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Araştırma Makalesi * Research Article

Relationship of Seafarer Supply with Labour Force and Economic Indicators: Analysis of European Union Coastal Countries

Gemi İnsanı Arzının İş Gücü ve Ekonomi Göstergeleri ile İlişkisi: Avrupa Birliği Kıyı Ülkeleri Analizi

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Abstract: This study examines the relationships between seafarer supply and both labour force dynamics and key economic indicators within the maritime sector, focusing specifically on 22 coastal countries that are members of the European Union. Based on bibliometric analysis and Spearman correlation analysis, statistically significant relationships were identified between seafarer supply and key labour market indicators, such as the number of unemployed individuals and the size of the labour force. The analysis reveals that there are relationships ranging from low to moderate between the supply of seafarers and certain economic variables, such as GDP and ocean-based service trade; however, these relationships are not statistically significant. In this regard, the study demonstrates that the supply of seafarers is more closely linked to the structural characteristics of the labour market than to macroeconomic indicators, thereby presenting findings on this relationship, which has been examined only to a limited extent in the literature, and making a significant contribution. These findings indicate that labour dynamics in the maritime sector must be addressed through more effective human resources management and policy frameworks. Furthermore, it is assessed that such approaches, once developed, have the potential to enhance the resilience and sustainability of the maritime sector amid fluctuations in global trade.

Keywords: Seafarer supply, labour force dynamics, maritime sector, economic indicators, European Union.

Öz: Bu çalışma, denizcilik sektöründe gemi insanı arzı ile iş gücü dinamikleri ve temel ekonomik göstergeler arasındaki ilişkileri, Avrupa Birliği'ne üye 22 kıyı ülkesi özelinde incelemektedir. Bibliyometrik analiz ve Spearman korelasyon analizine dayalı olarak, gemi insanı arzı ile işsiz sayısı ve iş gücündeki kişi sayısı gibi temel iş gücü göstergeleri arasında istatistiksel olarak anlamlı ilişkiler tespit edilmiştir. Gerçekleştirilen analiz, gemi insanı arzı ile GSYH ve okyanus ekonomisi temelli hizmet ticareti gibi bazı ekonomik değişkenler arasında düşük ile orta düzey arasında değişen ilişkiler bulunduğunu göstermektedir; ancak bu ilişkiler istatistiksel olarak anlamlı değildir. Bu yönüyle çalışma, gemi insanı arzının makroekonomik göstergelerden ziyade iş gücü piyasasının yapısal özellikleriyle daha yakından ilişkili olduğunu ortaya koyarak, literatürde sınırlı ölçüde incelenen bu ilişkiye yönelik bulgular sunmakta ve önemli bir katkı sağlamaktadır. Bu bulgular, denizcilik sektöründe iş gücü dinamiklerinin daha etkin insan kaynakları yönetimi ve politika çerçeveleriyle ele alınması gerektiğine işaret etmektedir. Ayrıca, geliştirilecek bu tür yaklaşımların küresel ticaretteki dalgalanmalar karşısında denizcilik sektörünün dayanıklılığı ve sürdürülebilirliği üzerinde olumlu etkiler yaratma potansiyeline sahip olduğu değerlendirilmektedir.

Anahtar Kelimeler: Gemi insanı arzı, iş gücü dinamikleri, denizcilik sektörü, ekonomik göstergeler, Avrupa Birliği.

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INTRODUCTION

Every way we move – by rail, road, air, even sea – relies on solid connectivity, and that has always been true. Roughly 80% of global cargo travels by sea, underscoring the vital role of strong sea connections in keeping trade flowing (Mishra et al., 2021: 424). Liner shipping is vital to the global economy and is supported by liner services that offer fixed schedules, established routes, and stable freight rates. Given the spread of international trade and globalization, along with the growing volume of the global trade network, the significance of maritime trade becomes clearer.

Liner connectivity is vital to shaping trade performance, as it affects coastal countries with direct access to sea routes and landlocked countries that depend on efficient logistics networks to facilitate international trade. For coastal nations, strong liner shipping connectivity enhances their ability to participate in global commerce, attract foreign investment, and stimulate economic growth. In contrast, landlocked countries rely on seamlessly integrating land transportation systems and strategic alliances with neighboring countries to access maritime trade routes, underscoring the importance of reliable shipping services for economic progress. This interdependence of various modes of transportation highlights the need for comprehensive policies and investments to increase connectivity, ultimately providing increased trade opportunities and supporting economic resilience for all countries involved (UNCTAD, 2015).

The United Nations Conference on Trade and Development (UNCTAD) has launched a program to assess liner shipping connectivity worldwide by calculating the Liner Shipping Connectivity Index (LSCI). This index is a key indicator of a country's integration into global shipping networks. The LSCI is derived from five essential components of the maritime transport sector: the total number of ships, their container-carrying capacity, the maximum size of vessels, the number of shipping services, and the number of companies operating container ships in a country's ports (Jouili, 2019: 5). While this index is an important criterion in evaluating a country's liner shipping capabilities, the sector has increasingly gained an international character due to globalization and cooperative relations between countries in the maritime sector.

The globalization of trade has led to the expansion of container fleets and a shift from single-entity shipping to multi-player alliances, improving service delivery and maximizing economies of scale (Chen et al., 2022: 1). According to Chen et al., current research models in liner shipping alliances rely on specific joint operations and assumptions. Future developments will introduce a multi-level cooperation mode that incorporates various transportation modes and freight rates. Follow-up research should focus on optimizing models with multiple partners, diverse cooperation modes, hybrid operational patterns, varying freight rates, different container types, and multiple departure-arrival port pairs, all while considering the overall profit of the intermodal network (2022: 11).

Designed to increase the efficiency and profitability of merchant shipping amid globalization, this alliance system will significantly reshape the dynamics of talent acquisition in the maritime sector. Meanwhile, traditional human resource management practices must evolve to meet the emerging needs of organizations. It is suggested that organizational resilience is closely connected to both the factors within the maritime industry and the rapidly changing technological advancements affecting the sector. According to Li et al. (2024), these factors can be categorized into organizational learning capabilities and technological specialties, which include sub-factors such as digitalization, technological collaboration, innovation-focused human resource management, and digital leadership.

According to Tovar and Wall (2022), digital and physical connectivity are complementary, so increased digitalization should be encouraged. In this regard, complementary policy and regulatory measures must be implemented to strengthen this connectivity. Two related measures include promoting stronger links among domestic, regional, and global networks by eliminating restrictions on regional or domestic cabotage markets, allowing international lines to transport domestic trade and feeder cargo, and emphasizing competition in the assignment of port concessions to terminal operators. Modernizing ports means investing in technology, building institutions, and the people behind the work. UNCTAD, for example, notes that progress really accelerates when public and private groups come together. Another idea is to expand the hinterland (attract jobs from local manufacturing hubs and neighboring regions) to help drive overall growth (Tovar and Wall, 2022: 6).

LITERATURE REVIEW

In today's digital and interconnected global landscape, the workforce in maritime-related industries is inextricably linked to digitalization, global trade networks, and technological advances. A comprehensive review of the literature on this topic reveals that, while specific subtopics are well covered, fewer comprehensive studies have explored other aspects. To examine the literature concerning the maritime logistics labour market more thoroughly and identify its strengths and weaknesses, the Web of Science (WoS)—a leading database for academic literature—was analyzed using bibliometric methods. The WoS database was searched using previously determined keywords, and a comprehensive study was obtained, including prominent publications in maritime transport, authors, keywords, and the distribution of publications over time. The keywords examined on this topic are as follows:

- Human Resource Management
- Talent Acquisition
- Unemployment Rate
- Labour Force Participation Rate in the maritime sector
- Supply and Demand in the maritime sector
- Seafarer Supply
- Liner Shipping Connectivity Index

According to these keywords, the search for the WoS database is executed as follows;

TS=(("Human Resource Management" OR "Talent Acquisition" OR "Recruitment" OR "Crew Management" OR "Seafarer Recruitment" OR "Maritime Workforce" OR "Seafarer Management") AND ("Maritime Industry" OR "Shipping Industry" OR "Marine Transportation" OR "Merchant Shipping" OR "Maritime Sector")) OR ("Seafarer Supply" OR "Crew Supply" OR "Seafarer Shortage" OR "Maritime Labour Supply"))

As a result of this search, 68 articles were found that were related to the scope of this article. The WoS results were analyzed using the 'Bibliometrics' package in R (Aria and Cuccurullo, 2017).

The word cloud in Figure 1 highlights key terms in maritime research, with each word's size reflecting its frequency of occurrence. Maritime education and training, human resource management, and career motivations immediately stand out as the main themes covered in this study. It can be seen that recurring terms like seafarer shortages, retention, and even COVID-19 point to very immediate industry challenges. Then there are quieter words like digital recruiting or Belize, which point to emerging trends or issues tied to specific regions. Ultimately, the mix brings together workforce concerns (think careers and management) with operational hurdles like shipping accidents, giving us a clear, if somewhat rough, snapshot of where the field stands and where it could go next.



Figure 1. The Word Cloud

The co-occurrence map of titles illustrated in Figure 2 delineates key thematic clusters within maritime research. Central terms such as "seafarer," "management," "human resources," and "maritime" emerge as foundational elements in the field. Word clusters like "sustainable," "industry," and "development" are ubiquitous, signaling a growing push for greener practices and solid economic foundations in the maritime business. At the same time, phrases like "shortage," "recruitment," and even the half-formed "COVID-" bring to mind some very pressing labour issues that are, broadly speaking, hard to ignore. You also notice terms like "Chinese," "English," and "students" cropping up, suggesting that the research is equally invested in regional specifics and educational details; in other words, local factors are of interest. Then there's the use of words like "analysis," "study," and "system," which reveal the methods used, relating day-to-day operations to management practices and socio-economic realities; this mix, which includes long-tested priorities as well as issues like crew management, paints a constantly changing, somewhat multifaceted picture of the field.

