Deniz Taşımacılığı ve Lojistiği Dergisi
2022, 3(1)

Review Arcticle

Investigation of Turkish Ports Within the Scope of Port Location Selection and Green Port

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Article Submitted
15 December 2021
Article Accepted
31 January 2022
Available Online
31 January 2022

Keywords
Maritime
Port
Site selection

Abstract

Ports are closely related to the economy of both the country and the neighbouring countries, especially the region they are located in. Countries whose economic power is based on maritime trade should attach great importance to the selection, construction and development of new ports in order to meet the increasing import and export volume and market demands in the developing and changing world trade with technology. Otherwise, it will be difficult for countries to compete economically in the market, especially in their foreign trade. Climate, raw materials, energy, transport, land, market, strategic situation etc. the selection of a port location to be made by considering the criteria will make great contributions to the development of the regional economy. In addition, it is thought that making the most suitable choices for the environment, considering the concept of a green port, which is still a popular topic, with a proactive environmentalist approach in its construction, will also play a role in encouraging the protection of the ecosystem in which the port is located throughout its lifetime. In this study, Turkey's main ports were examined by using a comprehensive literature review, taking into account the concept of green ports.

1. Introduction

From past to present, ports have a very important place in maritime transport. Ports that serve ships carrying cargoes subject to maritime transport are built by making huge infrastructure investments. After a port is built, it carries out its economic activities for many years. One of the most critical processes for the port investments to reach the planned targets is the correct selection of the port location. Since ports are multidimensional structures, there are many and different types of criteria to be considered in site selection.

Port strategy and legal processes, especially the approach to environmental safety and security practices, have been common study topics in this area in recent years (Adams et al., 2009; Canbulat, 2014; .Teerawattana and Yang, 2019).

The aim of this study is to reveal the criteria taken into account in the selection of port location in the literature, to determine the methods used in port location selection and to examine how ports are evaluated in the context of green ports. Thus, it is aimed to contribute to the planning of port facilities, which are planned to be built in the coming periods, as more accurately as possible.

Due to the environmental problems seen recently, more environmentally friendly port activities and the concept of green port have emerged. For this reason, the evaluation of ports within the scope of the concept of green port has been examined in detail under a separate heading from port location selection.

Turkey is a country with a total coastline of 8,333 km. As of 2020, there are 180 port facilities and piers operating under 71 Port Authority in Turkey (DGM Statistics Bulletin, 2020). These facilities are generally located in or near the centers of cities. For this reason, pollution arising from ships and port operations will primarily affect urban life negatively. In addition, they have the potential to cause damage to the ecosystem by causing irreparable

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http://dx.doi.org/10.52602/mtl.1037262

pollution problems in the seas. Therefore, it is aimed to reduce the negative effects of ports on the environment by taking a proactive approach with the concept of green port and establishing an effective management system that includes the preference of renewable energy and recyclable materials within the scope of sustainable and environmentally friendly development, with an effort to protect nature and reduce pollution. The main components of the green port policy are; ecosystem protection and improvement, reducing emissions affecting air quality in ports, cleaning port and coastal waters, cleaning the port floor, cooperation with stakeholders and organizing necessary trainings, carrying out port site design, management practices and operations, establishing port design, operation and management systems within the scope of sustainability (Türklim, 2013). In this context, in the light of the export and import data provided by the Ministry of Transport, the Ministry of Commerce and the customs directorates, Turkey's important port regions have been evaluated in the context of the choice of port locations and the concept of green ports.

In this part of the study, the selection and importance of the port location and the concept of green port are mentioned and information about the purpose of the study is given. In the second section, the studies on port location selection were compiled and the most important criteria and methods in these studies were tried to be determined. The advantages and disadvantages of the multi-criteria decision methods used in these studies are given. In the third section, information is given about eco-ports, green port policies, environmental improvement targets of important ports in developed countries within the scope of green ports, international legislation on green ports, environmental performance evaluation methods of ports according to the green port concept and green port studies in Turkey. In the fourth section, some important ports of Turkey are evaluated in terms of location selection and green port concept. In the fifth section, it has been concluded that the port area of interest in the port location selection affects the criteria and analysis method to be used, and information about Turkey's position and situation in the academic studies and field applications on green ports in the world. In addition, a port to be built with a general site selection road map, which is tried to be reached in the study, accelerates the economic, infrastructure, superstructure development of the region, country and neighboring countries, as well as sustainability in terms of ecosystem and green harbor as a result of medium and long-term strategies for climate and environment-friendly development. Considering the importance of studies on this subject and the importance of studies on this subject, it is revealed that more contributions should be made to the literature.

2. Port Location Selection

Two types of questions arise regarding the location selection of ports: (1) which criteria should be taken as a basis for port location selection? (2) in which methods should the determined criteria be processed and the most suitable port location should be decided? Therefore, in this section, previous studies were compiled to seek answers to both questions, and the criteria and methods that were mostly taken into account were tried to be determined. Since the determined criteria and the chosen method directly affect the decisions taken, it is very important to make these two critical decisions correctly.

