

**Implementing green port policies for the sustainability of the Egyptian ports:  
Case Study (Damietta Port)**

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Received: March 3, 2023; Accepted: March 16, 2023; Available online: March 18, 2023

**ABSTRACT**

Seaports are the link between countries through maritime transport networks all over the world. They also promote international trade and support global economic growth. However, it represents a source of environmental pollution through emissions to air and water pollutants from maritime transport activities and is also linked to climate changes, energy consumption and noise generated, which entails many challenges faced by decision makers on how to address the effects of environmental risks associated with ports environmentally, economically and socially. Therefore, the concept of green ports can help decision-makers to address the expected challenges and problems, as the green concept mainly presents three aspects of operations within ports and development planning, including energy conservation, environmental protection and care. The idea of seeking to use the concept of green ports to address the extent to which potential environmental threats to Egypt's marine environment have worsened by applying to the port of Damietta, which is an ongoing challenge for future generations and has multiple impacts on our social, cultural and economic values as well as on our natural and physical environment. That is why the importance of this study came to work on trying to employ the concept of green ports to face the extent of the exacerbation of the impact of potential environmental threats to ports, which represents a continuous challenge for current and future generations and has multiple effects on our society, cultural and economic values, as well as on our natural and physical environment. The port of Damietta was chosen as a case study to apply the concept of green ports to it, due to its importance for the local and international trade.

**Keywords:** Green ports - Green policies - Port sustainability - Damietta – Egypt.

**INTRODUCTION**

Ports refer to developments accommodating large deep draft ships requiring basin and channel depths of 10m and more, while Harbours refer to facilities designed for light draft vessels needing basin and channel depth of 5 to 10m (EEAA, 2005). Ports are the backbone of international trade and the main engine of globalization. Now they play a bigger role than just processing goods on the wharf. They have become platforms that contribute to shaping social and environmental performance around global transport systems. Their management and

operational strategies are intertwined with environmental, social and economic regulations across many scales and in many areas from local to global.

Sustainable development is directed at the interdependence of environmental, social and economic systems and promotes equality, justice and global citizenship, (Dalal-Clayton and Bas, 2002; Komiyama and Kraines, 2008). Besides achieving environmental balance (including health of natural ecosystems, depletion of raw materials, climate change), With sustainable economic stability, social

development and equity (Gavrilescu and Chisti, 2005; Vezzoli and Manzini, 2008).

### Theoretical background

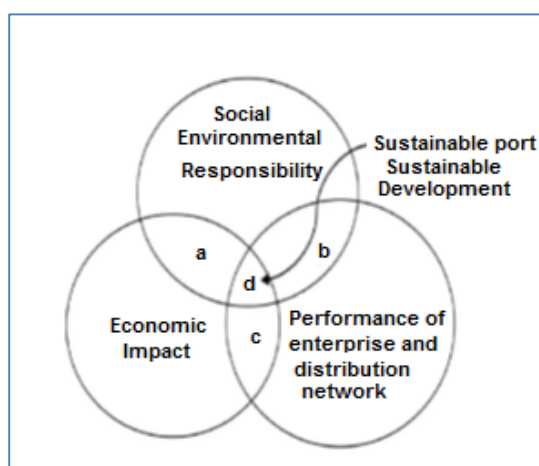
#### The concept of sustainable development

Sustainability can be defined as "a process of change in which the exploitation of resources, the channelling of investments, the direction of technological development and institutional change are all harmonious, and enhances both current and future possibilities for meeting human needs and aspirations, i.e. meeting the needs of the present without compromising the ability of future generations to meet their needs (Brundtland, 1987; Gavrilescu and Chisti, 2005).

Sustainable development guides the interdependence of environmental, social and economic systems and promotes equality, justice and global citizenship (Dalal-Clayton and Bass, 2002; Komiyama and Kraines, 2008). To incorporate the so-called triple bottom line of environmental balance (including natural ecosystem health, raw material depletion, and climate change), as well as long-term economic stability, socioeconomic development, and equity (Vezzoli, E.Manzini, 2008).

