–2024). This analysis is conducted on two levels:
  - **Level A: The Port-City Interface,** through indicators such as land use, port area, number of berths, storage areas, number of terminals, maximum water depth, and transport and movement networks.
  - **Level B: The Port Region,** through indicators such as land use, economic activity structures, logistics networks, transport and movement networks, and networks of special economic zones.

2. Ports Competitiveness Conceptual Framework

The competition among port regions has become a complex and multifaceted concept. There is a common misconception that ports compete with each other. However, after several readings, it can be clarified that the competition is actually between terminal operators or providers of transport and multimodal logistics services (actors in supply chains). For instance, if a port has global terminal operators such as PSA, DP World, or Hutchison Ports, it will be more competitive than others. It is important to note that these operators will not establish themselves in a port unless its urban hinterland is prepared to accommodate port-related activities and the resulting dynamics (economically and urbanly) (Munim and Saeed, 2019). The nature and characteristics of competition depend on several criteria, including:

- The type and classification of port regions, such as feeder port regions and hub port regions.
- The type and diversity of goods and cargo handled by the ports and their urban hinterland (e.g., containers, liquid bulk, dry bulk, general cargo) (SheiNholeslami. A., et al., 2024).

- The availability of inland terminals and logistics zones in the ports's urban hinterland. Inland terminals mainly compete for the services of intercontinental shipping lines, capable of accommodating large vessels with capacities up to 24,000 TEUs. This necessitates ports establishing connections with as many nearby inland terminals as possible, which must have efficient multimodal transport networks.
- The infrastructure and technological networks in port regions.
- Policies of port authorities aimed at providing the best facilities (both physical and non-physical) to all actors involved in supply chains (such as stevedoring companies, shipping companies, shippers, and multimodal operators).

2.1. Ports Competitiveness Conceptual Framework

2.1.1. Ports Competitiveness Conceptual Framework

The first level of port competition is the competitiveness of private companies and terminal operators at the ports, where multiple service providers can exist within a single port. This competition can serve as a management approach to enhance the efficiency of port activities. Competition among operators or facility providers within the same ports can generally lead to increased port efficiency, improved services, and enhanced added value generated by the ports and their activities. This, in turn, naturally helps to increase the economic and urban dynamics in the urban hinterland of these ports (Notteboom et al., 2022).

2.1.2. Inter-port competition within a multi-port gateway region

The concept of multi-gateway regions provides an expanded framework for competition among ports and represents the second level of such competition, where multiple shipping, handling, and terminal operators expand their activities across more than one maritime gateway within the same urban area. Competition primarily revolves around providing superior basic infrastructure, technology, and logistics facilities linked to a multi-modal transport network, all at lower costs for port users. The advantage lies with the maritime gateway, whose urban hinterland is best prepared for activities stemming from ports, thereby generating economic and urban dynamics of that kind within those regions (Notteboom, 2010).

2.1.3. Inter-port competition within a port range

The third level involves competition among a group of ports located on the same coastline and sharing the same urban hinterland area. Strong competition can be observed at this level, particularly in urban hinterland areas shared by multiple maritime gateways. Logistics facilitation and cost competitiveness provided by terminal operators and shipping agents play a crucial role in attracting a larger share of activities and markets within the hinterland (Baert and Reynaerts, 2020), such as in Egypt's Red Sea coast with ports like Ain Sokhna, Adabiya, and Suez.

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2.1.4. Inter-range competition

The fourth and final level of competition among maritime port regions involves global-scale competition between port regions worldwide. For example, ports in Europe versus ports in the Mediterranean compete in this arena, necessitating political and economic alliances and strategies. This competition highlights the orientations and policies of nations towards developing their maritime ports and hinterlands, integrating them with major global trade routes, terminal operators, and shipping agents. For instance, the role of the European Commission within the European Union is to develop Europe's ports and enhance their global competitiveness. Rotterdam Port in the Netherlands ranked first in global competitiveness for the years 2020 and 2021, with a growth rate of traded goods and commodities reaching 41.8%. Antwerp Port in Belgium ranked second in global competitiveness for the years 2020 and 2021, with a growth rate of traded goods and commodities reaching 47% (Notteboom et al., 2022).

2.2. Key Dimensions and Indicators of Port Competitiveness

There are many studies that have attempted to identify the most important dimensions and indicators of port competitiveness. One study categorized indicators of competitiveness and global trade into three main groups. The first group of indicators describes the maritime connectivity of ports, including the number of global shipping lines (Shipping Network) and the volume of goods transported through them. The second group of indicators focusses on port efficiency, which includes factors such as port area, storage capacities, depth and number of berths, throughput ratio, and the number of terminals (Arvis et al., 2018). The third group of indicators examines the port's connectivity with its hinterland and its elements, including transport networks, logistics networks, special economic zones, and various infrastructure networks (Arvis et al., 2018).

Other studies have focused on indicators of port efficiency across three dimensions. The first dimension pertains to the efficiency of connecting the port with its hinterland, encompassing indicators such as an efficient inland logistics network, inland transportation costs, intermodal links, land distance and connectivity to major shippers, and the size and activity of Free Trade Zones (FTZ) in the port hinterland (Zhang, X. and Roe, M., 2019). The second dimension addresses the efficiency of connecting the port with global shipping lines, including indicators such as the cargo proportion of transhipment cargo, frequency of large container ships calling, number of direct calls from ocean-going vessels, and volume of total container cargoes (Zhang, X. and Roe, M., 2019). The third dimension focuses on the efficiency of maritime service at the port, with indicators such as the port price for cargo handling, transfer, and storage, availability of professionals and skilled labour in port operations, service quality as the capacity for the ship's size, water depth in the approach channel and at the berth, zero waiting time service, maritime traffic, port accessibility, and container dependency (Zhang, X. and Roe, M., 2019).