2.1. Port Location Selection Criteria

The application of multi-criteria analyses is an important development in port site selection studies. Although it contributes a lot, it is focused on the expectations of the senders (Slack, 1985).Port costs are an important criterion for companies in large-volume transportation where it is essential to benefit from economies of scale (Wiegmans et al., 2008).

Various studies have been carried out regarding the selection of port location in different geographies of the world and criteria specific to the region have been determined. For example, Hasanzadeh et al. (2013) determined ecological, economic and social criteria in their study for the location selection of the oil pier in the Persian Gulf. Zavadskas et al. (2015) For port location selection in the East Baltic Sea, access to the port by rail, access to the port by road vehicles, industry interest in the port, space use efficiency, preservation of natural coastal areas, impact of rail access on existing settlements, construction cost, port expansion capacity, ease of access of ships to the port, competition with other ports in the Baltic Sea, storage capacity, port area operational efficiency criteria. In another study, three topographic criteria such as tide level, land use and coastline change were used for port location selection on the Thi Vai river in southeastern Vietnam (Nguyen et al., 2021).

For different regions of Turkey, many studies have been conducted on port location selection for various port types. These studies are listed below in chronological order:
In the study conducted to determine the most suitable place for Ro-Ro transportation on the European Side of

Istanbul, the criteria were taken into consideration such as public benefit, distance from city traffic, environmental compatibility, proximity to loading/unloading points, land transportation connection and total costs (Yıldırım, 2006).

Two factors affecting port location selection; can be expressed as regional and local factors. Regional factors that affect port location selection, proximity to international maritime traffic, (Hinterland), incentives, taxation practices, proximity to energy sources, regional wage policy, integration with other transportation modes, strategic and political situation of the region, if any status of other ports, proximity to the market, expansion possibilities, economic suitability for industrial development and industrial investments, labor force, climate, land costs, etc. can be counted as. As local factors, ground surveys of the region are one of the most important items in the port location selection. In these studies, previous geological findings and maps, geophysical methods and technologies are used. While a soft ground on which dredging can be made is preferred, the bearing capacity of the ground on which the port structures will be built should be sufficient. In terms of marine factors, the current and the associated shallowing possibilities (heels, etc.), tides, tsunami probability, changes in water level (bathymetry) should be evaluated very well. For İstanbul Silivri port, economic factors, transportation opportunities, topographic features of the region, geological and geomorphological factors and mineral deposits of the region were examined as site selection factors (Koldemir, 2008).

The criteria determined for the port location selection for Ro-Ro transportation in the Marmara Region are regional factors (feasibility, future maritime trade potential of the region, land transportation, military reasons, political reasons) and local factors (topography and bathymetry, dredging, wave characteristics, water depth, geological factors, icing, stream, sociological factors, other ports in the region, economic factors, meteorological factors) were evaluated in two categories (Yaran, 2009).

Karaca (2009) used economic feasibility study (establishment location analysis, port hinterland, marketing dimensions, transportation opportunities, geological structure, meteorological situation, traffic demand forecast), technical feasibility study (structures of ports on the sea and land sides, port equipment) and financial feasibility study (port investment cost, port operating cost, net present value criterion, benefit/cost ratio, internal efficiency method) in the selection of port location in her study.

According to the study conducted using the port hinterland, the structural features of the port and the transportation system preference factor, it has been revealed that the Gebze-Derince port area is the most suitable location in terms of combined transportation (Erdem, 2012).

İzmit region came to the fore in the port location selection, which was made considering regional factors (proximity to international maritime traffic, hinterland, incentives, climate, labor supply, land and railway connection) and local factors (bathymetric characteristics, construction costs according to the terrain, prevailing wind). Kavlakçı, 2014).

In another study on ports, regional factors such as economic viability, future maritime trade potential of the region, availability of land transportation, military and political reasons, topographic and bathymetric information, dredging, wave characteristics, tidal wave, tsunami, wind waves, water depth, geological local factors such as factors, icing effect, stream and solids transport along the coast, sociological factors, experiences that can be obtained from other ports and sea structures in the region, economic and meteorological factors with Legal factors such as laws, regulations and communiques regarding the coast, coastal facilities and ports in Turkey have been taken into account (Öner, 2015).

For the container port in Izmir and its vicinity, cost, sustainability, performance and physical conditions has been considered as the main criterion as the factors affecting the establishment location (Özel, 2018).

Cost, sustainability, performance and physical conditions was used as the main criteria in the study on port location selection in the Western Black Sea region (Pekkaya and Bucak 2018).

In the study conducted on the port need in the Kapıdağ Peninsula, geomorphological features, socio-economic status, earthquake risk of the region, road and rail transportation, bathymetric features, climatic features with the status and capacities of the existing ports in the region were taken into account (Erdönmez, 2019).

As in this section, when various studies on port location selection are examined, the criteria most commonly taken as a basis for port location selection are presented in Table 1.

Table 1. Port location selection criteria.