#### Green Port and sustainable development

The concept of sustainable port development is defined when a port is able to meet its own needs without jeopardizing its future (ESPO, 1995). In light of the connections between ports, transportation activities, people, and nature as indicated in Figure (1), the green port strikes a balance in the relationships between environmental, social, and economic performance. Resources must be used efficiently, adverse effects on the regional environment must be reduced, environmental management must be improved, and the environment in the port area must be improved in all decisions relating to the construction and operation of the port (Jiuh-Bing *et al.*, 2013). Therefore, green port can be defined as a port that performs its activities and causes minimal damage to the environment and society, and provides measures to improve and control the quality of air, water, noise and waste (Chen *et al.*, 2019). Also, the term "green port" refers to a port with sustainable development, which balances economic and environmental interests and ensures that port socio-economic growth does not outpace the capacity of the corresponding natural system.



**Fig. (1). Concept of sustainable port**  
Source: (Jiuh-Bing *et al.*, 2013).

#### Port problems for sustainability

Analysis of the Environmental Report of ESPO (2020) through the

European Port Sector's for the period 1996 to 2019 (Table 1) indicated that energy consumption was the second

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environmental issue during 2016. The most serious environmental challenges associated with ports during 2019 were deterioration of air quality , the resulting substantial socioeconomic consequences. Climate change appeared as the third priority in 2019 followed by noise of port operations , relations with the local

community and the effectiveness of building cooperation and strengthening relations with the neighbouring community, handling of ship's waste and waste from port activity, port land development and seabed-related port operations, dredging operationnd finally water quality.

**Table 1. The environmental priorities of European ports during the period 1996 – 2019**

priority	1996	2004	2009	2013	2016	2017	2018	2019
1	Port development (water)	Garbage / port waste	Noise	Air quality	Air quality	Air quality	Air quality	Air quality
2	Water quality	Dredging operations	Air quality	Garbage / port waste	Power consumption	Power consumption	Power consumption	Power consumption
3	Dredging disposal	Dredging disposal	Garbage / port waste	Power consumption	Noise	Noise	Noise	Climate change
4	Dredging operations	Dust	Dredging operations	Noise	Relationship with local community	Water quality	Relationship with local community	Noise
5	Dust	Noise	Dredging disposal	Ship waste	Garbage / port waste	Dredging operations	Ship waste	Relationship with local community
6	Port development (land related)	Air quality	Relationship with local community	Relationship with local community	Ship waste	Garbage / port waste	Port development (land related)	Ship waste
7	Contaminated land	Hazardous cargo	Power consumption	Dredging operations	Port development (land related)	Port development (land related)	Climate change	Garbage / port waste
8	Habitat loss/ degradation	Bunkering	Dust	Dust	Water quality	Relationship with local community	Water quality	Port development (land related)
9	Traffic volume	Port development (land related)	Port development (water)	Port development (land related)	Dust	Ship waste	Dredging operations	Dredging operations
10	Industrial effluent	Ship discharge (bilge)	Port development (land related)	Water quality	Dredging operations	Climate change	Garbage / port waste	Water quality

Source; (ESPO, 2020)

### Drivers and pressures leading ports to achieve sustainable green strategy:

A range of challenges arise in terms of providing effective port services, taking advantage of their unique location and reducing global environmental problems (Luoand and Yip, 2013). According to Cusano (2013) the main Challenges for 21st century ports include the following (Fig. 2) :

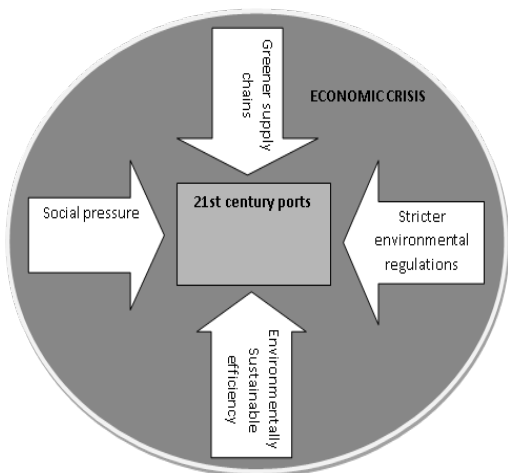
- Increase citizenship's awareness of the negative impact of port operations and external factors (especially in the case of proximity of port to densely populated areas).