The OECD had another perspective on global port competitiveness indicators, dividing them into three main groups. The first group of indicators described maritime shipping lines' connectivity and measured port centrality and geometry (Merk and Notteboom, 2013). The second group of indicators focused on logistic chain and operational indicators, including waiting time, service time, total tonnage handled by the port, number of logistics areas in the direct hinterland, area of logistics and storage spaces, and logistic service ranges (Merk and Notteboom, 2013). The third group of indicators addressed the port hinterland and its components, with key indicators such as multifunctional inland network, sizes of urban cities in the region, types of economic activities, range rate between the port and the inland terminal, relative concentration index (RCI), and size of the free economic zone in the port's hinterland (Merk and Notteboom, 2013).

The World Bank has developed another perspective on global port competitiveness indicators. what is known as the Logistics Performance Index (LPI), The LPI measures the efficiency of the logistics performance of a country or a group of ports, and it is composed of six main elements and indicators: efficiency and effectiveness of customs, quality of infrastructure, transport network, and information technology; ease and efficiency of arranging international shipments; competence and quality of logistics services; ability to track and trace consignments during international transportation; and timeliness of shipments in reaching their destination within the scheduled or expected delivery time. The LPI provides a comprehensive evaluation of ports' logistics performance, which is critical for their global competitiveness (World Bank, 2023).

3. Dynamic Relations between Ports and their Urban Spillover

3.1. Levels of Spatial Dynamic Relations between Ports and their Urban Spillover

There are several spatial models that have attempted to explain the dynamics relations between ports and their urban spillover, which can be categorized into two levels: the Port-City Interface level and the Port Region level.

3.1.1. Level A: the port-city interface

The Bird model is considered one of the earliest spatial models that attempted to explain the spatial exchange relationships between ports and their urban interfaces due to global competitiveness. The model is based on three fundamental stages:

- Setting stage (Origin): During this stage, the port is located near the city centre on the coast, close to marketplaces. Port facilities were simple, focussing mainly on wholesale trade, storage services, and passenger transportation.

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- Expansion stage (Growth): Port facilities began expanding due to the increased maritime traffic of large vessels and volumes of traded goods. This expansion led to the enlargement of port docks and storage areas, with industrial activities becoming predominant (Ignaccolo et al., 2013).
- Specialization stage: As technological advancements increased the number of ships and the volume of traded goods, ports expanded further to accommodate various industrial and logistical activities. Additional specialized docks were constructed to handle containerized cargo, raw materials, grains, petroleum, and coal. Some parts of the port were deepened to accommodate large vessel drafts. Due to the scale of activities, ports expanded beyond the city limits, leading to the decline of port activities in their original downtown locations (Bird, 1971).

3.1.2. Level B: the port region

Several spatial models have emerged to develop upon the Bird model, particularly focussing on the regional level of ports due to the urban region's significance in accommodating activities resulting from increased port global competitiveness. One of the most notable models is the Port Regionalization Model, which illustrates the spatial exchange relationships between ports and their regions through four stages:

- Distinctive location stage: the port is situated at the intersection of land and water, initially handling limited cargo and passenger traffic (Notteboom and Rodrigue, 2005).
- Expansion stage: the port's role expands within a limited hinterland, serving production or consumption centres, which provides economic efficiencies and accelerates its growth.
- Functional specialization stage: due to economic efficiencies and infrastructure development in the hinterland, the port evolves into a specialized functional role. Its connections extend to encompass the urban area, leading to increased industrial, commercial, and service activities. Integrated logistics centres emerge to support the port's role.
- Regionalization stage: the port begins to form its own region due to its interconnections with the urban area, including a multimodal transport network and intermediary stations for the distribution and collection of goods and merchandise (Notteboom and Rodrigue, 2005).

Due to increased global competitiveness, several spatial models have emerged to develop upon the previous Bird model, with one of the most significant being the Port Range Model. This model provides a comprehensive explanation of the dynamic spatial exchange relationships between ports and their regions, delineating these relationships across six stages (Rodrigue and Notteboom, 2011):

- Scattered ports stage: during this stage in the mid-nineteenth century, ports were dispersed along the coastline with very weak connections to urban hinterlands. Port activities primarily involved basic cargo and passenger transport and storage (Sdoukopoulos, E., & Boile, M., 2020).

- Penetration and hinterland capture stage: with technological advancements in transport and production, ports began penetrating their hinterlands. Each port developed its own specialized hinterland where related activities were concentrated. Internal transport and movement networks were developed to connect these ports with non-port urban agglomerations. Ports varied in their roles as main ports or feeder ports, supporting trade, industry, and storage activities (Rodrigue and Notteboom, 2011).
- Interconnection and concentration stage: during this stage, ports focused on interconnecting with their adjacent hinterlands, increasing their centrality through relationships with other ports via maritime shipping routes.
- Centralization stage: ports achieved high centrality through primary network formations, dividing into two types: internal networks linking ports to internal urban centres and nearby industrial areas, and external networks involving maritime shipping connections with other ports. Major port activities included trade (wholesale and retail), manufacturing, and storage (Sdoukopoulos, E., & Boile, M., 2020).
- Decentralization and insertion of transshipment hub stage: this stage began with globalization and significant technological advancements, leading to the emergence of transshipment hub operators and substantial logistics developments associated with the container revolution. Ports were expanded to accommodate larger vessels, increasing storage units in the hinterland. Internal networks became denser, linking production sites, consumption areas, and urban agglomerations with ports. External networks expanded through regular maritime service networks and hierarchical sequencing in the main linkage axes. Major port activities included trade, manufacturing, and container distribution (Ducruet, 2006).
- Regionalization stage: this stage involves the integration of ports with inland freight distribution centres (dry ports) and internal stations as clusters of economic activities in the hinterland, forming the port's region and scope. It is characterized by functional interdependence and mutual development between the ports and their internal networks, including new economic activity areas such as free trade zones (FTZs), dry ports, multimodal and multifunctional connection networks, and advanced logistics zones as part of a global supply chain. Urban centres also play a pivotal role in this stage. This has led to the formation of hinterland boundaries for ports (Hinterland-Based), and with port regionalization, reciprocal relationships have developed with other ports, becoming more complex through the global shipping network. This has resulted in the creation of what is known as the foreland areas for ports (Foreland-Based). Consequently, the ports region now encompasses both of hinterland and foreland areas (Rodrigue and Notteboom, 2011).