Main Criteria	Sub Criteria	Explanation
Regional Factor	Proximity to Market	The distribution of the demands in the region according to the services to be provided by the port operators is very important for the effective and economic performance of the services.
Regional Factor	Transportation and Transportation Facilities	Transport factors and cost are very important in the cost calculation of services. Therefore, transportation possibilities should be evaluated well in the construction of the port area. In the service cycle of the port, the integration of the highway, airway and railway with its hinterland is extremely important for the goods to reach their exit and departure points.
Regional Factor	Labor and Regional Wages	When choosing a port, it is necessary to pay attention to the fact that there are many working days, that it is qualified and cheap.
Regional Factor	Expansion Possibilities	Warehouses and stockyards in the port area should be designed to serve handling speeds that may change in the future.
Regional Factor	Proximity to Energy Sources and Traffic Nodes (Strategic Situation)	Proximity to energy sources and traffic nodes will make it easier to compete by reducing service time and cost in the port's service cycle.
Regional Factor	Incentives, Tax Practices, Investment Suitability, Political and Military Situation, Bureaucratic Practices	The support, exemptions and facilitating practices of the region or country where the port is planned should be analyzed well for the cost and construction process. The political and military conjuncture should be well evaluated in terms of future projections of the port.
Local Factor	Climate, Meteorological Situation	The climatic conditions of the region to be established for the construction of the port should be analyzed. (Min-max and average temperature values, wind force, humidity, precipitation, frequency of natural disasters, currents and tides, geophysical condition of the seabed)
Local Factor	Ground Properties, Geological Condition, Land Costs etc.	First of all, topographic and bathymetric data should be analyzed well. (The fact that the region is mountainous, the sea is shallow, if there is a current, the possibility of heeling etc.)
Local Factor	Marine Factors	In the place where the port will be built, the undercurrent and shallowing situations should be well analyzed against the situations that require high cost such as waves formed by the winds, tides, earthquake waves and tsunami probability, dredging.

2.2. Port Location Selection Methods

In this section, analysis methods used in port location selection are compiled. When various studies are examined, some of the methods used in port location selection are presented in Table 2. When the studies are examined, it is understood that multi-criteria decision-making methods are used almost entirely in port location selection, and these methods are rarely accompanied by geographic information systems.

Due to the advantages that AHP provides to the user, its usage area is seen as a common method. According to Tüminçin (2016), the advantages of AHP are; Because it divides the problem into simple structures, it is easy to understand the content, complex, multi-criteria and multi-person problems can be structured hierarchically, complex problems can be simplify, qualitative and quantitative criteria can be handled together, the consistency of the decision maker's judgments can be tested, consensus can be easily reached and the results obtained can be reliable. determined as high rate. According to Karabacak (2012), the disadvantages of AHP are listed as making it difficult to create comparison matrices if the number of criteria and alternatives is high, requiring a clear definition of criteria, and comparisons taking a long time if the decision maker is a group.

Table 2. Methods Used in Port Selection.

Writer	Subject	Method
Slack(1985)	Containerization, Inter-Port Competition and Port Selection. Maritime Policy and Management	Deadwood (DW) Survey
Yıldırım (2006)	Ro-Ro port location selection for İstanbul	AHP
Wiegmans et al., (2008)	Port and Terminal Selection by Deep-Sea Container Operators. Maritime Policy & Management	Decision Making Theory
Koldemir(2008)	The Importance of Regional Economy, Coastal Geology and Geomorphology in Selecting a Port Location in the Marmara Region: Silivri Port	Case Study
Yaran (2009)	Ro-Ro port location selection in Marmara Region	Analytical Network Process
Karaca (2009)	Site selection for ports	Feasibility Studies
Hadipour et al. (2012)	Pier site selection in coastal areas	Geographic Information Systems
Erdem (2012)	Port location selection for combined transport	Fuzzy AHP
Hasanzadeh et al. (2013)	Oil pier site selection in the Persian Gulf	Analytical Network Process
Kavlakçı (2014)	Determination of the most suitable port area alternative	Fuzzy AHP / Fuzzy TOPSIS
Zavadskas et al. (2015)	Port location selection in the East Baltıc Sea	AHP / ARAS-F
Öner, 2015)	Ports and Turkey Practice in Maritime Trade	Feasibility Study and Literature Research
Pekkaya and Bucak(2018)	Regional Port Establishment Site Selection with Multi-Criteria Decision-Making Methods: An Application in the Western Black Sea Region	PROMETHEE, TOPSIS and VIKOR
Özel (2018)	Determination of container port location around İzmir	VIKOR
Erdönmez (2019)	Port Locating Process in New Port Construction: The Case of Kapıdağ	Expert Consultation
Nguyen et al. (2021)	Port location selection on the ThiVai river in southeastern Vietnam	Geographic Information Systems / AHP