- To impose stronger restrictions in many regions of the world in order to monitor and mitigate port incidents.

- Supply chains have become greener and the port as part of the chain must react/adapt to this situation.

- Maintaining competitiveness requires a strong balance between social and environmental efficiency and sustainability.

- All of these issues exist in an economic setting defined by the current economic crisis, which has an impact on the policy and decision-making processes connected with the surrounding pressures.



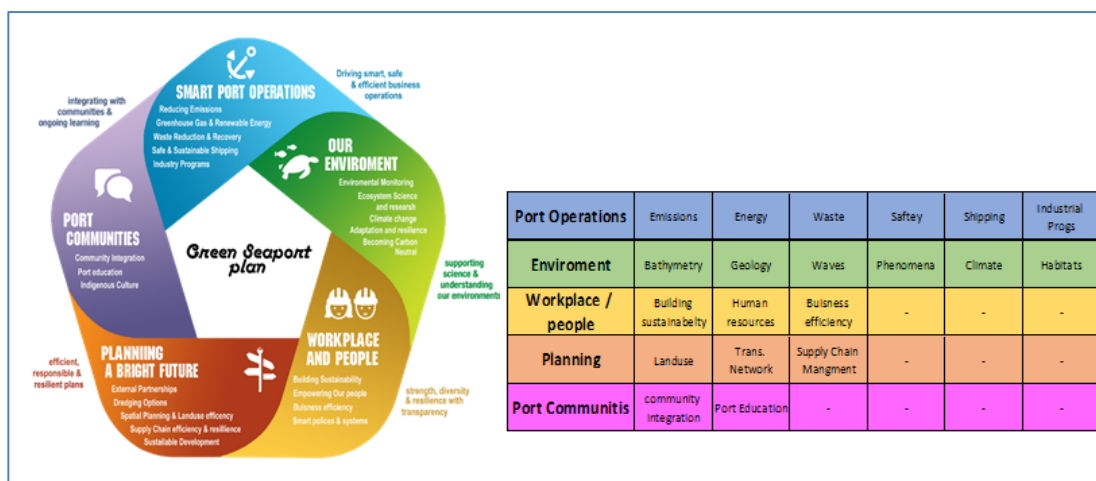
**Fig. (2). Challenges for 21st century ports**  
Source: (Cusano, 2013)

**Stages of implementation of sustainable green ports**

There are various steps that may be taken to make a port "greener" and to access the design of a green logistics system, all of which are intended to reduce the negative impacts on the port's environment and achieve a "greener" status as a method of creating and running port operations to minimize environmental deterioration, loss of biodiversity, and unsustainable use of natural resources. Effective economic performance, environmental sustainability, and social justice can be achieved by paying attention to resource efficiency, investment orientation, technology advice, and institutional transformation, (Jiuh-Bing *et*

*al.*, 2013). The green port approach can be achieved through sustainable planning for five phases as shown in Figure (3) as follows:

- Smart processes based on alternative fuels, renewable energy and waste recycling.
- Environmental changes with adaptation and resilience to the surrounding environment.
- The port's spatial and human efficiency rates.
- Planning for a bright future by increasing the efficiency of land use, transport hubs and movement.
- Achieving community participation in the port and upgrading the human component educationally and culturally.