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4. Research methodology

Ports with significant global competitiveness have evident dynamic relationships with their urban spillover, as demonstrated by the prior literature study. Based on this, the study's methodology identifies Egypt's most competitive port based on important metrics derived from the earlier literature review and assesses the impact of global competitiveness on that port region on two levels: changes that happened at the city-port level and changes that happened in the port region, which were statistically and spatially analysed.

4.1. Measuring The Global Competitiveness of Egyptian Ports and their Urban Spillover

The indicators of global competitiveness were measured on the existing commercial seaports of Egypt and their urban spillover, totalling fourteen ports. Based on the previously presented literature review, twenty-six indicators were identified to measure the global competitiveness of the Egyptian ports and their urban spillover, which were then grouped into seven clusters as showen in Table (1) as follows: (Shipping Networks Indicators, Inland Networks Indicators, Logistic Services Indicators, Inland Terminals & Ports Indicators, Urban-Economic Performance Indicators, Port Performance Indicators, and RCI Relative Concentration Index). Table 1 shows clusters and key quantitative indicators in each of them. The research was based on five dimensions of indicators measuring the global competitiveness of Egyptian ports. The first dimension was measuring the efficiency of connecting the ports to the Continental Shipping Network through Shipping Network Indicators. The second dimension was measuring the efficiency of connecting the port to its urban spillover through inland network indicators. The third dimension was measuring the efficiency of supply chains and logistics services in ports' urban spillover through logistic services—inland terminals and port indicators. The fourth dimension was measuring the efficiency of the ports' urban spillover through the Urban-Economic Performance Indicators (RCI Relative Concentration Index). Finally, the fifth dimension was measuring the efficiency of the ports' performance through port performance indicators. **The z-score analysis** was used to standardise data by measuring the number of standard deviations each data point is from the mean, facilitating comparisons across the different indicators for measuring the global competitiveness of Egyptian ports and their urban spillover and identifying outliers for anomaly detection. **Cluster analysis** was used to classify the global competitiveness levels of Egyptian ports, followed by **factor analysis** to identify the indicators influencing this classification.

Fig. (1) and Table (2) illustrate the results of the statistical analysis conducted using both Z-score analysis, cluster and factor analysis on the Egyptian commercial ports, which include a total of 14 ports. All data and indicators used in the analysis correspond to the year 2025.

TABLE 1 - KEY QUANTITATIVE INDICATORS FOR MEASURING THE GLOBAL COMPETITIVENESS OF EGYPTIAN PORTS AND THEIR URBAN SPILLOVER

competitiveness Indicators clusters	Indicators Code	Indicators
Shipping Networks Indicators	S1	Continental Shipping Network (1)
	S2	Average volume of cargo / continental shipping lines (1000 tons/year) (1)
Inland Networks Indicators	I1	Degree of Connectivity (2)
	I2	Travel time to nearest major urban city (Min.) (3)
	I3	No. of airport in the port's range (4)
Logistic Services Indicators	L1	Existing and approved logistic areas (Fedden) (5)
	L2	Maximum design capacity for logistic areas (million tons/year) (5)
	L3	Maximum container capacity (TEU) (5)
	L4	Container handling volume for 2023 (TEU) (5)
	L5	Cargo handling volume 2023 (million tons) (5)
Inland Terminals & Ports Indicators	T1	The areas of existing and approved dry ports in the port's range (Fedden) (5)
	T2	Investment volume for dry ports in the port's range (million EGP) (5)
	T3	Maximum design capacity for dry ports in the port's range (TEU) (5)
Urban-Economic Performance Indicators	U1	Population size for city port (2017) (6)
	U2	No. of public/private special economic zones (SEZs) in the port's range (7)
	U3	The volume of exports for (SEZs) in the port's range (million dollars) (7)
	U4	Phases of economic development in ports governorates (8)
Port Performance Indicators	P1	Total port area - land and water area (km2) (1)
	P2	Maximum port water depth (meters) (1)
	P3	Total number of berths (1)
	P4	Total length of berths (meters) (1)
	P5	Number of port's terminals (1)
	P6	Maximum storage capacity (million square metres) (1)
	P7	Growth rate of total port cargo 2006-2023 (%) (1)
	P8	Container Cargo ratio (%) (1)
RCI Relative Concentration Index	R1	Share of container throughput for port from national total (%) / Share of Population for urban city port from national total (%) (9)

Sources: (1) The official website of the maritime transport sector in Egypt (https://www.mts.gov.eg/en/). (2) It was calculated according to the types of the transportation network (regional roads & railways network) which connected with the port city, and a relative weight was given to each type to standardize the values and and they were summed. (3) The Travel time was determined by measuring the road network and knowing its speed limit. (4) The official website of the Ministry of Civil Aviation in Egypt (https://www.civilaviation.gov.eg/). (5) The official website of The General Authority for Land and Dry Ports in Egypt (https://ldp.gov.eg/en/). (6) Egypt's census of population, buildings and establishment. (7) The official website of The General Authority for investment and free zones in Egypt (https://www.investinegypt.gov.eg/). (8) National Urbna Policy report. (9) It was calculated according to showen equation.