The advantages of the TOPSIS method can be listed as follows. It is one of the best ways to indicate the change in rank among alternatives when a non-optimal alternative is proposed. Since it gives the closest result to the positive ideal solution and the farthest to the negative ideal solution, it is based on a logical idea compared to other simple weights. It is an intuitive method that is easy to implement and simple to understand. The method is the best and most successful method in order change. After the evaluation of the distances to the ideal point between the minimum and maximum values that the determined criteria can take, ranking can be realized thanks to the TOPSIS method. The method is a method with increasing or decreasing utility tendency of each criterion among the alternatives. It is used in many areas because it provides an important support to decision makers. The method has some advantages as well as some disadvantages. The effect of uncertainty on decision criteria is an important problem encountered in the decision-making process. In the method, it is necessary to assign an initial weight for each of the criteria. The results obtained in the method can sometimes contradict the basic ideas. If the weights of the criteria are too small, the distance between the criteria and the negative ideal solutions may increase (Kallo, 2015; Özdemir, 2015: 134; Koyuncu ve Özcan, 2014). The ARAS method was developed by Zavadskas and Turskis for the solution of multi-criteria decision making problems. In the method, the optimum values and the utility function values of the decision options are compared (Zavadskas & Turskis, 2010: 159-172; Shariati vd., 2014: 411; Özbek, 2018a:35).

VIKOR can be used to make a decision or rank alternatives in case of conflicting criteria. The decision maker is responsible for approving the final solution. At the same time, they can add their own preferences to the final solution (Kuzu, 2015). The decision maker can also weight the criteria with his own judgment. An initial weight must be assigned for each of the criteria. In addition, it is necessary to know not only the weights of the determined criteria, but also whether they are a benefit or a cost element. The method identifies compromise solutions that help the decision maker reach the final decision in the ranking and selection of alternatives. It gives not only a single ordering, but also the compromise solutions of the orders. The decision maker can see the best alternative or alternatives. It is an easy-to-understand method with simple results, which has been used in many fields in recent years. Feasibility studies are based on the investigation of the project's technical, financial and economic data in

order to determine the economic potential and practical feasibility of a project. Feasibility studies should be done before the final investment decision is made and implementation projects are prepared. Its biggest advantage is to provide predictability and to help final decision makers take the right decision by examining all aspects of an investment idea, by making comprehensive analyzes and evaluations accompanied by relevant data and information. Its disadvantage is that the results it will reveal in an incomplete evaluation have the potential to overshadow advantageous investments and may mislead decision makers.

ANP is a method that helps to model and solve decision problems that cannot be modeled hierarchically. In the ANP method, first of all, a network structure related to the problem should be created. While creating the network structure, the internal and external dependencies between the criteria in the problem should be determined correctly. Then, as in the AHP method, pairwise comparisons and then consistency analyzes are performed. Local priorities obtained as a result of pairwise comparisons are combined in a supermatrix structure to obtain global priorities. By taking many exponents of the supermatrix, the limit supermatrix is obtained and a more effective decision is made than AHP by choosing the alternative with the highest importance weight (Çakın E. 2013).

Geographic Information System (GIS); Complex social, economic, environmental etc. on the world. It is a set of hardware, software, personnel, geographical data and methods that perform the functions of collecting, storing, processing, managing, spatial analysis, querying and presenting large volumes of geographic data to assist users in decision-making processes based on space/location for the solution of problems. With Geographical Information Systems, studies are carried out on database creation, querying, statistical and geographical analysis and their display. In addition to these studies, the advantages of Geographic Information Systems are; to reveal spatial and other spatial information in a holistic way in a single system, to include the most appropriate structure for querying and analysis of geographic information, by creating maps and spatial information in digital form. To provide diversity in extracting and displaying new and complex data from existing information (Ünaldık 2019).

3. Green Port

Eco-ports have become the main environmental initiative of the European port sector to address current environmental challenges. The overall aim of eco-ports is to raise awareness of environmental challenges, ensure regulatory compliance and set a high environmental management standard (Sotiris, 2017). Supporting this situation, port operations, which include environmental approaches, have been at the forefront in the policy determination processes. In addition to institutions that take an active role in determining policies such as governments, international or national organizations, maritime companies, like port owners and shipowners, are eager to make their organizations environmentally friendly "green port" (Canbulat, 2014).

The main components of the green port policy are as follows: improving air quality, improvement of energy consumption, noise pollution, deep dredging (seabed celaning and deepening), improvement of water quality, compliance and cooperation with local administrators, optimization of port development, disposal and recycling of waste from ships, planning of port waste management and dust pollution in port (Köseoğlu ve Solmaz, 2019).

Green port practices that emerge within the scope of sustainable and environmentally friendly development are based on volunteerism. With this policy, it is aimed to reduce the negative effects of ports on the environment by establishing an effective management system that includes the preference of renewable energy and recyclable materials, with an effort to protect nature and reduce pollution. The main components of the green port policy are; ecosystem protection and improvement, reducing emissions affecting air quality in ports, cleaning port and coastal waters, cleaning the port floor, cooperation with stakeholders and organizing necessary trainings, carrying out port site design, management practices and operations, establishing port design, operation and management systems within the scope of sustainability (Turklim, 2013).