Figure 2. Co-Occurrence Map

The factorial map shown in Figure 3, created using Multiple Correspondence Analysis (MCA), reveals the conceptual structure of the dataset by visually grouping keywords into three thematic groups. The red cluster on the left focuses on seafarer supply issues, particularly those exacerbated by the COVID-19 pandemic, and highlights terms such as "shortage," "selection," "impact," and "officers," suggesting significant labour market disruptions. The larger blue cluster to the center-right is more dispersed and covers broader topics in human resources, training, management, and organizational challenges in the maritime and shipping industries. This cluster highlights themes of diversity, leadership, and workforce sustainability. Lastly, the smaller green cluster in the bottom-right centers on terms such as "social resource" and "exploring evidence," indicating research focused on social dimensions and resource exploration. The horizontal (Dim 1) and vertical (Dim 2) axes account for 17.04% and 15.51% of the variance, respectively, suggesting that while these dimensions capture some conceptual distinctions, the topic space remains moderately complex and overlapping.

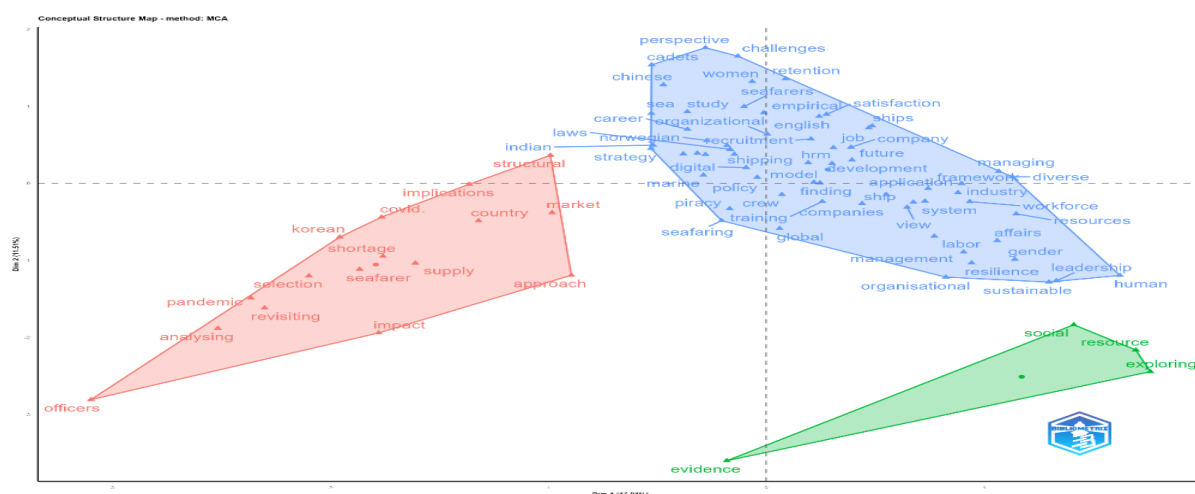


Figure 3. *Factorial Map*

This thematic map, illustrated in Figure 4 of the R Bibliometrix package, categorizes research themes by degree of development (density) and relevance (centrality), dividing them into four quadrants. In the Motor Themes quadrant (top-right), the prominent topics include "maritime industry," "seafarer market," "ship development," and "career/company factors." These themes are highly developed and central to the research field, highlighting their significance. In the Basic Themes quadrant (bottom-right), broader topics such as "seafarers" and "shipping" are identified as fundamental yet less developed internally, suggesting they are widely connected areas. The Niche Themes (top-left), which include specialized subjects like "organizational" issues, "policy," and "laws," are well-developed but tend to be isolated, indicating their specialized nature. Finally, in the Emerging or Declining Themes quadrant (bottom-left), themes such as "crew," "strategy," and "model" emerge, reflecting either nascent research fronts or areas that are experiencing a decline in attention. The field is primarily anchored by applied, labour-market-centered issues within the maritime industry. At the same time, there appear to be gaps in organizational studies and emerging needs related to crew dynamics.

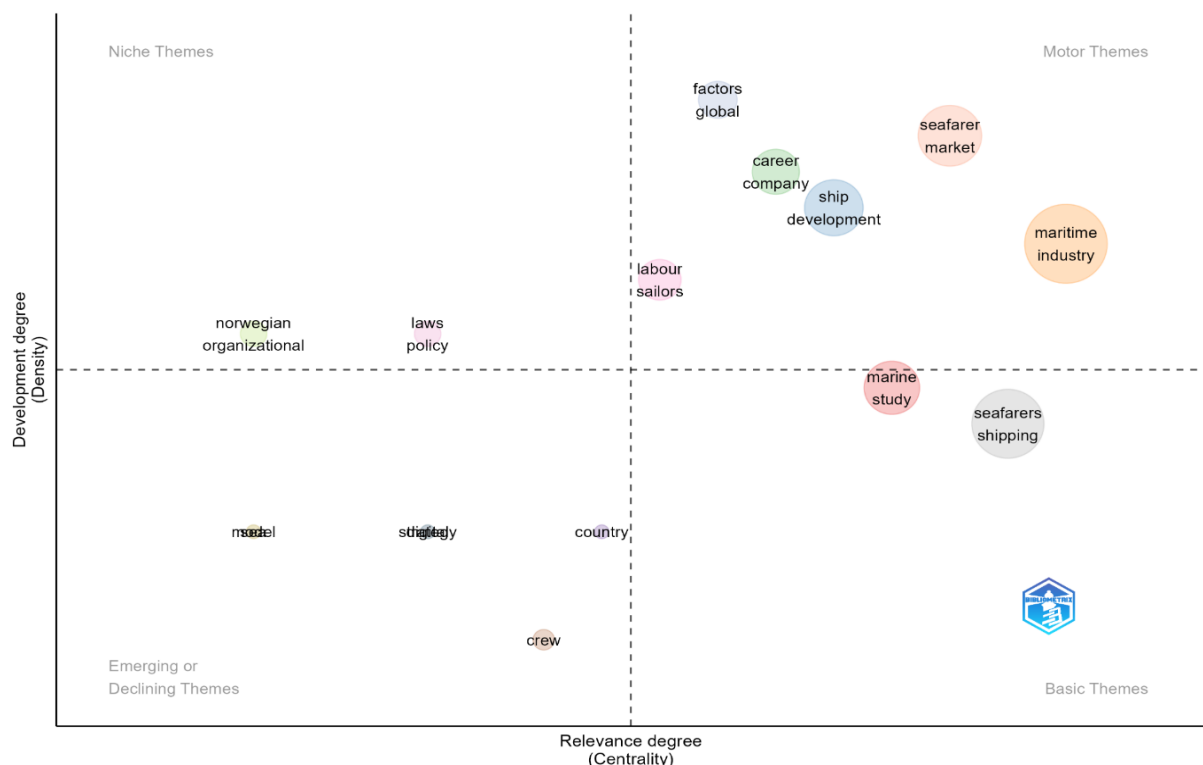


Figure 4. *Thematic Map*

When prominent articles in the WoS database are examined in detail, it can be argued that the studies reviewed offer valuable insights into the complex dynamics of human resource management (HRM) and the recruitment and retention of seafarers in the maritime industry. These studies focus on various geographical regions, challenges, and strategic frameworks for addressing HRM issues within the global shipping industry.

De Silva et al. (2011) investigate the factors influencing the retention of officer-seafarers from the Indian subcontinent in the international shipping industry. Through a survey of more than 200 experienced officers, the study identifies four key determinants of retention: long-term career prospects, a smooth and fair recruitment process, improved relations with maritime authorities, and an employee-friendly organizational culture. The study emphasizes the importance of creating a supportive and positive work environment and argues that organizational culture is crucial to retaining officer seafarers.

Similarly, Aydoğan and Arslan (2021) explore how HRM practices influence organizational commitment within the maritime sector. Based on surveys from 104 employees in international maritime companies, their study finds that tailored HRM practices can enhance employee loyalty and performance. Both studies underscore the significance of an organization's internal environment;

however, De Silva et al. (2011) focus more specifically on organizational culture while Aydoğan and Arslan (2021) consider a broader range of HRM practices.

Progoulaki and Theotokas (2010) and Goulielmos et al. (2011) present contrasting perspectives on the role of HRM in the shipping industry. Progoulaki and Theotokas (2010) apply the resource-based view (RBV) to HRM, arguing that human resources confer a unique, inimitable competitive advantage. Their research highlights the undervaluation of human resources in Greek shipping companies, despite their potential to increase long-term competitiveness. This study highlights the importance of integrated HRM systems, particularly the compatibility between shore-based and seafaring personnel. In contrast, Goulielmos et al. (2011) examine the advantages and disadvantages of third-party ship management companies (TPSMs) in ship management. While the TPSM model facilitates international recruitment and training, it may also limit direct control over crew and operational costs. Progoulaki and Theotokas (2010) focus on the internal development of competencies and dynamic capabilities within organizations, suggesting that shipping companies should invest in their internal HRM frameworks to achieve sustainable competitive advantages.

Nguyen et al. (2014) discuss the challenges faced by the Vietnamese maritime industry in recruiting and retaining. They identify issues such as the low quality of maritime graduates, inadequate training opportunities, and competition from foreign companies offering better working conditions. Their study advocates for improved training programs, improved working environments, and proactive recruitment practices. This aligns with the findings of Thai et al. (2013), who discuss strategies to tackle the seafarer shortage in Singapore. Their research emphasizes that competitive salaries, bonuses, and corporate social responsibility initiatives are key to retaining seafarers. Both studies highlight the need for better recruitment strategies; however, Nguyen et al. (2014) focus on improving the quality of education and working conditions. Thai et al. (2013) emphasize the importance of tangible and intangible benefits to increase employee retention.

The study by Wang and Tae Yeo (2016) provides strategic insights into selecting foreign seafarer-supply countries for Korean-flagged vessels. Their research identifies the significance of crew costs, education quality, and the availability of trained seafarers in selecting a supply country. This study equips international shipping companies with the knowledge to recruit cost-effective, well-trained personnel in a competitive market. Meanwhile, Lobrigo and Pawlik (2015) examine the impact of national maritime policies on the maritime labour market. Their findings reveal that national strategies can significantly affect the supply and quality of seafarers and that key factors such as employment regulations and the quality of maritime education play important roles. Both studies highlight the importance of national and international factors in the recruitment process; Wang and Tae Yeo (2016) focus on specific selection criteria for foreign seafarers, while Lobrigo and Pawlik (2015) investigate how national policies shape the seafarer labour market.