**Fig. (3). Green ports plan.** Source: (NQBP, 2023)

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### Sustainable Green Port Policies

The balances relationships between ports and transportation activities as well as between people and nature are essential to the development of sustainable green port policy. These must increase all variables relating to resource efficiency, port construction and operation, and environmental impact reduction, as well as environmental management and the environment quality in the port region. These policies aim to create a green logistics system that will reduce the negative effects on the port's environment;

to implement cleaner production techniques that will decrease waste and emissions while improving product production through waste reuse; and to implement environmental control, protection, and security measures as well as sustainable port development based on low resource consumption. There are five criteria that boost application ease and balance social, economic, and environmental dimensions in order to maximize the policies of a sustainable green seaport (Taih-cherng *et al.*, 2013) as shown in Table (2).

**Table (2). Factors for achieving sustainable green seaport policies**

Proposed polices	Objective of the proposed policy	Proposed policy implementation variables
<b>1. for port operations</b>	Smart processes based on alternative fuels, renewable energy and waste recycling.	- Hazardous Waste Treatment - General waste treatment
<b>2. for environment</b>	Conserve the environment by observing environmental changes, adaptation and resilience to the surrounding environment.	- Preventing air pollution - Soil and sediment rolls - Improved water quality - Reduce noise
<b>3. for workplace and human resources</b>	Increase the port's spatial and human efficiency rates.	- Selection of suitable materials - Water consumption - Reduce energy consumption
<b>4. for port planning and operation</b>	Planning for a bright future by increasing the efficiency of land use, transport hubs and movement.	- Modern Environmental Trends of Green Ports - Wildlife Improvement - Marine Life
<b>5. for the port community</b>	achieving sustainable	- Community Promotion and Education - Training of port staff

Source: (Taih-cherng *et al.*, 2013)

### Research Problem

Due to the port responsibility for local and global environmental pollution especially climate change through shipping activities, the concept of green ports has become increasingly important around the world to mitigate and avoid he impact of potential environmental threats to the marine environment. Therefore, it is important to predict the impacts of seaports on Egypt's coasts and the work to understand the potential consequences through applying the concept of green port policies so as to mitigate and avoid

negative impacts and threatens on the sustainability of development. Also, what are the green port policies to be applied by the Egyptian authourties to develop and operate ports for Egypt's future shipping .

### Research Objective

The research seeks to ivestigate applying green port policies to Egyptian ports (Damietta Port as case study) in order to sustain the planned development strategies for the maritime transport sector while avoiding negative environmental repercussions. Therefore, the current study will discuss the following points:

I-International conventions, evidence and laws on port environmental protection procedures with global experiences

II-Key factors derived from global experiences in implementing green port policies

III- The current situation in Egyptian ports

IV-Egypt's port strategies to achieve greener concept

V-Implementation of green port policies

for the sustainability of Egyptian ports on the case study of Damietta port

## METHODOLOGY

The current study methodology depends on applying the descriptive analytical approach and using the comparative analytical method in the chosen case study. It was summarized in Figure (4).