It is possible to see the applications of green ports in the ports of the developed world. For example, the Port of Rotterdam is one of the largest port operators in the world in terms of annual handling capacity. It is the port that started the first concrete studies against exhaust gas emissions in 2007. In order to combat climate change, the Rotterdam Climate Initiative has established the Rotterdam Climate Initiative-RCI. Goals; To reduce CO2 emissions to half of 1990 levels by 2025, prepare for climate change and strengthen Rotterdam's economy. Another example is the Port of Amsterdam, which started to use wind and solar energy in order to prevent air pollution and save energy, and built biodiesel facilities in the port areas. In the Port of Hamburg, on the other hand, in 2011, the vehicles carrying the port personnel were converted to electric vehicles instead of diesel, and they set successful

examples in terms of carbon emissions and energy efficiency. It has been reported that they aim to convert all diesel-powered port equipment to electric motors in order to reduce carbon emissions by 40% by 2020 (Turklim, 2013). At the point reached today, exhaust emissions still exist as an environmental threat. Today, a significant part of port equipment (MHC, RTG, etc.) is powered by electricity. However, the exhausts of land vehicles coming to the port to take cargo continue to affect the air quality (Turklim, 2021).

3.1. Current International Legislations Regarding Green Port

Policies should protect and improve the marine ecosystem, reduce the emission intensity and values in the air, ensure the cleanliness of ports and coasts and spread awareness on green practices and approach, design, manage and operate port areas with the idea of being green, as well as reducing the negative impacts on the environment. and reducing energy consumption by increasing the use of renewable and environmentally friendly energy sources (Ateş and Akın, 2014; Anastasopouos et al., 2011; Türklim, 2013).

The expected impact from the Horizon 2020 tender is to achieve zero emission port operations by 2030. Accelerating the delivery of sustainable alternative fuels and electro-mobility in transport, energy storage, waste heat recovery in ports, promoting clean energy on-site, fuel production and distribution (especially clean hydrogen and electricity), as well as refueling and recharging possibilities. There are alternatives for fuel supply. These applications will also help improve energy-efficient and smart port operations, eco & smart logistics, low-emission intermodal integration, and reduce emissions impact for cities while improving cooperation with ports. All these results will enable ports and cities to commit and contribute to innovative solutions, including the development of follow-up actions (Görgün and Bardakçı, 2020).

The Green Deal Communication advocates rail and inland waterways as sustainable modes of transport for transport. It was also emphasized in the Green Agreement that sea and short-distance sea transport can be as effective as rail and inland waterways in providing an alternative to road transport (Bedük F., Aydın M. E., 2012).

On the other hand, some technical studies related to the use of electricity, which have an important share as much as air pollution minimization and waste management policy in the green port establishment, are handled within the scope of eco-ports. As a matter of fact, cold-ironing is one of the applications that increase the air quality and reduce noise pollution in ports, but the lack of international standards and the use of different voltages and frequencies in the electricity supply systems of different countries create limitations in the use of this technology (Turklim, 2021). Therefore, the electricity supply network is one of the most important green port establishment criteria in the technological context. In addition, the use of LED lighting system in port equipment, the use of renewable energy resources such as solar energy, hydraulic energy, biomass, geothermal energy, tidal energy, wind energy and hydrogen energy are important technical details for the green port establishment.

By supporting the growth of the transportation sector as of 2050, the European Union has stated among its priority targets to reduce CO2 emissions from ships by 40%. An action plan has been created within the scope of the EU twinning project for the control of ship-sourced emissions in Turkey. The "Climate Change Action Plan, CCAP" aiming to reduce carbon dioxide emissions was accepted. Within the scope of CCAP, it is envisaged to increase the use of "alternative fuel and clean vehicles" until 2023, and to make legal arrangements that encourage foreign-flagged cargo and passenger ships using our ports to reduce their emission (Şenol S., 2020). Table 3 lists the international legislation regarding green port policies.

3.2. Environmental Performance Evaluation Methods of Ports in Accordance with The Green Port Concept

In the review article, which was prepared quite comprehensively on the studies on the green port in the world, qualitative analysis methods were used in 53% of the studies, mathematical analysis methods in 18%, statistical methods in 9%, multi-criteria decision-making methods in 8%, fuzzy logic methods in 6% and simulation in the remaining 6% methods have been used. Most of the studies were carried out for Turkish ports. These methods used are bibliographic research, fuzzy AHP, fuzzy DEMATEL, fuzzy logic, entropy analysis, factor analysis, content analysis, statistical analysis, mixed methods, literature research, mathematical calculations, panel data analysis, simulation, SWOT analysis, case analysis, data envelopment. are face-to-face studies. Green port criteria are air pollution, water pollution, soil pollution, noise pollution, sustainability, waste management and disposal, energy management, dust and odor management, cold ironing and slow steaming, incentive and penalty practices in port fees, modal shift and intermodality, dangerous making an emergency plan for loads, use of automation

systems, compliance with the legislation and participation in social responsibility projects, providing environmental awareness training to employees, taking OHS precautions, designing green ports and ships, monitoring environmental quality, paying attention to professional competence and making financial liability insurance. (Keske et al, 2020).

Table 3. Legislations ensuring the development of green port policy (Turklim, 2013; Köseoğlu and Solmaz, 2019).