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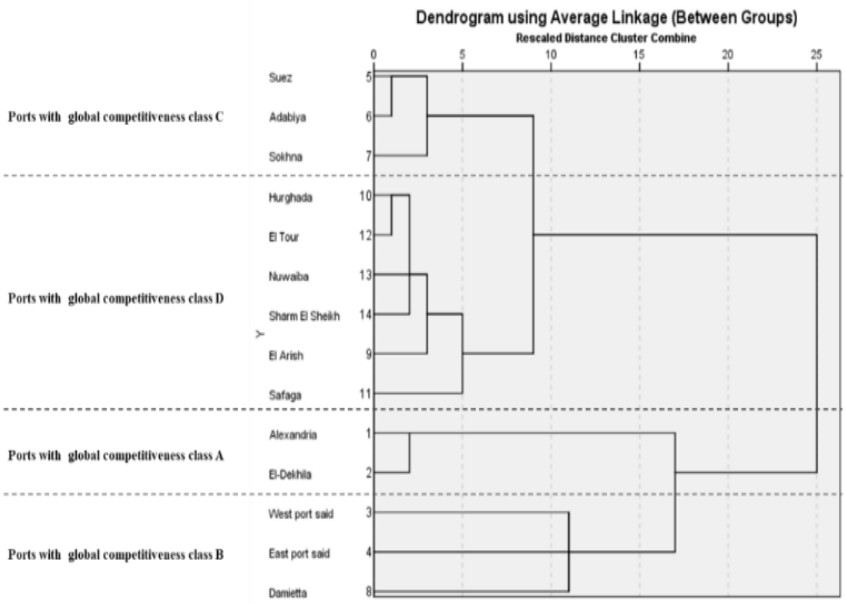

FIGURE 1 - STATISTICAL GROUPING OF EGYPTIAN PORTS BASED ON CLUSTER ANALYSIS (BY AUTHORS)

TABLE 2 - FACTOR ANALYSIS TO IDENTIFY KEY INDICATORS INFLUENCING PORT CLASSIFICATION

Communalities			
Code	**Indicators**	**Initial**	**Extraction**
(S1)	Continental Shipping Network	1.000	.905
(S2)	**Average volume of cargo / continental shipping lines (1000 tons/year)**	**1.000**	**.980**
(I1)	Degree of Connectivity	1.000	.862
(I2)	Travel time to nearest major urban city (Min.)	1.000	.780
(I3)	No. of airport in the port's range	1.000	.658
(L1)	**Existing and approved logistic areas (Fedden)**	**1.000**	**.961**
(L2)	**Maximum design capacity for logistic areas (million tons/year)**	**1.000**	**.985**
(L3)	**Maximum container capacity (TEU)**	**1.000**	**.970**
(L4)	Container handling volume for 2023 (TEU)	1.000	.847
(L5)	Cargo handling volume 2023 (million tons)	1.000	.752
(T1)	**The areas of existing and approved dry ports in the port's range (Fedden)**	**1.000**	**.974**
(T2)	**Investment volume for dry ports in the port's range (million EGP)**	**1.000**	**.971**
(T3)	**Maximum design capacity for dry ports in the port's range (TEU)**	**1.000**	**.967**
(U1)	**Population size for city port (2017)**	**1.000**	**.960**
(U2)	No. of public/ (SEZs) in the port's range	1.000	.849
(U3)	**The volume of exports for (SEZs) in the port's range (million dollars)**	**1.000**	**.977**
(U4)	Phases of economic development in ports governorates	1.000	.893
(P1)	Total port area - land and water area (km2)	1.000	.845
(P2)	Maximum port water depth (meters)	1.000	.631
(P3)	Total number of berths	1.000	.851
(P4)	**Total length of berths (meters)**	**1.000**	**.943**
(P5)	**Number of port's terminals**	**1.000**	**.942**
(P6)	**Maximum storage capacity (million square metres)**	**1.000**	**.965**
(P7)	Growth rate of total port cargo 2006-2023 (%)	1.000	.868
(P8)	Container Cargo ratio (%)	1.000	.808
(R1)	**RCI Relative Concentration Index**	**1.000**	**.987**

Sources: Extraction Method: Principal Component Analysis.

4.2. Assessing The Mutual Influence between The Most Competitiveness Port and its Urban Spillover

After identifying the most competitive Egyptian port globally, an analysis was conducted to assess the mutual influence between the port's competitiveness and its urban spillover during two different periods (2010-2024) at two levels:

Level A: The Port-City Interface, through some indicators such as land use, port area, number of berths, storage areas, port's terminals, maximum water depth, and transport network.

Level B: The Port Region, through some indicators (land use, economic structure, logistics network, transport network and special economic zones).

5. RESEARCH RESULTS

5.1. Measuring The Gglobal Competitiveness of Egyptian Ports and their Urban Spillover

Cluster analysis of global competitiveness indicators classified Egyptian ports and their urban spillover into four levels, as shown in Fig. (2), as below is an analysis of the most important features of these levels:

Ports with global competitiveness class A

The most globally competitive ports at the national level possess several distinguishing features, including high-performance indicators in terms of port infrastructure (number of berths, terminals, storage areas, and water depth), are characterized by high connectivity to continental shipping lines, high connectivity to production and consumption centres in their urban spillover through an inland multi-modal transportation network (roads, railways). Their urban spillover is flexible and capable of accommodating related industrial and logistical activities, as it contains: (special economic zones, dry ports and intermediate terminals, logistics areas, and industrial zones). At this level are the ports of Alexandria and Dekheila.

Ports with global competitiveness class B

The second level of global competitiveness at the national level is characterized by high performance indicators due to their strategic locations on major global trade routes. However, the key distinguishing feature of this group is the limited availability of developable land in their urban spillover. This has resulted in a locked spillover that is unable to expand further in the future, constrained by the surrounding land uses, such as urban settlements, agricultural areas, industrial zones, and natural and environmental factors. The ports of Damietta, Port Said, and East Port Said fall into this second level.

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Ports with global competitiveness class C

The third level of global competitiveness is at the national level, where the ports are characterised by average performance indicators, are distinguished by good connectivity to the continental shipping network and have good connections to production and consumption centres in their urban spillover, where they are characterised by a good inland transport network and a good logistics system. At this level are the ports of Suez, Adabiya, and Al-Sokhna.