In contrast, studies by Mack (2010) and Menelaou and Violaris (2012) suggest practical solutions to challenges in the maritime industry. Mack (2010) explores how globalization affects the organizational lives of Norwegian seafarers, revealing the challenges associated with cultural diversity and technological complexity in ship operations.

In conclusion, the reviewed studies provide a comprehensive understanding of the complex challenges and strategies in human resource management (HRM) within the maritime industry, particularly regarding the recruitment and retention of seafarers. The research highlights the significance of organizational culture, HRM practices, and national policies in shaping seafarer retention and organizational commitment.

De Silva et al. (2011) and Aydoğan and Arslan (2021) seem to show that what happens inside a company (its culture and properly designed HR practices) can actually increase employee loyalty and help retain them. Meanwhile, Progoulaki and Theotokas (2010), when paired with Goulielmos et al. (2011), offer a very different angle; generally speaking, Progoulaki and Theotokas (2010) lean on a resource-based approach to explain the role of HR, while Goulielmos et al. (2011) begin to explore models that include third-party management, which somewhat shifts the strategic focus.

Recruiting and retaining seafarers is not the same everywhere – each region seems to face its own set of obstacles. For example, Nguyen et al. (2014) and Thai et al. (2013) repeatedly show that increasing training efforts, making workplaces more friendly, and offering truly competitive wages can help alleviate the shortage of skilled crew, especially in emerging maritime markets. Meanwhile, Wang and Tae Yeo (2016) and Lobrigo and Pawlik (2015) generally note that having sound national maritime policies and careful selection of supply countries play an important role, even if these factors sometimes receive less attention.

Multinational, multicultural work environments tend to throw a mixed bag of challenges at teams. Research by Brenker et al. (2017) and Mack (2010) suggests that groups with diverse cultural backgrounds sometimes encounter unforeseen operational disruptions, underscoring the need for tailored cultural coaching and, in many cases, a more natural way to blend team efforts. In many cases, Menelaou and Violaris (2012) imply that simple technology solutions, such as crew management systems incorporated into HR tasks, can alleviate these challenges and increase overall operational efficiency.

Research shows that, in many cases, the maritime industry benefits from taking a broad, complex look at HR management, bringing together clear organizational structures, cultural insights, and emerging technologies to address the tough issues of recruiting and retaining crew. By creating a truly supportive workplace, experimenting with HR approaches tailored to daily needs, and ensuring that national policies align with what is really needed at sea, the industry can improve its ability to attract and retain talented seafarers, even as global competition continues to increase.

The maritime sector is a cornerstone of global trade and plays a critical role in the growth and sustainable development of the world economy. More than 90 percent of global trade flows through ships, and these shipping lines; you could say that our trade is almost entirely at sea. Over the last 20 years, the volume of cargo moved through these ocean routes has roughly doubled, a trend that clearly shows how much we rely on shipping (Germir, 2022). Seafarers who work in this sector and are employees of maritime companies hold an essential position regarding the sustainability and efficiency of marine transport (International Chamber of Shipping, 2023: 7).

Labour supply is defined as the total number of labour hours offered by the workforce willing to work within a specific time frame and at a designated wage level (ILOSTAT, 2025). The supply of seafarers is typically influenced by economic, social, technological, political, and demographic factors. Seafarer numbers are not keeping pace. A 2021 study by BIMCO and ICS says that demand today is, to put it bluntly, far outpacing current demand, and many experts believe this shortfall will continue until at least 2026 (BIMCO and ICS, 2021). If things continue like this, you could see everything from volatile shipping routines and heavy workloads to worsening conditions on board and rising costs for shipping companies, not to mention an increased reliance on offshore crews, all of which could spell trouble down the road. It seems important to take a close look at how seafarer supply, general labour trends, and economic signals fit together; after all, understanding this interaction helps when balancing supply and demand and creating truly sustainable labour policies. After all, keeping this delicate balance intact is not just crucial for the shipping industry; it also has ripple effects on national and global economic flows, as the shipping business is at the heart of international trade.

RESEARCH METHODOLOGY

Understanding how seafarer supply, the wider labour pool, and different economic signals fit together is often seen as crucial for maritime businesses to continue to thrive in the long term. In many cases, once these connections are clear, companies create enduring strategies, and this insight, in turn, pushes policymakers towards sound decisions. For the marine sector's steady growth and global competitiveness, it is essential to clearly understand the connections between the supply of seafarers, the labour force, and economic indicators. Accurately analyzing this relationship will enhance the effectiveness of seafarer labour force planning, which currently faces a supply-demand imbalance tilted towards excess demand, as well as the development of sustainable employment policies in the maritime sector. The steps of the research are presented as a diagram in Figure 5.

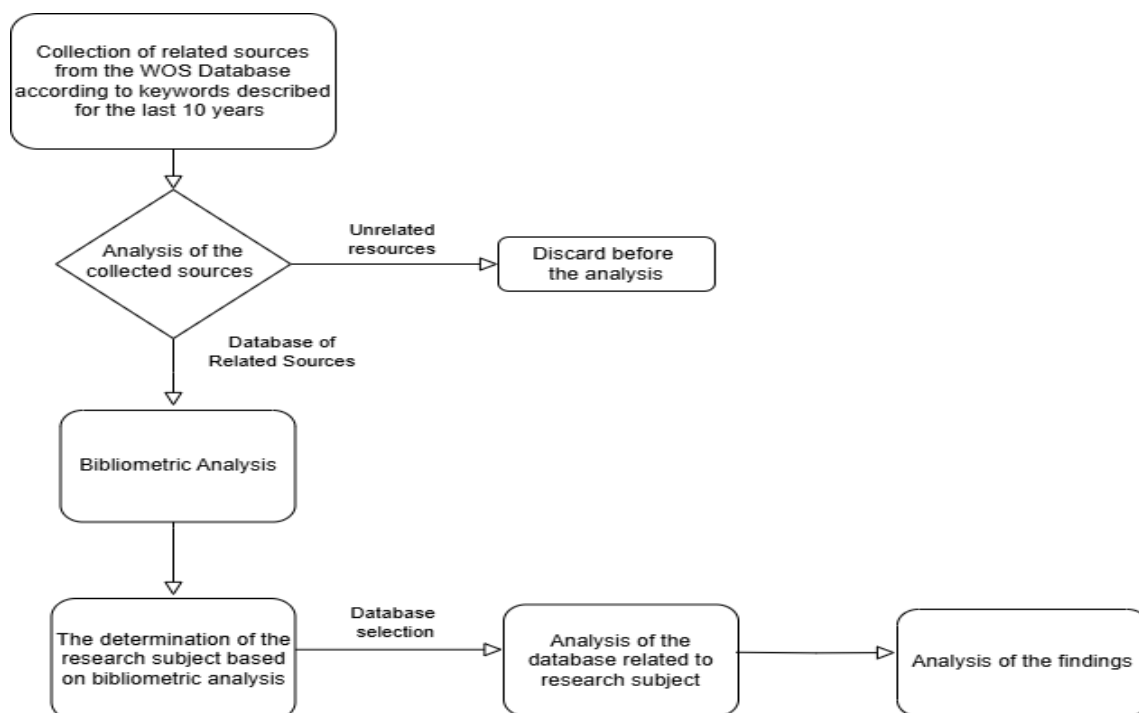


Figure 5. *The Steps of Research*

While the maritime sector has notable indirect economic impacts on landlocked countries, we have excluded these nations from our analysis. This decision is based on the premise that the dynamics between the maritime labour force and the maritime sector do not directly influence landlocked states. By focusing on EU countries that affect maritime, labour, and economic indicators—while nations around the world have all sorts of quirks—we've really ramped up our research methods. In our study, we've focused on 22 coastal EU countries, a selection that in many ways mirrors the full lineup of the 27 member states expected by 2025.

This study explores how seafarer supply, general labour availability, and various economic indicators come together against the backdrop of coastal countries worldwide. We leaned on EU coastal countries for our sample, not only because the region generally operates with common maritime rules and shared standards, but also because these features tend to simplify a complex picture. In most cases, the EU's maritime sector provides a clear link between labour trends and economic figures, which strongly supports our analysis. In this context, it can be asserted that the methodological consistency of the research is strengthened by examining EU countries that influence maritime, labour, and economic indicators while operating within a shared framework.

Research Hypotheses

It is assumed that all chosen labour market and economic indicators have a statistically significant relationship with the supply of seafarers. As a result, the following are the hypotheses developed for this study:

H₁: Seafarer supply is significantly associated with the number of unemployed individuals.

H₂: Seafarer supply is significantly associated with the number of individuals participating in the labour force.

H₃: Seafarer supply is significantly associated with the number of employed individuals.

H₄: Seafarer supply is significantly associated with the number of unemployed youth.

H₅: Seafarer supply is significantly associated with Gross Domestic Product (GDP).

H₆: Seafarer supply is significantly associated with import volume.

H₇: Seafarer supply is significantly associated with export volume.

H₈: Seafarer supply is significantly associated with economic growth.

H₉: Seafarer supply is significantly associated with ocean economy-based service trade (imports).

H₁₀: Seafarer supply is significantly associated with ocean economy-based service trade (exports).

H₁₁: Seafarer supply is significantly associated with the liner shipping connectivity index.

In hypothesis testing, alpha (α) represents the accepted margin of error—the level of significance—and is used as a threshold value. Typically, an Alpha (α) value of 0.05 (5%) is accepted in statistical tests. This means that if the p-value from the test is less than the Alpha value, the research hypothesis is accepted (Cevahir, 2020: 26). The hypothesis tests in this study were conducted at a 95% confidence level ($p < 0.05$). This confidence level indicates that the results are statistically significant at the 5% level, meaning the probability of the observed relationship occurring by chance is less than 5%.

Limitations of the Study

The study has some limitations, and these are presented below:

1. As of 2025, the European Union consists of 27 member states: Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Austria. Among these countries, Austria, Hungary, Luxembourg, Slovakia, and Czechia are landlocked and were therefore excluded from the study's scope.

2. Among the labour force indicators whose relationship with the supply of seafarers will be examined, the number of unemployed, labour force participants, and employed and unemployed youth are included in the survey scope. In contrast, other labour force indicators (labour force participation rate, employment rate, unemployment rate, youth unemployment rate, underemployment, and the non-labour force population) are outside the scope of the survey.