International Legislation	Purpose
1949, Coast Protection Act	To allow and control sea-related works in waters suitable for maritime transport.
1964, Harbours Act	Providing management for the sustainable development of ports, providing financial support for maintenance-repair and improvement.
1972, London Convention	Convention on the prevention of pollution of the seas by wastes and harmful substances.
1973/1978MARPOL, International Convention on the prevention of pollution from ships	Prevention of operational and accidental pollution in the seas. It includes rules for the control of petroleum, bulk toxic liquids, packaged toxic liquids, ship-derived waste, wastewater and chimney emissions.
1987, Dangerous Goods Regulation in Ports	It includes regulations to control the transport, loading, unloading and storage activities of all dangerous goods.
1990, Environmental Protection Act (EPA.)	To establish legal regulations for waste management and emission control.
1992, Transport and Work Act, (TWA)	In addition to the 1964 Port Act legislation, it includes regulations that emphasize environmental problems and impose responsibilities on port authorities.
2001, European Eco-Management and Audit Program, (EMAS).	It includes regulations for developing policies to improve and support the environmental and financial situations of businesses.
2004, Environmental Management System Standard ISO14001:2004.	It includes regulations within the scope of effective use of natural resources, Reduction of damage to the environment and reduction of wastes arising from production.
2012, ESPO Green guide (European Sea ports organisation)	Guidance on green port practices to member states, port stakeholders and managers, and the public.
2015, ISO14001:2015	An updated version of the environmental management system within the scope of changing and developing dynamics.

3.3. Green Port Efforts in Turkey

These facilities are generally located in or near the centres of cities. For this reason, pollution arising from ships and port operations will primarily affect urban life negatively. In addition, they can cause serious pollution problems in the seas that are difficult to compensate and cause damage to the ecosystem. Many port facilities in Turkey are located close to the city centre. Accordingly, the impact of the port on the city (traffic density, exhaust emissions, noise, etc.) brings the people of the city and the ports face to face from time to time. Sea and air quality may decrease due to activities originating from ships and ports. In order to minimize this environmental risk, the ports take a series of precautions during both investment and operation phases.

Before mentioning the green port, practices operating in Turkey, it would be appropriate to give information about the locations and current status of the ports in Turkey. As of 2021, there are a total of 206 coastal facilities serving coastal facilities in Turkey. Although the forms and features of these facilities are different from each other, the service purpose is determined according to their features. 44% (90 units) of these facilities continue their activities in the Marmara region, 24% (50 units) in the Mediterranean region, 18% (36 units) in the Black Sea region and finally 14% (28 units) in the Aegean region is doing. If we need to specify the ports that serve maritime trade on a provincial basis, there are 35 in Kocaeli, 21 in Istanbul, 20 in Hatay, and finally 11 in Izmir. The characteristics, sizes and capacities of these ports are different from each other (Turklim, 2021). The fact that port activities are so intense in Turkey, which has the peninsula feature surrounded by seas on three sides, is of course expected and desirable considering the trade volume. A total of 484.1 million tons of cargo was handled at Turkey's ports in 2019, of which 224.8 million tons were loaded and 259.2 million tons were unloaded (Turklim, 2021). At this point, it is seen how essential it is for ports to operate as green ports. Green port practices, which are both environmentally friendly and contribute to the ports economically in the long run, are currently based on volunteerism in Turkey. Green port applications in Turkey started with the Green port / Eco port cooperation protocol dated 16.12.2014 signed between the General Directorate of Maritime Trade (DTGM) and the Turkish Standards Institute (TSE) within the body of the Ministry of Transport, Maritime Affairs and Communications (UDHB) (TSE, 2014). The protocol is currently still valid. Currently, the current name of the Ministry and the

Directorate officially is the Ministry of Transport and Infrastructure (UAB), the General Directorate of Maritime Affairs.

Esmer et. al. (2010) analyzed the lean and green dimension of a Turkish port through simulation and determined the optimal number of cargo handling equipment. Ateş and Akın (2014) presented the green port legislation and the certification process required for a green port in Turkey. In order for ports in Turkey to have a green port certificate, it is necessary to obtain the ISO 14001 certificate by the Ministry of Transport and Infrastructure of the Republic of Turkey (Bal, 2014).

It is observed that port operators, which are at the top in terms of cargo handling capacity in Turkey, adopt green port practices and are in the process of developing environmentally friendly practices. The ports of Asyaport, Aksaport, Marport, Borusan Lojistik, Ege Ports, Petkim Port, Bodrum Cruise Port, Solventaş Port, Ford Otosan Port, Evyap Port and Kumport, Kuşadası are the ports that are entitled to use the "Green Port" logo and title (IHA, 2015; Koşar Danışman and Özalp, 2015; Akgül, 2017; Satir and Dogan-Saglamtimur, 2018). Green port certificates issued by the Ministry of Transport and Infrastructure in Turkey are valid for five years as of the date of issue and must be renewed every year. Coastal facilities must apply for renewal within the scope of the relevant legislation two months before the expiry of the validity period of their certificates (UAB, 2021)"

12 of the ports located in the Sea of Marmara have a green port certificate (Yakan Dündar, 2020). Other ports should also continue to operate within the scope of green ports. For example, according to the study by Yalılı Kılıç and Adalı (2020), the noise level from ships at the passenger port in Bursa-Mudanya exceeds the green port criteria.