Ports with global competitiveness class D

The fourth and lowest level of nationally competitive ports is characterized by low performance indicators. These ports are distinguished by poor connectivity to continental shipping lines and weak linkages to production and consumption centres within their urban spillover. They are further characterized by poor inland transport networks and logistics systems. The ports of El-Arish, Nuweiba, Sharm El-Sheikh, Al-Tor, Hurghada, and Safaga fall into this least competitive level. The study found that the ports of Alexandria and Dekheila are the most globally competitive ports at the national level. Factor analysis of the global competitiveness indicators for Egyptian ports and their spillover revealed that the most influential factors in their ranking were related to logistics services, inland terminals and ports, and overall port performance indicators. This suggests that the Port of Alexandria and Dekheila have high operational efficiency and a common flexible urban spillover that can accommodate the diverse elements of the logistics system.

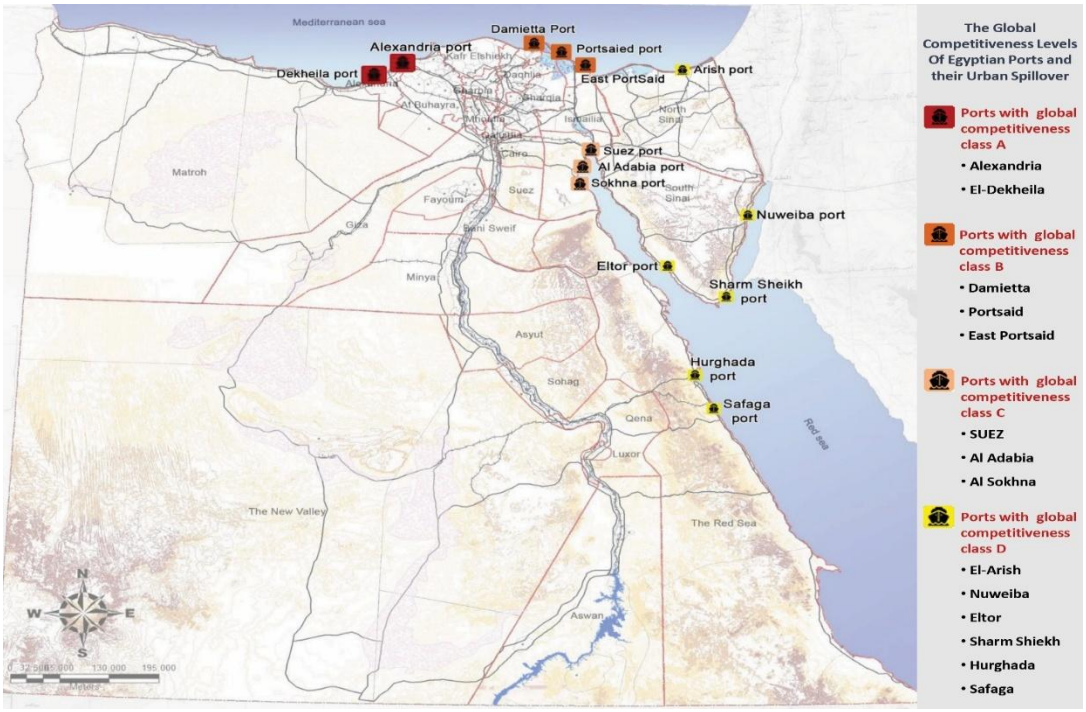

FIGURE 2 - THE GLOBAL COMPETITIVENESS LEVELS OF EGYPTIAN PORTS AND THEIR URBAN SPILLOVER (BY AUTHORS)

5.2. Assessing The Mutual Influence between Alexandria Port and its Urban Spillover

The port of Alexandria is situated in the northern city of Alexandria, which is Egypt's second-largest urban region. Approximately 60% of Egypt's foreign trade flows through this port; the study found that it is the most nationally competitive port in Egypt. The study evaluated the impact of the port's global competitiveness on its surrounding urban spillover at two levels, as follows:

Level A: The Port-City Interface

The study assessed the changes occurring as a result of the Port of Alexandria's global competitiveness and its impact on the port-city interface, examining both the current situation and the port's future expansions. These changes were measured over the period from 2010 to 2024, as that was the timeframe for which most of the necessary data was available. The study then outlined the key findings regarding the results of these changes in the points that follow.

The heightened competitiveness of the Port of Alexandria led to changes in the land uses surrounding the port-city interface. Specifically, industrial uses, companies, and business areas increased by 15%. Additionally, the land uses located directly west of the port and along the waterfront have been modified. A decision was made to remove approximately 150 feddans of residential, service, and industrial uses in this area (a process that is currently underway). These removed lands will then be annexed by the Alexandria Port Authority and used to develop the new Port of Mex, as well as internal terminals, berths, and storage facilities, in line with the approved master plan for the Greater Port of Alexandria (https://apa.gov.eg/ar/).

The heightened competitiveness of the Port of Alexandria led to changes in its performance indicators. The key changes included: a 39.7% increase in the port's area, a 66.6% increase in the warehouse and storage areas, a 26.4% increase in the volume of cargo handled, and a 32% increase in the volume of containers handled. Table 3 shows the most important changes that have occurred in the port's performance indicators between 2010 and 2024.

TABLE 3 - KEY CHANGES THAT HAVE OCCURRED IN THE PERFORMANCE INDICATORS OF ALEXANDRIA PORT BETWEEN 2010-2024.

Alexandria Port performance indicators	2010(1)	2024(2)	Rate of Change %
Total Port Area (Km^2)	6.8	9.5	39.7%
Total number of berths	50	68	36%
Total length of berths (meters)	7625	14350	83%
Maximum port water depth (meters)	12.8	17.5	36.7%
Number of port's terminals	6	10	66.6%
Warehouses and storage area (million m^2)	1.05	1.75	66.6%
Container handling volume for 2023 (TEU)	616000	813768	32%
Cargo handling volume (million tons)	22096	27940	26.4%

Sources: (1) Report of Misr national transport study – JICA - 2012. (2) The official website of the maritime transport sector in Egypt (https://www.mts.gov.eg/en/).