3. GDP, import volume, export volume, economic growth, ocean economy-based service trade (imports), ocean economy-based service trade (exports), and liner shipping connectivity index are included in the scope of the study. In contrast, other economic indicators (such as per capita income, sectoral value added, industrial consumption index, poverty rates, and income distribution) are excluded from the scope of the study.

4. The number of young unemployed includes people between the ages of 15 and 24.

5. All data used in this study are from 2021, and the analysis was conducted within a cross-sectional framework. However, 2021 was a period marked by significant and extraordinary effects on global labour markets and macroeconomic indicators in the wake of the COVID-19 pandemic. In this context, a cross-sectional analysis based on data from a single year may reflect short-term fluctuations and shock effects rather than long-term structural relationships. Therefore, the findings should be evaluated within the framework of conditions specific to a particular period, rather than as permanent and generalizable relationships between the relevant variables. Future studies examining these relationships over time using multi-year panel data sets will yield more robust, generalizable results.

6. A total of 11 hypothesis tests were conducted, each corresponding to a pre-specified research hypothesis. No adjustment for multiple comparisons (e.g., Bonferroni correction) was applied. While this may increase the risk of Type I error, the analyses are structured around two conceptually distinct groups of variables (labour market indicators and economic indicators). Therefore, the findings are reported at conventional significance levels but should be interpreted as exploratory and indicative rather than confirmatory.

7. The analyses used in this study were conducted based on a specific set of variables and a specific year of data; a sensitivity analysis—which tests the extent to which model results change under different combinations of variables or alternative subsets of data—was not performed. Furthermore, advanced validation techniques such as cross-validation were not employed to assess the consistency and

generalizability of the findings. This limits the extent to which the identified relationships would hold under different sample structures or alternative model specifications. In future studies, conducting sensitivity analyses across different variable sets, alternative time periods, and subsamples, along with applying cross-validation techniques, will enhance the robustness and reliability of the findings.

8. The total value added produced by all producers in an economy is known as the gross domestic product, or GDP. Before deducting fixed capital depreciation, value added is calculated by subtracting the cost of intermediate goods and services used in production from total gross output. The United Nations System of National Accounts states that value added should be measured at either producer prices, which include net product taxes paid by producers but do not include sales or value-added taxes, or basic prices, which do not include net product taxes. Crucially, since producers bill transportation expenses separately, they are not included in either valuation method. While industry-level value added is usually measured using basic prices, the overall GDP is reported at purchasers' prices (World Bank, 2025).

9. International merchandise trade (import and export volumes) measures the value of goods entering or leaving an economy's stock of material resources. Unless otherwise stated in the country notes, export value is recorded on a free-on-board (FOB) basis. In contrast, import value is calculated on a CIF (Cost, Insurance, and Freight) basis, which includes cross-border insurance and transportation costs from the exporting country to the importing country. The volumes of imports and exports shown in the survey are based on the general trade system. In this system, imports include all goods entering a country's economic zone, and exports include all goods leaving that zone (UNCTADSTAT, 2025).

10. The economic growth rate refers to the change in gross domestic product (GDP) calculated at market prices and based on constant local currency. Aggregate values are based on constant 2015 prices and expressed in US dollars. GDP is the total value added by all resident producers in an economy, less taxes and subsidies that are not included in the products. This calculation is performed without any deduction for the depreciation of goods produced or for the depletion and degradation of natural resources (World Bank, 2025).

11. Data on trade in ocean economy-based services (imports and exports) provide annual statistics on exports and imports of ocean-related services for individual economies and selected groups of economies by ocean economy sectors in current dollars. Annual growth rates are also included. The services trade sectors within the sustainable ocean economy include the following elements (UNCTADSTAT, 2025):

- Sea and coastal tourism,
- Trade in fishing services,
- Maritime transportation and related services,
- Port services, related infrastructure, and logistics services,
- Coastal and marine environmental services,
- Marine research and development activities and related licenses,

12. The liner shipping connectivity index value, which shows a country's integration into global liner transportation networks, is published quarterly, and the first quarter (Q1) index value is used in this study. The liner shipping connectivity index is calculated based on the following six components (UNCTADSTAT, 2025):

- Number of weekly scheduled ship calls (voyages) in the country,
- Total annual capacity of twenty-foot equivalent units offered in the country,
- Number of regular line transportation services to and from the country
- Number of companies offering regular line transportation services to and from the country,
- Twenty-foot equivalent unit capacity of the largest vessel operating in the country,

- The number of other countries with which the country is connected by direct line transportation service.

Data Collection Tools and Data of the Study

The research data are collected in three different groups. The first one is the number of seafarers supplied, which refers to the common data whose correlation with other data groups will be examined. The second is labour force indicators, and the third is economic indicators.

Data on Labour Indicators

The data on labour force indicators include the number of unemployed people in the labour force, the number of employed people, and the number of young unemployed people in the sample of 22 coastal EU countries. This data has been compiled from statistical databases maintained by internationally recognized organizations. The data obtained are shown in Table 1.

Table 1. *Data on Labour Indicators of the Study*

Country	Seafarer Supply (Number of People)	Number of Unemployed	Number of Participants in the Labour Force	Number of Employed	Number of Young Unemployed
Belgium	4980	322800	5117600	4794800	126500
Bulgaria	22762	168200	3150400	2982300	40800
Cyprus	2926	34900	451900	417000	14600
Denmark	26159	150800	2937600	2786900	70200
Estonia	4498	42600	658700	616100	12600
Finland	10011	209500	2679000	2469500	79000
France	15914	2362800	29771200	27408400	877900
Germany	12234	1532700	41684800	40152000	494600
Greece	30507	665600	4488500	3822800	190900
Ireland	1242	159900	2452100	2292200	64600
Italy	3601	2348300	24197500	21849200	783200
Latvia	8088	70200	892200	822000	15300
Lithuania	3105	104600	1414400	1309800	22900
Poland	31222	564700	16910800	16346100	206200
Portugal	1238	334400	4957000	4622600	126600
Romania	17708	456900	8124500	7667600	171900
Slovenia	374	47900	1002200	954200	14600
Spain	24487	3421100	22916200	19485200	987700
Sweden	12527	481300	5334000	4852700	213000
Croatia	20495	192600	1785400	1649200	54200
Netherlands	9667	397600	9369300	8971700	197100
Malta	628	9500	272300	262900	3900

Source: UNCTADSTAT, 2025; ILOSTAT, 2025.

Data on Economic Indicators

The data on economic indicators include GDP, import volume, export volume, economic growth, ocean-based services trade (imports), ocean-based services trade (exports), and the liner shipping connectivity index for the 22 coastal EU countries that constitute the study sample. This data has been compiled from statistical databases maintained by internationally recognized organizations. The compiled data are shown in Table 2.

Table 2. *Data on Economic Indicators of the Study*

Country	Seafarer Supply (Officers + Crew) (Number of People)	GDP (\$) (x million)	Imports Volume (\$) (x million)	Export Volume (\$) (x million)	Economic Growth (%)	Trade in Services Based on the Ocean Economy (Imports) (\$) (x million)	Trade in Services Based on the Ocean Economy (Exports) (\$) (x million)	Liner Shipping Connectivity Index (Q1)
Belgium	4980	598490	526615	551478	6.2	15206	10745	360.28
Bulgaria	22762	84420	46210	41157	7.8	1027	950	21.77
Cyprus	2926	30370	10397	3905	11.4	2817	5987	52.98
Denmark	26159	408380	120307	125945	7.4	34728	55629	96.81
Estonia	4498	37200	23613	21560	7.2	1255	1162	31.59
Finland	10011	294220	86013	81996	2.7	4597	1927	69.26
France	15914	2970000	715082	585021	6.9	26890	58863	278.79
Germany	12234	4350000	1421512	1636742	3.7	38867	49558	337.96
Greece	30507	218300	77105	47218	8.7	13585	30860	183.9
Ireland	1242	531310	120301	190658	16.3	8210	2006	55.14
Italy	3601	2180000	567421	615635	8.9	18109	22340	262.04
Latvia	8088	38190	24446	20833	6.9	439	8089	31.87
Lithuania	3105	67040	44488	40706	6.4	1176	732	45.24
Poland	31222	689170	342075	340634	6.9	4449	1691	125.76
Portugal	1238	256060	98200	75229	5.9	4644	6078	161.35
Romania	17708	286580	116203	87388	5.5	2536	1161	61.3
Slovenia	374	61530	57560	57352	8.4	1193	1478	67.45
Spain	24487	1460000	419700	379969	6.7	18479	15420	381.89
Sweden	12527	637190	187108	189524	5.9	6502	5687	107.96
Croatia	20495	69010	34527	21878	12.6	749	9558	60.83
Netherlands	9667	1050000	757380	840032	6.3	14155	19421	402.96
Malta	628	19720	7133	3064	13.5	8538	376	121.78

Source: UNCTADSTAT, 2025; World Bank, 2025.

Data Analysis

The analysis of the data obtained for the research was conducted using IBM SPSS Statistics V. 30.0. The "normality test" was applied to determine whether the research data conformed to the normal distribution before the analysis. To perform parametric analyses, the data must be normally distributed (Pallant, 2016). In this context, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess normality; the results are presented in Table 3.

Table 3. Kolmogorov-Smirnov and Shapiro-Wilk Statistic Normal Distribution Test Results

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Seafarer supply	0.165	22	0.122	0.903	22	0.033
Number of unemployed	0.307	22	<0.001	0.672	22	<0.001
Number of labour force participants	0.298	22	<0.001	0.733	22	<0.001
Number of people employed	0.322	22	<0.001	0.680	22	<0.001
Number of youth unemployed	0.323	22	<0.001	0.697	22	<0.001
GDP	0.292	22	<0.001	0.680	22	<0.001
Import volume	0.295	22	<0.001	0.727	22	<0.001
Export volume	0.263	22	<0.001	0.696	22	<0.001
Economic growth	0.190	22	0.037	0.890	22	0.019
Trade in services based on the ocean economy (imports)	0.201	22	0.021	0.820	22	0.001
Trade in services based on the ocean economy (exports)	0.254	22	<0.001	0.733	22	<0.001
Liner shipping connectivity index	0.215	22	0.009	0.836	22	0.002

The p (Sig.) value calculated as a result of the Kolmogorov-Smirnov test is $p=0.122$ for the seafarer supply, $p=0.037$ for economic growth, $p=0.021$ for trade in services based on ocean economy (imports), and $p=0.009$ for the liner shipping connectivity index. For all other data groups, $p<0.001$. The p (Sig.) value calculated as a result of the Shapiro-Wilk test is calculated as $p=0.033$ for the supply of seafarers, $p=0.019$ for economic growth, $p=0.001$ for ocean economy-based service trade (imports), and $p<0.001$ for all other data groups.