As a result of the work carried out within the scope of carbon footprint and green port in Limaş port operation, it has been seen that the transition to led lighting and the use of E-MHC are applications that are compatible with the green port understanding and increase the environmental quality in the port. Apart from this, for the continuation of the activities in the port with a more environmentally friendly approach; It has been evaluated that renewable energy sources such as solar energy should be used and that electricity and LPG should be used as an alternative to the use of diesel in vehicles other than mobile port cranes (Gültepe Mataracı, 2016).

It is to determine and prioritize the performance factors of green port applications by taking expert opinion with the DEMATEL method in enterprises that have received green port certificate in Istanbul. It has been determined that the most important of these criteria are "Sustainable Environmental Management", "Minimum Pollution" and "Minimizing Waste". On the other hand, it has been determined that the least important criteria are "Reducing Greenhouse Gas Emission", "Reducing Clutter in Transport Movements", "Noise Reduction", "Creating Better Transport Structures", "Managing Pressure in Nature", "Increasing Distribution Efficiency", "Reducing Accidents and Injuries" and "Reducing Land Transport Intensity at an Economical Level" respectively (Korucuk and Memiş, 2019).

As a result of their study, Köseoğlu and Solmaz (2019) identified incompatibilities in some of the criteria for being a green port in Turkey, according to international standards, and presented new regulation proposals for green ports in Turkey, criteria for being a green port and certificates.

4. Evaluation of Some Important Ports of Turkey in Terms of Site Selection and Green Port Concept

Aliağa Port has a national and international strategic importance in terms of its geographical location. According to the study, Aliağa Port is located on the route of the ships that organize expeditions between the ports of Turkey on the Mediterranean, Aegean, Marmara and Black Sea coasts in cabotage (domestic trade) transportation; In import, export and transit transportation, its connection with the ports of the Black Sea, Mediterranean and Western European countries, and its connection to the Indian Ocean Road by following the Suez Canal and the Red Sea increases its importance in maritime transportation (EroğluveBozyiğit, 2013). In addition to all these data, the fact that Aliağa Port is located in the center of the city constitutes the biggest negative aspect. The port affects the urban transportation negatively and also causes environmental and noise pollution when evaluated within the scope of green port.

Ambarlı Port, which is the port that handles the most containers in Turkey, is at an important point in terms of having the industrial power of Istanbul behind it and providing nourishing services to the Black Sea ports.

Industrial piers of public and private institutions are located in the Marmara Region, around Ambarlı and in the Gulf of Izmit. This is a factor that improves the location advantage for both Ambarlı and Kocaeli ports. The connection of Trans-European and Pan-European trade routes with Turkey is important for Marmara ports. At the same time, the fact that Haydarpaşa Port cannot be used actively pushes customers to this port. The acquisition of Kumport Port by Cosco Shipping in 2015 also increases the strength of this port in terms of commercial corridors. However, this port puts a heavy load on the Istanbul highway traffic, which is already busy due to its location. Access to Ambarlı Port can only be provided by sea and road. Since a railway infrastructure entering the port area is not available at the port, the connection between the railway and the hinterland, which is extremely important for the ports, could not be provided.

Asyaport Port was built in Tekirdağ to operate a container port and was put into service in 2015. With a depth of 18 meters, a dock of 2010 meters and a capacity of 2.5 million TEU, it is on the scale of world ports. Asyaport was planned and built as an international transit port (as a main port-hub port) (Piber, 2014).One of the important location advantages of the port is that it is in a position to prevent large ships coming from Europe, Africa, America or Arabia from getting stuck in the Bosphorus traffic. At the same time, it is in a position to relieve the possible congestion of Ambarlı Port and the ports in Kocaeli. Turkey's largest commercial and industrial cities such as Istanbul and Kocaeli are also located near the port.

Kocaeli Port is Turkey's industrial and port city due to its location. It includes terminals and industrial piers serving many different freight groups. In addition, being in the Pan-European and Trans-European corridors increases the competitiveness of the port. The shift of industrial establishments from Istanbul to Kocaeli is also a factor that increases the hinterland area. It is the third largest container handling port in Turkey. It connects Anatolia and Istanbul with its coast to the Black Sea and the Sea of Marmara, and its location in the gulf and transit passageways (Bayraktutan and Özbilgin, 2013). However, Kocaeli port is more congested than other ports in terms of road traffic density.

It is at an important point for trade in the Middle East region in the Eastern Mediterranean. With its strong hinterland connections, Mersin International Port is in good connection with the inner parts of the Turkey (Coşkuntuncelve Rad, 2015). Mersin Port is a main port for the industrial and agricultural power of the Eastern Mediterranean region. In addition to being on important sea route routes, Mersin Port is connected to industrialized cities of Turkey and neighboring countries such as Syria, Iraq and Iran by rail and land. According to Merk and Bağış (2013), Mersin Port has given more positive signals in recent years about being a main port, unlike most ports in the Eastern Mediterranean, due to its location. At the same time, it provides service with large capacities in a location very close to ports that are used extensively in international transportation such as Port Said and Haifa ports. This increases the location advantage of Mersin Port. However, besides these advantages, the port also has strategic disadvantages. As a result of the global conjuncture, both the pandemic and the constraints of the price-money system, the economies in the places where there is a marketing opportunity are shrinking. Thus, strategically emerging opportunities are limited by threats.