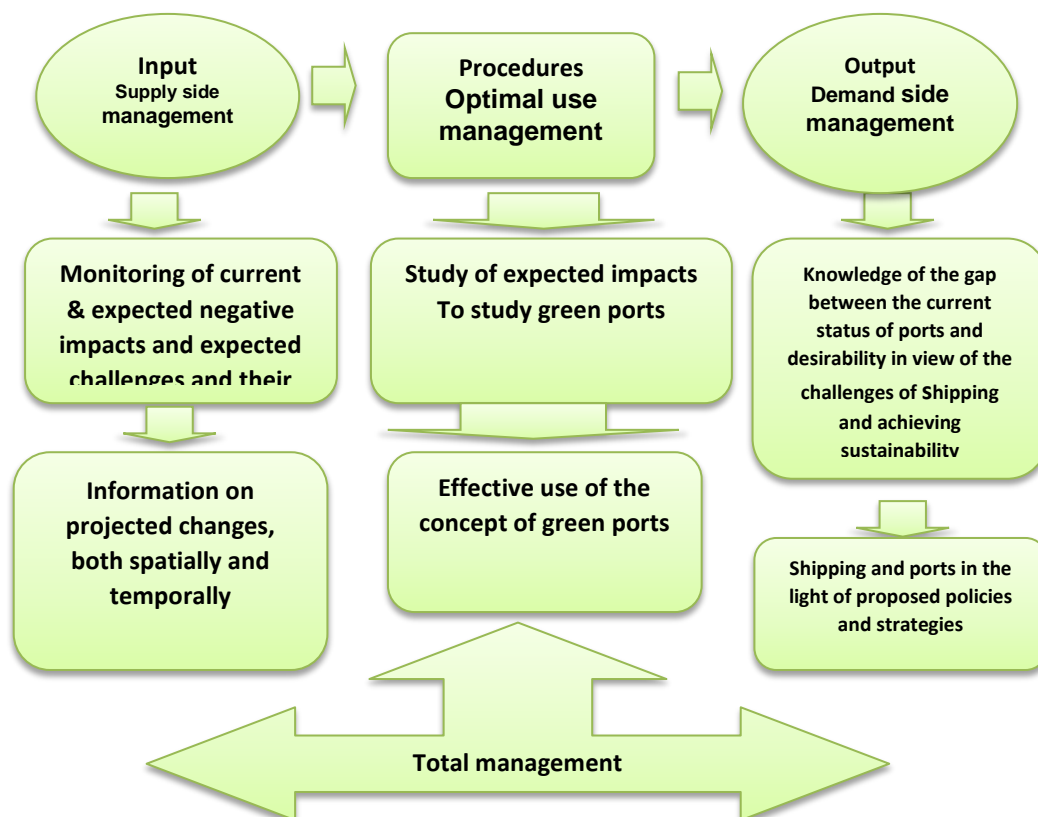


Fig. (4). Methodology of the research. Source: Prepared by authors.

## RESULTS AND DISCUSSION

**I-International conventions, evidence and laws on port environmental protection procedures with global experiences**

Diverse studies have been conducted in international experiments that have been interested in the work of policies (Tseng and Pilcher, 2019; Yahya, 2019; initiatives (Jasmine, *et al.*, 2019; RUSJUNA, 2020) and programs (Jusoh *et al.*, 2017) as well as the development of a set of tools, approaches, and indicators (Lawer *et al.*, 2019) in order to accomplish the

sustainable development of seaports. A few international legislations created by the Global Authority have served as standards for environmental protection (UNCTAD, 2016). The most important global actions, programs and studies to achieve sustainability of ports are as follows:

Initiatives: covered by port policies in the US, Azerbaijan, India, South Korea, Singapore, and Malaysia (RUSJUNA, 2020; Abeng, 2020).

• Classification of global ports according to their significant programs and strategies:

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the top 30 global ports (Jasmine et al., 2019) were chosen according to the following:

- Basic Ballast Water Management as given in BWM 2004 Convention.
- Fuel quality supply for ships at ports
- Electricity and Fuel Saving Initiative which includes: Variable Flow Cooling Air Conditioning System (VRF), Curbside Lighting Project, and LED System Application
- Environmental techniques and initiatives, including the adoption of marine protected areas, beach cleaning and mangrove cultivation, quarterly environmental control and, finally, waste management.
- Green Port Programs: Where Countries have diversified programs to implement Green Port Principles in North America, India, Malaysia and Singapore (Jusoh *et al.*, 2017) .
- Tools, techniques and indicators (Lawer *et al.*, 2019) including: infrastructure techniques, pricing, integrated management approaches were summarized in the study of a number of ports at Europe and West Africa.
- International conventions such as:
  - MARPOL Convention for the Prevention of Marine Pollution by Dumping of Wastes.
  - International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 1990)
  - International Convention for the Control of Harmful Anti-fouling Systems on Ships
  - Among the many studies published by international or regional organizations on the topic of protection of the port environment

(Yahya, 2019)

- Environmental factors for ports and harbours as given by the World Bank Reference 126/190 (environmental issues to be considered in port and port area management).
- GESAMP's assessment of the environmental effects of port development.
- Port: UNCTAD/SDD/PORT/1, 1993, reports from a project.
- ESPO (2003), which contains ESPO 2003, with a Code of Best Practices in Part III and the Ten Commandments.
- Eco Port: reports from a project supported by the EU that aims to apply environmental management technologies, create standards and databases, and communicate for best practices.