Different normality tests should be preferred depending on the sample size. The Shapiro-Wilk test should be used if the sample size is smaller than 50 ($n<50$). Suppose it is larger than 50 ($n > 50$). In that case, the Kolmogorov-Smirnov test should be used (Büyüköztürk, 2007: 42). Since the study sample size is 22, the data will be evaluated for normality using the Shapiro-Wilk test. Suppose the test result is $p > 0.05$. In that case, the data group is normally distributed. In contrast, $p < 0.05$ indicates a non-normal distribution (Cevahir, 2020: 14). When Table 3 is examined, it is seen that the p-values for all data groups are less than $\alpha = 0.05$ according to the Shapiro-Wilk test results. From this, it is evident that none of the data groups follow normal distributions.

Spearman correlation analysis is also recommended for analyzing non-normally distributed data (Cevahir, 2020: 113-114). Because applying a parametric method to non-normally distributed data leads to erroneous results (Field, 2018). Therefore, nonparametric analysis was applied to the data. Spearman's Correlation Analysis, a nonparametric method, was used to determine the relationship between the data collected for the study. Table 4 shows in which intervals the r correlation value, which measures the level of relationship between the data, reflects which level of relationship, and in which intervals the p-value shows which statistical significance levels.

Table 4. Table Showing the Interpretation of r and p Values in Pearson and Spearman Correlation

Interpretation of the r value		Interpretation of p-value	
r=0.00	no relationship	$0.01 \leq p < 0.05$	statistical significance
r=0.01-0.29	low level of association	$0.001 \leq p < 0.01$	high level of statistical significance
r=0.30-0.70	moderate relationship	$p < 0.001$	very high level of statistical significance
r=0.71-0.99	high level of association	$0.05 \leq p < 0.10$	tendency to significance (borderline significance)
r=1	perfect relationship	$p > 0.10$	the difference was due to chance (not statistically significant)

Source: Köklü et al., 2007; Kul, 2014: 12.

RESULTS

Under this heading, the results of the Spearman correlation analysis applied to the data collected within the scope of the research, along with the findings, are presented.

Findings on the Relationship Between Seafarer Supply and Labour Indicators

Table 5. Spearman Correlation Analysis Results for the Relationship Between Seafarer Supply and Labour Force Indicators

			Number of unemployed
Spearman's rho	Seafarer supply	Spearman r	0.553**
		Sig. (2-tailed) (p)	0.008
		n	22
			Number of labour force participants
Spearman's rho	Seafarer supply	Spearman r	0.488*
		Sig. (2-tailed) (p)	0.021
		n	22
			Number of people employed
Spearman's rho	Seafarer supply	Spearman r	0.379
		Sig. (2-tailed) (p)	0.082

		n	22
			Number of youth unemployed
		Spearman r	0.512*
Spearman's rho	Seafarer supply	Sig. (2-tailed) (p)	0.015
		n	22

**Correlation is significant at $p < 0.01$ level.

* Correlation is significant at $p < 0.05$ level.

A Spearman correlation was used to examine the relationship between the supply of seafarers and the number of unemployed. A moderate ($r = 0.553$, $0.30-0.70$), highly significant ($p = 0.008$, $0.001 \leq p < 0.01$), and positive correlation was observed between seafarer supply and the unemployed. A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. This yielded a p-value of 0.008, which was less than the alpha level ($p < \alpha$). This finding indicates that the relationship between unemployment number and the supply of seafarers based on this result is statistically significant, and thus cannot be attributed to chance. The finding of a positive and significant correlation between the supply of seafarers and the number of unemployed suggests that the supply of seafarers may tend to concentrate in countries with a larger labour pool. This suggests the sector may be moving in step with the overall size of the labour force rather than being directly driven by unemployment. In this context, hypothesis H_1 is accepted. The relationship between the supply of seafarers and the number of unemployed is shown in Figure 6.

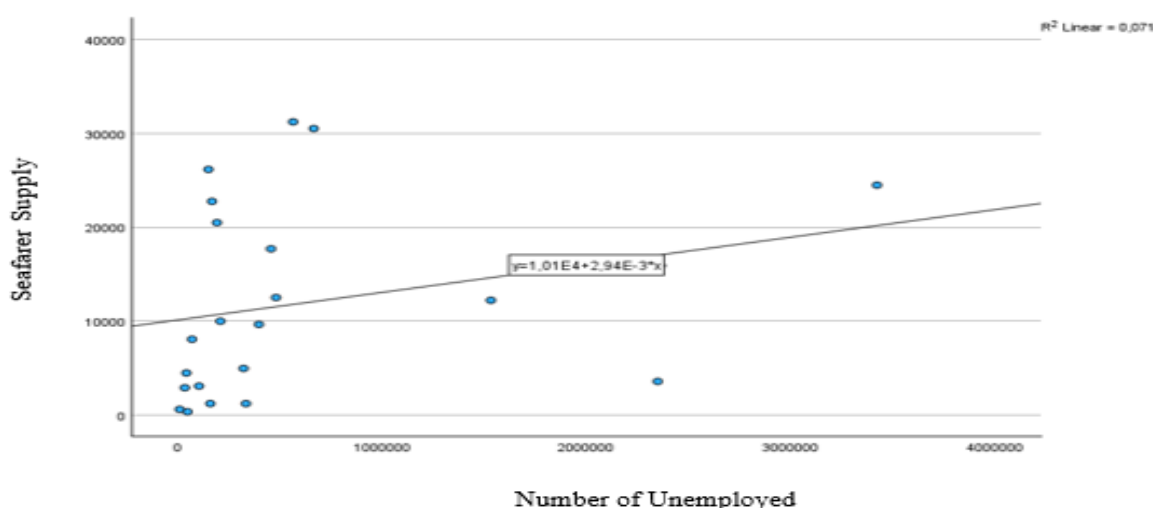


Figure 6. Correlation relationship between seafarer supply and the number of unemployed

Spearman's correlation was employed to assess the relationship between the supply of seafarers and the number of labour force participants. Moderate ($r = 0.488$, $0.30-0.70$), statistically significant ($p = 0.021$, $0.01 \leq p < 0.05$), and positive correlation was recorded between labour force participation and seafarer supply. A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The alpha level ($\alpha = 0.05$) is higher than the resulting p-value of 0.021. This finding indicates that there is a statistically significant correlation between the number of labour force participants and the supply of seafarers, with a 95% confidence level of less than 5% that the correlation is due to chance. The finding of a positive and statistically significant relationship between the supply of seafarers and the number of people entering the labor force suggests that the supply of seafarers may tend to be higher in countries with a larger labor force. This indicates that seafarer supply may move in parallel with the overall scale of the labour market rather than reflecting labour force participation dynamics per se. In this context, hypothesis H_2 is accepted. The relationship between the supply of seafarers and the number of labour force participants is shown in Figure 7.

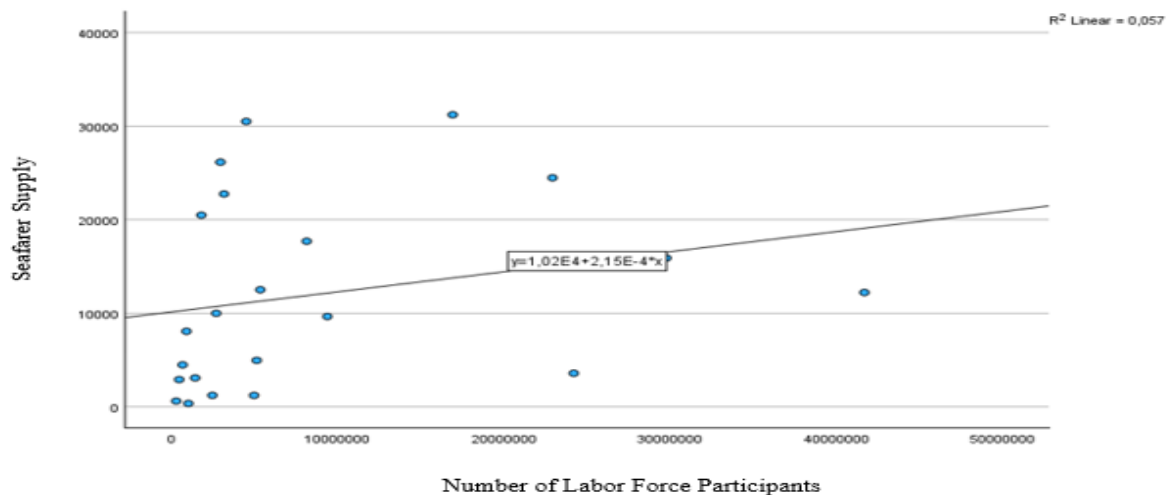


Figure 7. *Correlation Relationship Between Seafarer Supply and the Number of Labour Force Participants*

Spearman's correlation measured the relationship between the supply of seafarers and the number of employed. A moderate ($r=0.379$, $0.30-0.70$), borderline significant ($p=0.082$, $0.05 \leq p < 0.10$), and positive relationship was found between the supply of seafarers and the number of employees. A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The resultant p-value is 0.082, which exceeds the alpha value (0.05) ($p > \alpha$). This result suggests that there is no statistically significant link between the supply of seafarers and the employed populace. Also, it indicates that the odds of this relationship being spurious exceed 5% at 95% confidence. The absence of a statistically significant relationship between the supply of seafarers and the number of people employed suggests that the supply of seafarers may not be directly linked to employment levels. This indicates that the supply of seafarers may fluctuate in response to other labour market dynamics rather than overall employment trends. Under these circumstances, the H_3 hypothesis is rejected. The relationship between the supply of seafarers and the number of employed is shown in Figure 8.