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The heightened competitiveness of the Port of Alexandria led to significant transformations in the inland transport network. This included: the development of new high-speed corridors directly connecting to the port through free-flowing intersections, such as the Mahmoudiya and New Al-Taemir corridors, Planning for an integrated monorail network to link the port area with the city of Alexandria, expansion and enhancement of the railway network serving the port, plans to connect the port to a high-speed rail network for improved connectivity to Cairo and Al-Alamein. These infrastructure developments were aimed at improving the overall transport connections and accessibility to the increasingly competitive port of Alexandria.

The enhanced competitiveness of the port of Alexandria led to the planning and establishment of extensive logistics zones southwest of the port, covering a total area of 928 feddans. These logistics areas are the largest ever developed for the ports of Alexandria, as per the approved master plan for the greater port of Alexandria (https://apa.gov.eg/ar/). The development of these sizable logistics zones was a strategic response to the increased competitiveness of the Port of Alexandria, aiming to bolster its logistics capabilities and support its growing operations. Figure (3) shows the most significant changes that occurred in the port-city interface of Alexandria port during the period between 2010 and 2024, The figure also illustrates some future projects for the development of ports, such as the (New Max Port), along with several road and railway projects that are being planned and whose initial steps are being implemented to strengthen the competitive role of Alexandria's ports. The research highlights the importance of these projects in predicting the future urban spillover of the city of Alexandria.

Level B: The Port Region

The study assessed the changes occurring as a result of the Port of Alexandria's global competitiveness and its impact on the port region. These changes were measured over the period from 2010 to 2024. The study outlined the findings regarding the results of these changes in the points that follow.

Population dynamics of the port city: according to the latest official census data from 2017, the population of the city of Alexandria reached 5,163,008 residents. This represents a high growth rate of 25% compared to the city's population of 4,123,869 residents in 2006. In contrast, the population growth rate for the city during the 1996–2006 period was only 18%. By studying the dynamic movement of the population from the city centre to the peripheral areas west of Alexandria around the ports of Alexandria, Dekheila, and the new extension areas, The research found that there were significant changes in population rates in the peripheral districts, reaching up to 75% compared to 45% in the city centre districts between 2006 and 2017. Also, the growth rates have reached 5.8 for the peripheral districts compared to 3.8 in the city centre districts between 2006 and 2017, as shown in Table 4. This indicates the attraction

of the ports and related activities for the population, which has affected the expansion of the urban spillover of Alexandria, as illustrated in Figure 3.

TABLE 4 - THE DYNAMICS OF POPULATION MOVEMENT FROM CITY CENTRE TO PERIPHERIES OF ALEXANDRIA.

Major zones for Alexandria city	Rate of Change % in population (96-2006)	Rate of Change % in population (2006-2017)	Population Growth Rate (96-2006)	Population Growth Rate (2006-2017)
*core of Alexandria – Old city	14%	45%	1.3	3.8
*periphery of Alexandria city	13%	75%	1.3	5.8

Sources: * Based on the results of delineating the urban region of Alexandria, within the project for preparing the strategic plan for Alexandria Governorate until 2030, General Organization for physical Planning GOPP – 2020.

Regional land uses: The proportion of the land for port-related activities (industry, trade, transportation, storage, and logistics services) has increased from 8% in 2010 to 13.2% in 2024, a 65% growth rate. Plans have been made to develop the southern hinterland and the lake areas to accommodate industrial, logistics, and service activities covering an area of approximately 283.8 thousand feddans, connecting them to the existing ports through multimodal transport corridors. The implementation of logistics zones in the lake area to serve the port has already begun, covering an area of 928 acres.

Economic Economic activity structure: The increased competitiveness of the Port of Alexandria has led to a notable evolution in the structure of the economic activities of the employed workforce and establishments. There is now a complete concentration of related activities with ports (location quotient greater than 1.5 in 2017 compared to 1.2 in 2006) of industrial, wholesale trade, transportation, and storage activities. The rates of change in the number of industrial, wholesale trade, and transportation/storage establishments reached 24.6%, 21.6%, and 56.4%, respectively, during 2006–2017, compared to 18.2%, 14.9%, and 35.9% during 1996–2006, according to official statistics. The textile, chemical, food, mining, and engineering industries are the most specialised industrial activities as of 2017, which are also consistent with the specialisation of the port of Alexandria in traded commodities and goods.

Logistics Services: The increased competitiveness of the Port of Alexandria has resulted in the planning and implementation of logistics zones southwest of the port, covering a total area of 928 acres. Additionally, planning and implementation have been undertaken to accommodate logistics activities and dry ports along the (Egypt-Alexandria Desert, Dabaa Axis) corridors in the port's hinterland, covering an area of approximately 300 acres. Most of these projects have been implemented by the Egyptian Armed Forces Engineering Authority.

Special Economic Zones - SEZs: The increased competitiveness of the Port of Alexandria has resulted in a rise in the number of economic zones within its urban hinterland, reaching a total of 72 public and private zones. This represents a growth rate of 44% during the period of 2010-2024, a notable increase compared to the 24% growth rate recorded between 1996-2006.