When Tatvan port is evaluated in terms of green port criteria, the conclusions are as follows: Lake Van is a closed lake, pollutants entering the lake are in a state of continuous accumulation. There may be a mixture of waste oils, domestic and hazardous wastes from the maritime transport of the Ferry Company, which has at least a century of history, into the lake. Pearl mullet, the only endemic fish living in the lake, is consumed as food by people in the basin. Pollutants participating in the food chain can reach people and threaten public health. In this respect, environmental practices should be implemented as soon as possible without wasting any time, and environmental impacts should be managed by creating projects and supports in order to achieve the title of green port (Ilık, 2020).

5. Conclusion

When the case studies are examined, it is seen that economic, social and environmental constraints affect the solution. On the other hand, protecting the environment for future generations and efficient use of resources can

be stated as a summary of environmental sustainability. Economic activities should not threaten natural ecosystems with limited resources and capacity. In this context, logistics centres, which save energy and resource use in the location selection model within the scope of green ports, are an important solution alternative for regions disadvantaged in terms of air pollution, traffic congestion and emissions. Thanks to the consolidation and connection of low-emission transport modes to be provided by logistics centres, greenhouse gas emissions caused by transportation and transportation activities will be reduced.

Based on the findings obtained, the criteria that will guide the construction of a new port can be reached from the said port investigations. As a matter of fact, while it cannot be expected that a port will have all the criteria at the same time, all of the port preference criteria have similar importance weights. In particular, the difference between port location, port fees and port infrastructure criteria is around 1.5%. This showed that there is no indispensable criterion for the selection of the main port within the scope of the study, and that all criteria must be found in the main port concept in a relationship. The importance weight of the proximity to the market and hinterland criteria was found to be 23.6%. Because proximity to the market and hinterland are related to how full the ship can leave the port at a point or how close it is to customer or industry needs. This criterion has been found to be the most important port selection criterion in many studies in the literature on port selection and the order of importance of port criteria. Right after this comes the port location criterion. This criterion is a criterion that directly affects the operational cost of the ship. The location of the port must give the ship a minimum deviation from its main course. At the same time, this criterion is closely related to proximity to the market and hinterland. As it can be understood from here, due to the technical and financial extra costs of the green port implementation, as well as the sanction burden of the green port implementation legislation, the location and proximity to the market criteria are much more decisive than ecological factors in the selection of the port establishment location.

On the other hand, when the relevant literature is evaluated; It can be said that there are few studies on which criteria should be considered in order for ports to receive green port certification, and besides, very different criteria are considered in these studies, that is, there is no unity. When this literature is examined in general; it can be said that the criteria of air pollution, water pollution, energy management and waste management come to the fore. It is natural for these criteria to come to the fore, as environmental issues are primarily considered in almost every sector that aims to alleviate the intensity of pollution, which is increasing day by day. In future studies, the potential of ports to be green ports can be evaluated. From this point of view, it can be suggested as a suggestion for ports that do not have green port certification to consider successful green port examples as role models. In addition, it can be said that the use of Multi-Criteria Decision Making (AHP, VIKOR, TOPSIS, ELECTRE etc.) techniques will give more accurate results, since it is a subject that requires consideration of both numerical and non-numerical criteria for studies to evaluate green port performances. In this context, it can be stated as another suggestion that ports should perform benefit, opportunity, cost and risk analysis and this can be resolved by the Analytical Network Process-Benefit, Opportunity, Cost and Risk (ANP-BOCR) method. In addition, the DEMATEL Method, which is frequently used in considering the relationships between the criteria, may be one of the techniques that researchers may prefer. However, it can be stated that the studies are generally published in journals such as "The Asian Journal of Shipping and Logistics, Transportation Research Part" and "Research in Transportation Business & Management" and that researchers may turn to these journals. As a result, the ever-decreasing resources and increasing pollution have brought the concept of sustainability to a more important dimension. The concept of sustainability, which is based on meeting the needs of the present generation without ignoring the needs of future generations, has made the ecological environment a priority and a demanded criterion in almost every sector. Green port and green logistics activities aiming to protect the environment can be given as examples. In this context, when environmental sustainability awareness is considered, the necessity of increasing the number of studies related to it emerges.

"In this study, a heterogeneous expert group consisting of experts from different interests and professions was formed. As a further study, the similar problem is addressed by the Regime Switching Fuzzy Analytical Hierarchy Process (RS-FAHP), which requires several homogeneous groups of experts to determine how results change depending on the perspective of different expert groups. On the other hand, analyzing the port location regardless of the terminal type may be the biggest limitation of the study. In this context, a study has been planned to determine the most suitable port location with its influencing factors, taking into account each terminal type such as container, liquid bulk, dry bulk and passenger."

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