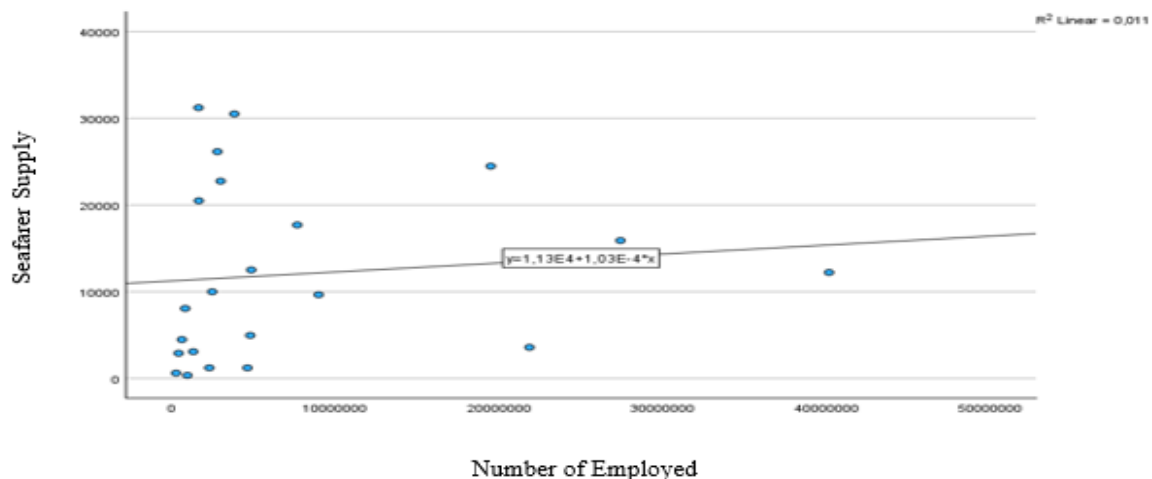


Figure 8. *Correlation Relationship Between Seafarer Supply and Number of Employed*

The relationship between the supply of seafarers and the number of young unemployed was measured by the Spearman correlation. A moderate ($r=0.512$, $0.30-0.70$), statistically significant ($p=0.015$, $0.01 \leq p < 0.05$) and positive relationship was found between the supply of seafarers and the number of young unemployed. A hypothesis test was performed at a 95% confidence level, with $\alpha=0.05$ as the margin of error for the test. As noted, the p-value we got is 0.015, which implies it is less than the alpha value (0.05), meaning ($p < \alpha$). This shows a statistically relevant connection between the supply of seafarers and the population of unemployed youths. Furthermore, the chances of this result being

incidental now drop to less than 5%, giving is 95% level of confidence. The finding of a positive, significant correlation between seafarer supply and the number of unemployed youth suggests that seafarer supply may tend to increase in countries with a high potential for young labour. This suggests that the maritime sector may be moving in step with the dynamics of the young labour force. In this context, hypothesis H₄ is accepted. The relationship between the supply of seafarers and the number of young unemployed is shown in Figure 9.

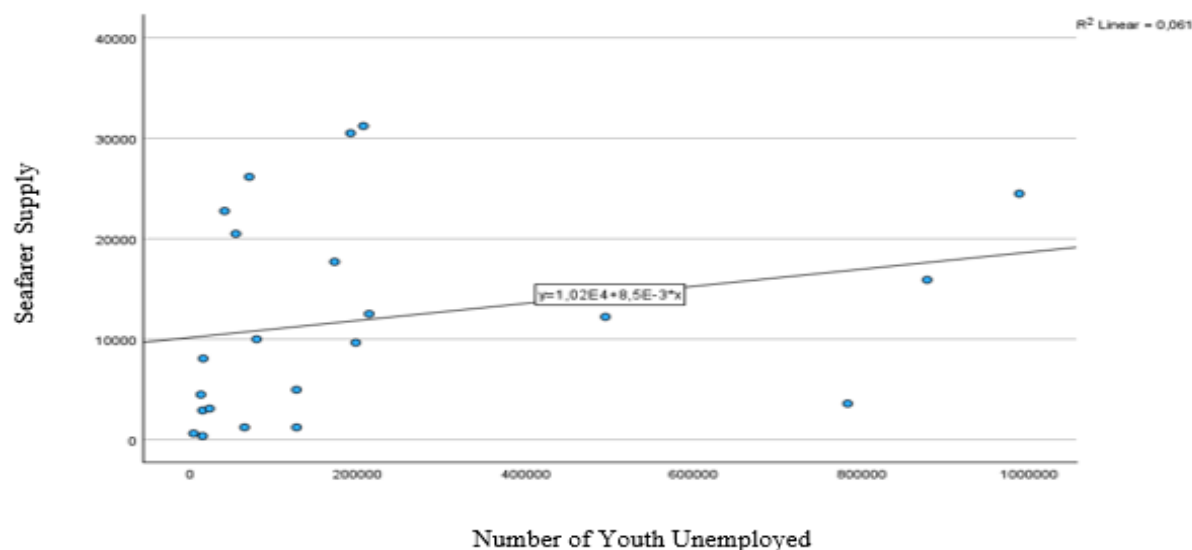


Figure 9. Correlation Relationship Between Seafarer Supply and the Number of Youth Unemployed

Findings on the Relationship Between Seafarer Supply and Economic Indicators

Table 6. Spearman Correlation Analysis Results for the Relationship Between Seafarer Supply and Economic Indicators

			GDP
Spearman's rho	Seafarer supply	Spearman r	0.405
		Sig. (2-tailed)	
		(p)	0.062
		n	22
			Import volume
Spearman's rho	Seafarer supply	Spearman r	0.321
		Sig. (2-tailed)	
		(p)	0.145
		n	22
			Export volume
Spearman's rho	Seafarer supply	Spearman r	0.268
		Sig. (2-tailed)	
		(p)	0.227
		n	22
			Economic Growth
Spearman's rho	Seafarer supply	Spearman r	-0.183
		Sig. (2-tailed)	
		(p)	0.414
		n	22
			Trade in services based on the ocean economy (imports)
Spearman's rho	Seafarer supply	Spearman r	0.173
		Sig. (2-tailed)	
		(p)	0.440
		n	22

		Trade in services based on the ocean economy (exports)	
Spearman's rho	Seafarer supply	Spearman r	0.355
		Sig. (2-tailed) (p)	0.105
		n	22
		Liner Shipping Connectivity Index	
Spearman's rho	Seafarer supply	Spearman r	0.185
		Sig. (2-tailed) (p)	0.411
		n	22

The relationship between seafarers' supply and GDP was measured using Spearman's correlation. A moderate ($r=0.405$, $0.30-0.70$), borderline significant ($p=0.062$, $0.05 \leq p < 0.10$), and positive relationship was found between the supply of seafarers and GDP. A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The obtained p-value is 0.062, which is greater than the alpha value (0.05) ($p > \alpha$). This result indicates that there is no statistically significant relationship between seafarer supply and GDP, and it suggests that the probability of the relationship between these two variables being coincidental exceeds 5% at the 95% confidence level. The fact that the relationship between the supply of seafarers and GDP is not statistically significant indicates that there is no consistent pattern of co-variation between these two variables. This suggests that a country's economic size may not, on its own, be a sufficient indicator of seafarer supply. In this context, the H_5 hypothesis is rejected. The relationship between the supply of seafarers and GDP is shown in Figure 10.

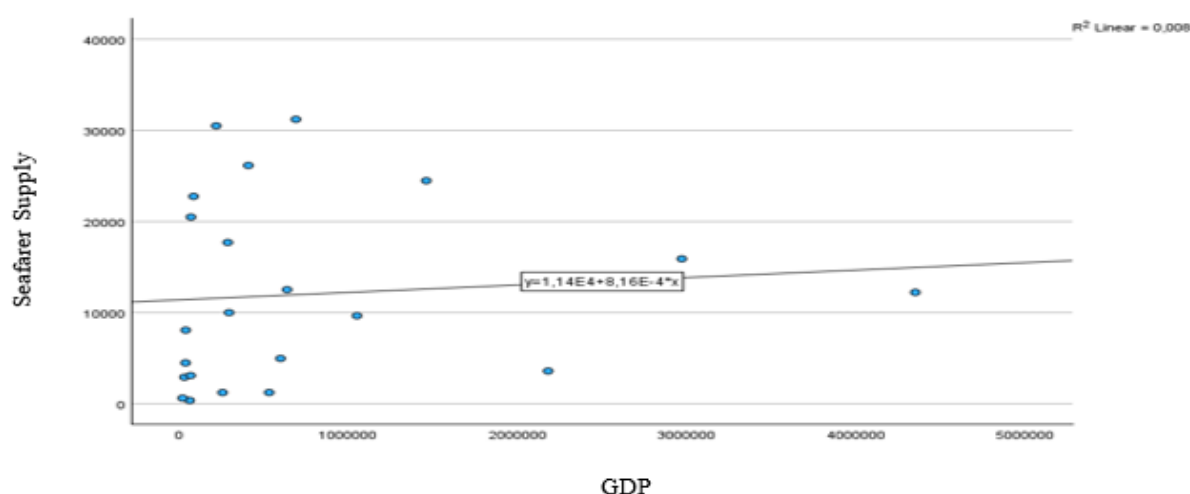


Figure 10. *Correlation Relationship Between Seafarer Supply and GDP*

The relationship between seafarer supply and import volume was measured using Spearman's correlation. A moderate ($r=0.321$, $0.30-0.70$) and positive relationship was found between seafarers' supply and imports' volume. Moreover, there is no statistical significance between the supply of seafarers and the volume of imports ($p=0.145$, $p > 0.10$). The test was carried out at the 95% confidence level. In this frame, the acceptable error margin was indicated at $\alpha=0.05$. The p-value of the analysis is 0.145, which is higher than the alpha value (0.05) ($p > \alpha$). The finding confirms that the level of seafarer supply is not related to the volume of imports and shows that the chance that the relationship between supply and imports is random is greater than 5% at the 95% confidence level. The absence of a statistically significant relationship between seafarer supply and import volume indicates no clear pattern of co-variation between the two variables. This suggests that import volume may have limited

explanatory power for changes in seafarer supply. In this context, the H_6 hypothesis is rejected. The relationship between the supply of seafarers and the volume of imports is shown in Figure 11.