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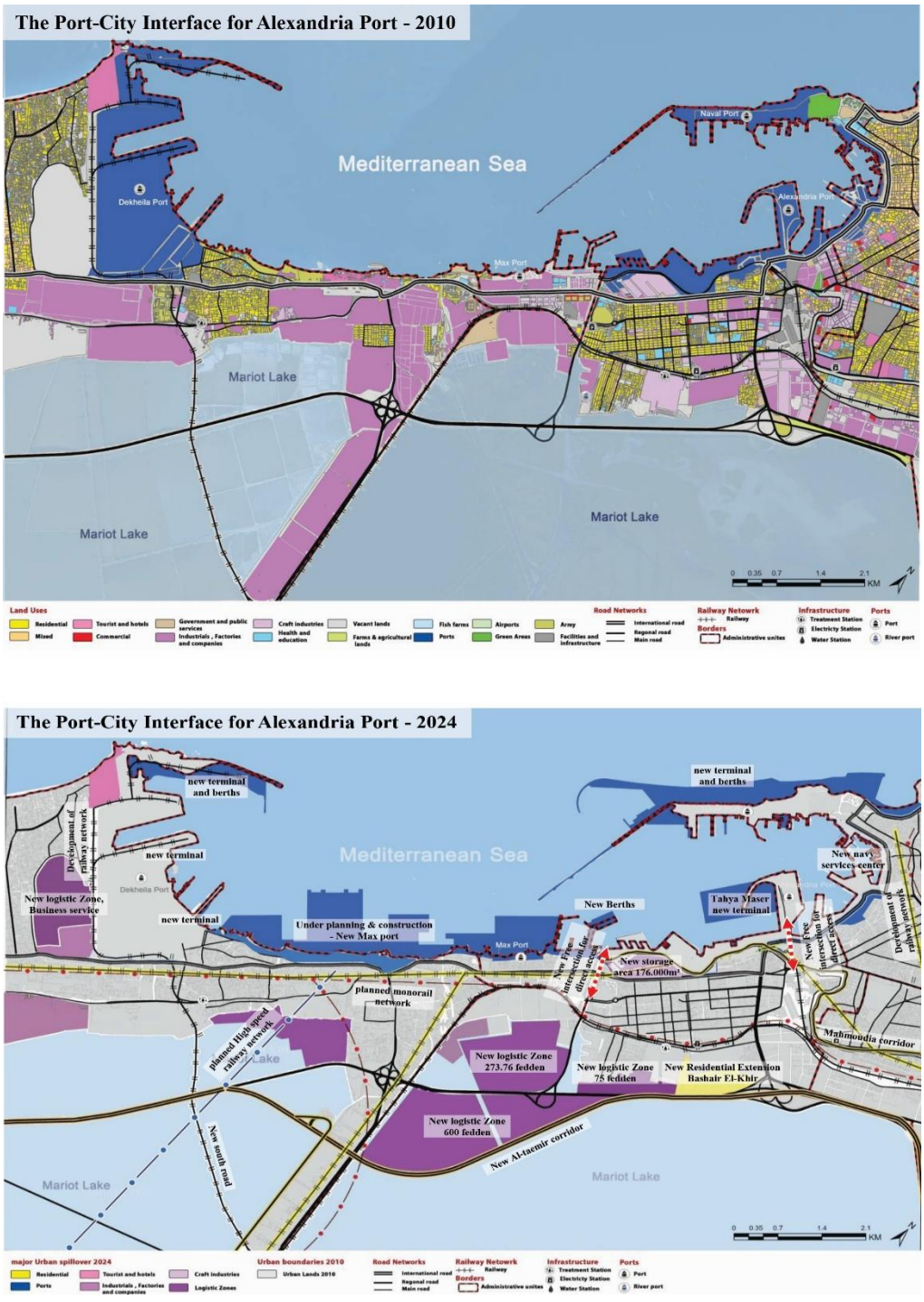

FIGURE 3 - CHANGES AND PROPOSED PROJECTS THAT OCCURRED IN THE PORT-CITY INTERFACE OF ALEXANDRIA PORT DURING 2010 TO 2024.

Source: The geo-database of Alexandria city which available at GOPP - The official website of the maritime transport sector in Egypt - https://www.mts.gov.eg/en/.

The heightened competitiveness of the Port of Alexandria led to significant transformations in the inland transport network. This included. Several expressways have been developed and directly connected to

Alexandria Port with free-flowing links and intersections such as the Cairo-Alexandria Desert Road, Wadi El Natrun-Alamein Road, Dabaa Axis, and the New Development Axis. A comprehensive monorail network has been planned to connect the port area with the city of Alexandria. Additionally, the railway network to the port has been expanded to a total length of 308 km, and plans have been made to link the port with a high-speed rail network to enhance connectivity with Cairo and Alamein, with an expected total length of 330 km. Figure (4) below illustrates the changes in the urban spillover of the city of Alexandria as a result of the competitiveness of the ports during different periods. It also highlights the key economic urban projects and infrastructure that have been implemented and planned within the Alexandria region. The study highlighted the importance of these projects in maintaining the global competitiveness of Alexandria's ports and in predicting the future urban spillover of the city.