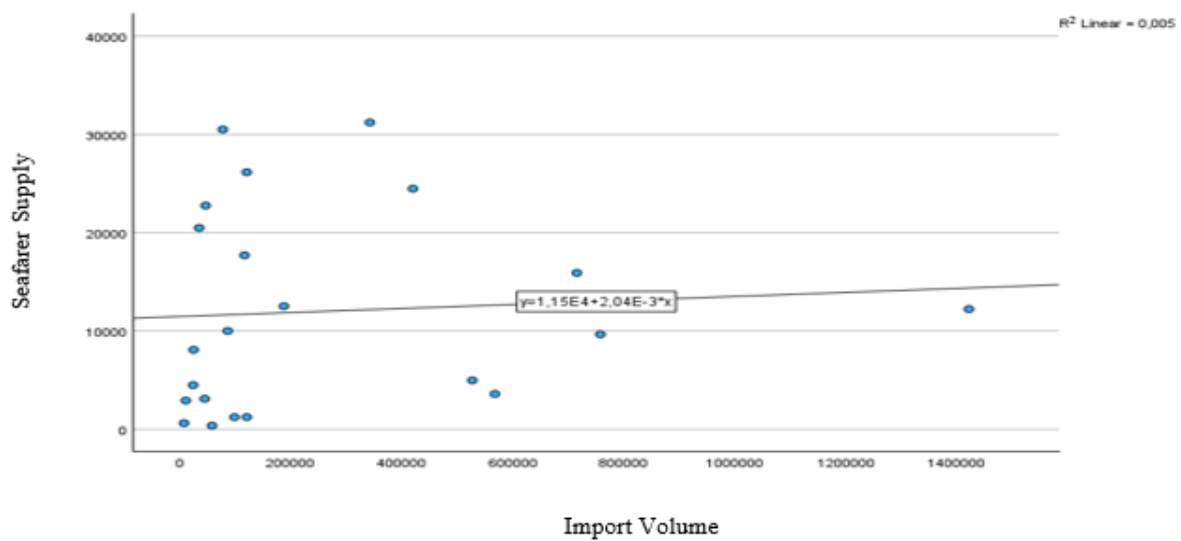


Figure 11. *Correlation Relationship Between Seafarer Supply and Import Volume*

The relationship between seafarers' supply and export volume was assessed using a Spearman correlation. A low level ($r=0.268$, 0.01-0.29) and positive relationship was found between the supply of seafarers and export volume. Moreover, there is no statistical significance between the supply of seafarers and the volume of exports ($p=0.227$, $p>0.10$). A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The significance testing resulted in a p-value of 0.227, which is greater than the alpha cutoff of 0.05 ($p>\alpha$). This means that there is no significant relationship between the seafarer supply and export volume variables, and that the likelihood of the association being due to chance exceeds 5% at the 95% confidence level. The weak, statistically insignificant relationship between seafarer supply and export volume suggests a weak correlation between the two variables. This finding suggests that the supply of seafarers may be linked to various economic or sectoral dynamics rather than a country's foreign trade performance. In this context, the H_7 hypothesis is rejected. The relationship between the supply of seafarers and export volume is shown in Figure 12.

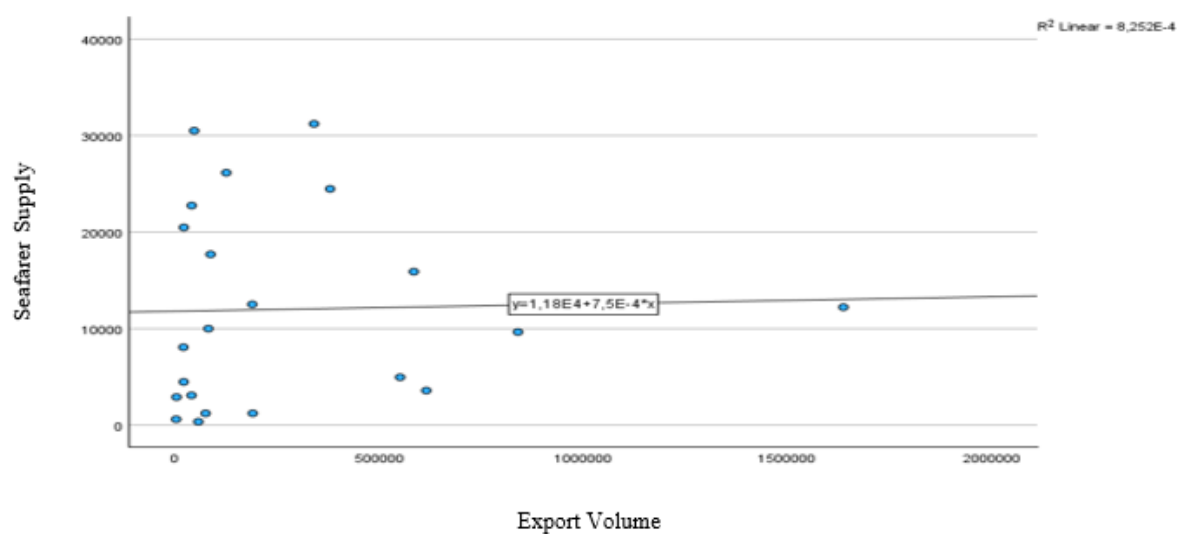


Figure 12. *Correlation Relationship Between Seafarer Supply and Export Volume*

The relationship between seafarer supply and economic growth was measured using a Spearman correlation. A low level ($r=-0.183$, $0.01-0.29$) and negative relationship was found between the supply of seafarers and economic growth. Moreover, there is no statistical significance between the supply of seafarers and economic growth ($p=0.414$, $p>0.10$). A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The significance testing resulted in a p-value of 0.414, which is greater than the alpha cutoff of 0.05 ($p>\alpha$). This means that there is no significant relationship between seafarer supply and economic growth variables, and that the likelihood of the association being due to chance exceeds 5% at the 95% confidence level. The finding of a weak and negative, yet statistically insignificant, relationship between the supply of seafarers and economic growth indicates that there is no systematic correlation between these two variables. This finding suggests that the supply of seafarers may be independent of short-term fluctuations in economic growth. In this context, the H_8 hypothesis is rejected. The relationship between seafarer supply and economic growth is shown in Figure 13.

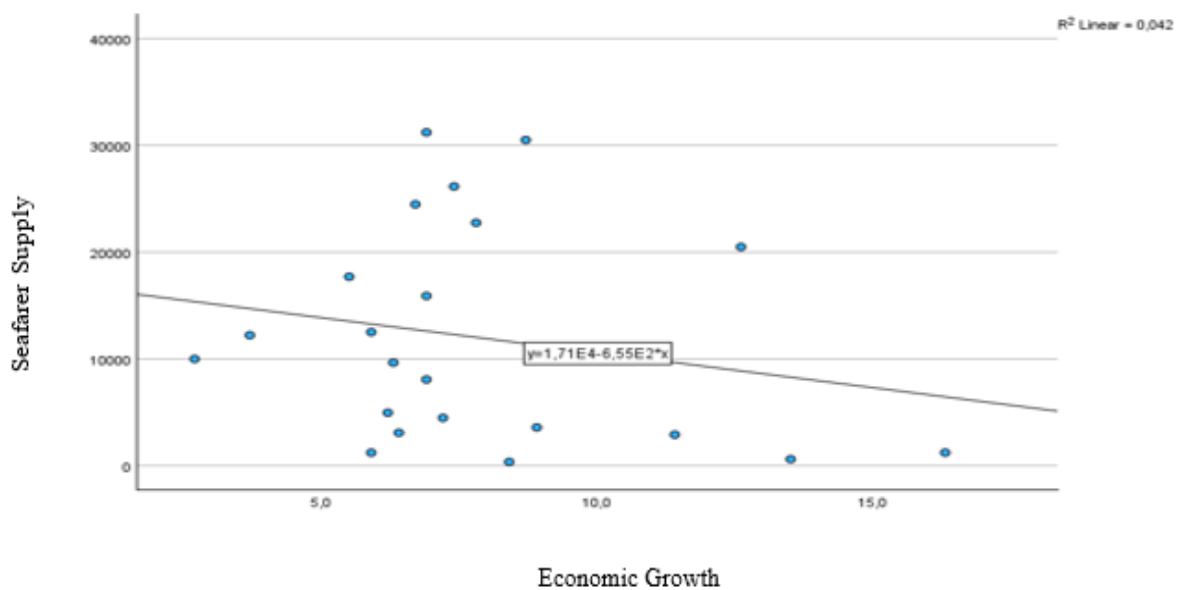


Figure 13. *Correlation Relationship Between Seafarer Supply and Economic Growth*

The relationship between the supply of seafarers and trade in ocean-economy-based services (imports) was measured using a Spearman correlation. A low ($r=0.173$, $0.01-0.29$) and positive correlation was found between the supply of seafarers and ocean-economy-based services trade (imports). Moreover, there is no statistical significance between the supply of seafarers and trade in ocean economy-based services (imports) ($p=0.440$, $p>0.10$). A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The significance testing resulted in a p-value of 0.440, which is greater than the alpha cutoff of 0.05 ($p>\alpha$). This means that there is no significant relationship between the seafarer supply and trade in ocean-economy-based services (imports) variables, and that the likelihood of the association being due to chance exceeds 5% at the 95% confidence level. The finding of a weak, statistically insignificant relationship between seafarer supply and service imports in the ocean economy indicates no clear pattern of co-movement between these variables. This finding suggests that changes in service imports may not be systematically correlated with changes in the supply of seafarers. In this context, the H_9 hypothesis is rejected. The relationship between the supply of seafarers and trade in ocean economy-based services (imports) is shown in Figure 14.

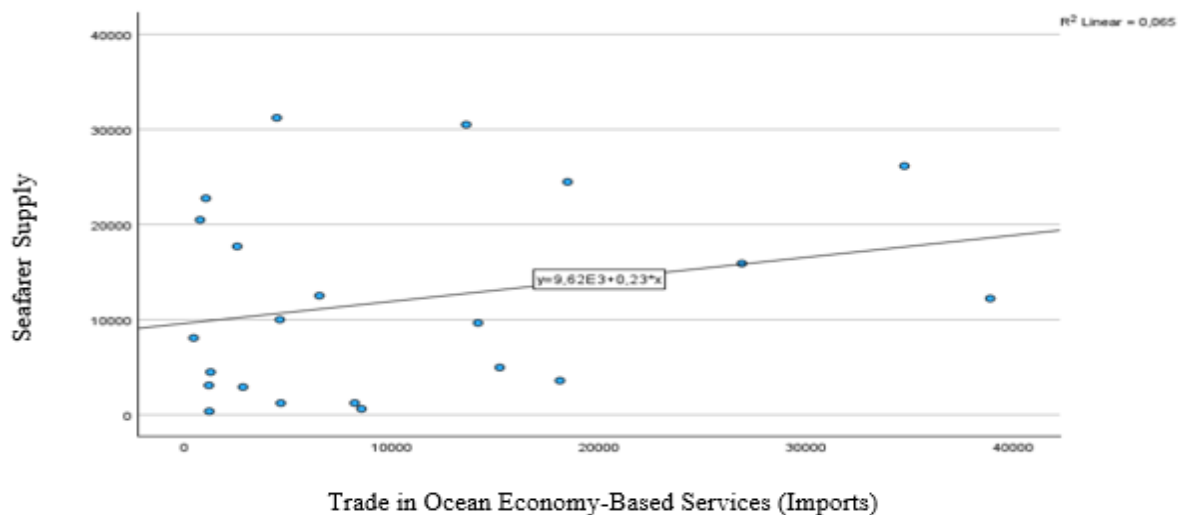


Figure 14. *Correlation Relationship Between Seafarer Supply and Trade in Ocean Economy-Based Services (Imports)*

The relationship between the supply of seafarers and trade in ocean-economy-based services (exports) was measured using a Spearman correlation. A moderate ($r=0.355$, 0.30 - 0.70) and positive correlation was found between the supply of seafarers and ocean-economy-based services trade (exports). Moreover, there is no statistical significance between the supply of seafarers and trade in ocean economy-based services (exports) ($p=0.105$, $p>0.10$). A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The significance testing resulted in a p-value of 0.105 , which is greater than the alpha cutoff of 0.05 ($p>\alpha$). This means that there is no significant relationship between the seafarer supply and trade in ocean-economy-based services (exports) variables, and that the likelihood of the association being due to chance exceeds 5% at the 95% confidence level. The absence of a statistically significant relationship between seafarer supply and ocean-economy service exports indicates that no generalizable correlation exists between these variables. This suggests that the supply of seafarers may exhibit a structure independent of the level of service exports. In this context, the H_{10} hypothesis is rejected. The relationship between the supply of seafarers and trade in ocean economy-based services (exports) is shown in Figure 15.

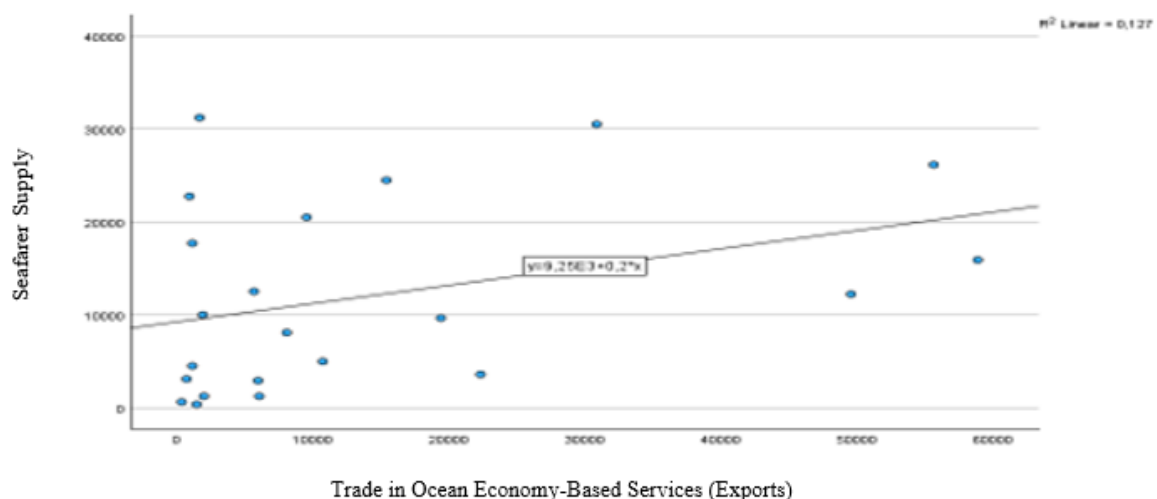


Figure 15. *Correlation Relationship Between Seafarer Supply and Trade in Ocean Economy-Based Services (Exports)*

The relationship between the supply of seafarers and the liner shipping connectivity index was assessed using a Spearman correlation. A low ($r = 0.185$, 0.01 - 0.29) and positive correlation was found between the supply of seafarers and the liner shipping connectivity index. Moreover, there is no

statistical significance between seafarer supply and liner shipping connectivity index ($p=0.411$, $p>0.10$). A hypothesis test was performed at a 95% confidence level, with $\alpha = 0.05$ as the margin of error for the test. The significance testing resulted in a p-value of 0.411, which is greater than the alpha cutoff of 0.05 ($p>\alpha$). This means that there is no significant relationship between seafarer supply and the liner shipping connectivity index variables, and that the likelihood of the association being due to chance exceeds 5% at the 95% confidence level. The absence of a statistically significant relationship between seafarer supply and the shipping connectivity index indicates that there is no systematic correlation between the two. This finding suggests that there may not be a systematic relationship between a country's level of integration into maritime transport and changes in the supply of seafarers. In this context, the H_{11} hypothesis is rejected. The relationship between the supply of seafarers and the liner shipping connectivity index is shown in Figure 16.

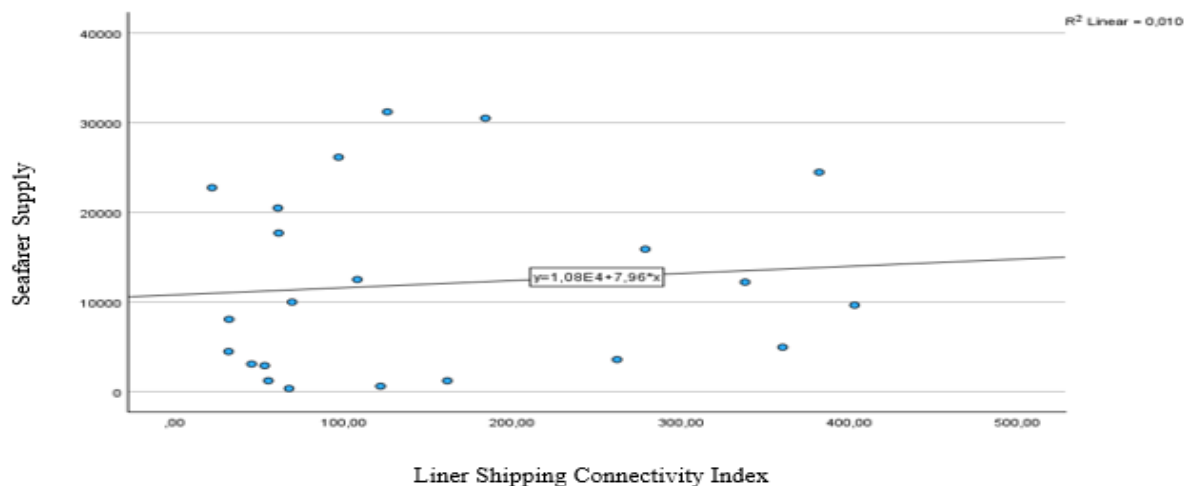


Figure 16. *Correlation Relationship Between Seafarer Supply and Liner Shipping Connectivity Index*

When these findings are evaluated together, it is observed that the supply of seafarers exhibits stronger, more systematic relationships with labour market indicators. In contrast, its associations with macroeconomic variables remain weak and statistically insignificant. This suggests that seafarer supply is more consistently associated with labour-market structural characteristics than with aggregate economic indicators. In particular, the significant relationships with labour force participation, unemployment, and youth labour dynamics indicate that demographic and structural labour-market conditions shape maritime labour supply. In contrast, the absence of statistically significant relationships with GDP, trade volume, and economic growth indicates that seafarer supply does not exhibit a consistent association with macroeconomic performance. In this context, the findings highlight the greater explanatory relevance of labour-focused and sector-specific perspectives in understanding seafarer supply.

CONCLUSION

This study has explored the intricate relationships among seafarer supply, labour force dynamics, and economic indicators across the maritime sectors of 22 European Union coastal countries. The analysis indicates that seafarer supply is more closely associated with selected labour market indicators than with macroeconomic indicators.

The findings reveal a statistically significant, moderate, and positive relationship between seafarer supply and key labour force indicators, including the number of unemployed, labour force participants, and young unemployed individuals. These results emphasize the importance of robust human resource management strategies, recruitment efforts, and training systems to mitigate the growing labour shortages in the sector. However, although moderate relationships were identified between the supply of seafarers and several economic indicators—such as GDP, import volume, and ocean economy-based service trade (exports)—these relationships were not statistically significant. This suggests that economic indicators alone do not fully capture the dynamics of seafarer supply.

The comprehensive literature review also underscores the necessity of a holistic approach to maritime human resources management that incorporates organizational culture, technological innovation, national policy frameworks, and multicultural crew management strategies. Future competitiveness in the maritime industry will rely on proactive talent acquisition, digital transformation, and the fostering of resilient, innovative work environments.

Given the anticipated ongoing shortage of seafarers, as reported by international organizations, this study reinforces the urgent need for sustainable labour force planning, enhanced maritime education and training, and strategic international cooperation. Addressing these challenges is essential for the maritime sector's future and ensuring the stability and growth of global trade networks that depend heavily on maritime transport. On the other hand, the projected increase in demand for seafarers must be assessed in the context of rapid digitalization. While automation and smart ship technologies may reduce the demand for traditional manual roles, they may also increase the need for seafarers with digital and cybersecurity skills. This suggests that the statistically significant labour market relationships we have observed (such as those between unemployment and labour force participation) may evolve into a more complex structure, with skill mismatches becoming the primary challenge rather than simple supply-and-demand figures. Therefore, to ensure the sector's resilience, future policies must prioritize initiatives for developing digital skills.

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DeepL Write and Grammarly were used solely for grammar, spelling, and fluency editing during the preparation of the English manuscript. The tool was employed only for language polishing; all scientific content, analyses, interpretations, and conclusions were produced and verified entirely by the author.

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