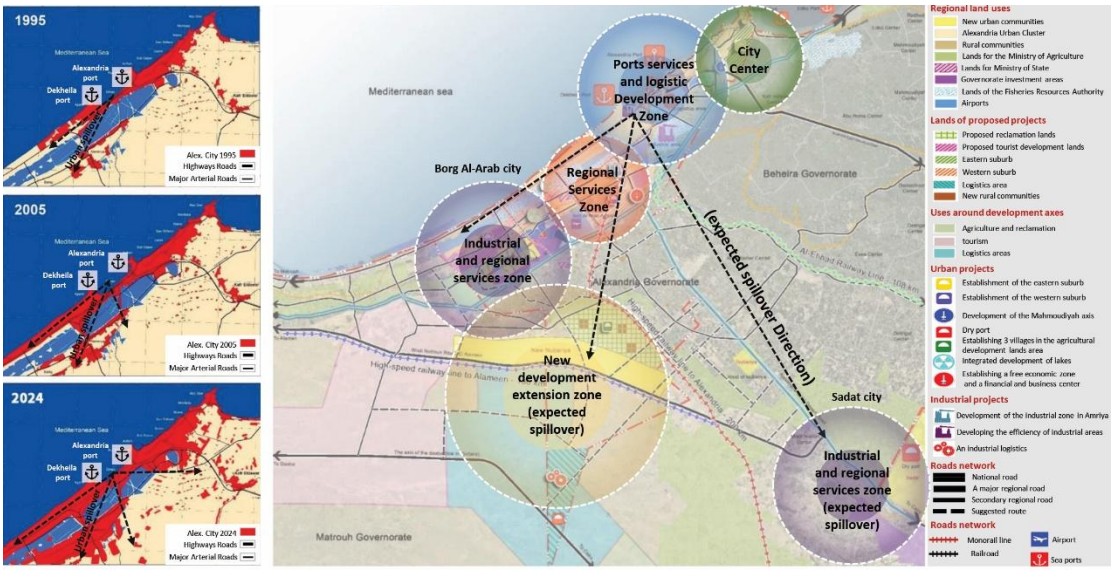

FIGURE 4 - SHOWS CHANGES AND EXPECTED IN URBAN SPILLOVER FOR ALEXANDRIA PORT REGION
Source: Authors depending on the analysis of the geo-database of Alexandria city which available at GOPP, Egypt.

6. RESEARCH DISCUSSIONS

Based on the theoretical literature review and practical application for assessing the mutual influence between the global competitiveness of Egyptian port regions and their impact on their urban spillover, we can confirm several important points, as follows:

Many studies and research have concluded that port price and the Logistics Performance Index (LPI) are among the most important global competitiveness indicators for ports. However, these indicators have not been applied to the Egyptian context due to the unavailability of data on Egypt's commercial ports. The research relied on alternative indicators to measure competitiveness, such as shipping networks, inland networks, and logistics services.

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Theoretical readings have emphasized that the most globally competitive ports are those with high efficiency in supply chains and logistics services within their urban spillover (Rodrigue and Notteboom, 2011). Additionally, these urban spillovers should be more flexible in accommodating various activities related to the ports through multi-model inland transport networks, inland terminals, dry ports, and logistic centres (Merk and Notteboom, 2013). This is consistent with the results of the practical part of the research, where the most influential factors for ranking the global competitiveness of Egyptian ports and their urban spillover were related to logistics services, inland terminals, dry ports, and port performance indicators.

All spatial models reviewed in the literature agree that ports, driven by global competitiveness and subsequent economic efficiencies, undergo expansion and development on two levels: initially within a limited scope at the port-city interface (Ignaccolo et al., 2013), and as the port's competitiveness accelerates growth, its interconnections expand to encompass its urban hinterland. Then the port moves towards decentralisation (Ducruet, 2006), developing multiple linkages with its urban spillover through infrastructure enhancements and increased logistical and industrial activities (Rodrigue and Notteboom, 2011). This aligns perfectly with the findings from the analysis of the Egyptian case, which showed that Alexandria Port began its growth and expansion at the port-city interface. And with increasing growth and economic efficiencies, it decentralised, expanding into the southern urban hinterland to meet its needs for logistics services and supporting activity centres.

Spatial models have shown that the dynamic changes between the ports and their urban hinterland, due to the port's global competitiveness, have reflected on: increased urban agglomeration of the port city; changes in the urban spatial structure of the region (Merk, 2013); shifts in economic activity structures towards manufacturing, maritime services, and logistics; and changes in internal transport networks (Akhavan, 2020). This aligns with the results of the Egyptian case study, which found that the competitiveness of Alexandria Port influenced the city's urban structure by expanding hinterland areas with new urban and rural communities and industrial and logistical activity zones. The study also identified significant changes in the economic activity structure, with high rates of the shift towards industrial, logistical, transport services, and wholesale trade activities, alongside notable changes in the internal transport network to enhance the connectivity of the port with its urban hinterland.

The research found that the global competitiveness of the ports of Alexandria has affected the urban spillover of the city and its direction, as well as the movement of the population from the old city center to the peripheral areas and new extensions (ports areas - west and southwest of the city of Alexandria). The research concluded that the ports of Alexandria are currently in the Regionalization stage, where the ports of Alexandria have an urban and logistical hinterland with special economic zones, storage centers,

logistics areas, new and existing industrial and urban centers and multi-modal transportation network. We can say that the ports of Alexandria went through several stages before this one. First, the Interconnection and concentration stage, where the ports of Alexandria focused on linking with the surrounding port area to concentrate related activities. Due to economic gains, the ports of Alexandria entered a new stage, the Centralization stage, where the ports connected with various industrial, logistical, and consumption centers (major cities) in their hinterland. The transportation network developed in this stage to increase the connectivity of the ports to these areas. With technological progress and the increase in the volume of goods handled by these ports, the ports of Alexandria entered the Decentralization stage. The hinterland of these ports became denser and broader. These stages are in line with the theoretical model of the dynamic spatial relationships between ports and their regions.

The research identified three main driving forces behind the port region's evolution: a strategic intermediary location near the global shipping network, close proximity to production and consumption centres, and major urban cities within the urban spillover. and a developed, multimodal infrastructure network that supports containerisation and facilitates transhipment operations. Finally, it includes a network of logistics zones, dry ports, and special economic zones that efficiently organise and manage supply chains.

7. CONCLUSIONS

The research clarified the mutual influence between port competitiveness and its urban spillover by identifying global competitiveness indicators to determine the most competitive port at the national level. Through statistical analysis of these indicators, it was found that the Port of Alexandria is one of the most globally competitive Egyptian ports. To analyze the impact of the global competitiveness of the Port of Alexandria region on the spatial, functional, and economic dynamics of its urban hinterland during two different periods (2010–2024). This analysis is conducted on two levels: (The Port-City Interface and the Port Region). One of the main challenges of the research is the difficulty in obtaining a comprehensive geo-database for the Alexandria region. Additionally, future research can explore scenarios of spatial integration for urban dynamics (role, size, function, networks, ranges, etc.) in port regions and their role in proposing urban development policies for these regions to achieve sustainability.

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