### **II-Key factors derived from global experiences in implementing green port policies**

Lower *et al.* (2019) indicated that for the application of the green port concept it is important to focus on (1) identifying priority tools and indicators to assess the green performance of ports (2) assessment of the benefits of implementing green port policies and initiatives, and (3) identification of tools for the greening of ports, including all instruments associated with policies, initiatives, programs and indicators and (4) finally evaluate initiatives undertaken in ports or cities with ports to improve environmental performance both through transnational port networks and through value chains. In the current study a key global activities for the application of the green port concept were given in Table (3).

**Table (3). Key global activities for the application of the green port concept**

No	Region/ Country	Notable Actions
1	Europe	Improve the self-diagnosis method (SDM). This is an optional process that enables ports to research their environmental policies. SDM is essential for obtaining a PERS certificate PORT. The port's sole environmental management standard for the port sector is called PORT PERS. The ECO Sustainable Logistics Chain Foundation (ECOSLC) now makes PERS accessible to everyone in the world.
2	USA	In order to improve environmental performance and boost economic prosperity, the U.S. Environmental Protection Agency's (EPA) Port Initiative collaborates with the port industry, communities, and all levels of government. Two components are measured: <ul style="list-style-type: none"> <li>• greenhouse gas emissions and air quality in ports</li> <li>• Make ports more environmentally friendly as cargo and people pass through.</li> </ul>
3	Asia	A paper to strengthen the Green Ports Award System (GPAS) was approved by APEC in 2016. Ports that employ strategies to lower port pollution are given the prize.
4	Australia	There is no known direct incentive for the port industry, but the Australian government supports: Goal of 20% renewable energy (RET). And Australian Carbon Fund incentives for energy efficiency

Prepared by authors after (Tseng and Pilcher, 2019; Jusoh *et al.*, 2017; Jasmine *et al.*, 2019; Yahya , 2019; RUSJUNA, 2020).

There are many factors that have contributed to the implementation of green port policies including (1) environmental policy and regulation, (2) economic leverage, and (3) human and technical influence.

Table (4) shows the coverage of the global experiences of these factors, which

was adopted as a main framework determining how to deal with green ports and on which to rely in the applied study of the study state of Damietta port.

The main factors affecting the implementation of green port policies are shown in Table (5).

**Table (4). Coverage of global experiences of the factors required to achieve green port policies .**

no	Region/Country	Environmental Policy and Regulation	Technical Leverage	Economic Leverage	Human
1	Europe	√	√	√	√
2	USA	√	√	√	√
3	Asia	√	√	√	√
4	Australia	√	√	√	√

Prepared by authors after (Yahya , 2019; Tseng and Pilcher, 2019; Jusoh *et al.*,2019; Jasmine *et al.*, 2019; RUSJUNA, 2020).



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**Table (5). Key factors and Policies affecting the implementation of green ports**

Key factors	Policies
Environmental Policy and Regulation	- Adoption of port environmental policies and international accords like MARPOL Regulatory oversight to safeguard the port's ecosystem and lessen possible contamination. Making environmental rules mandatory and gradually implementing a voluntary screening process for port companies to lighten the workload of port authority staff.
Technical Leverage	Developing a good green port environment by utilizing cutting-edge technology in green terminal equipment and ship amenities. The development of sophisticated control systems that can detect possible pollution sources and offer real-time pollution prevention solutions.
Economic Leverage	Employ operational cost reduction incentives to persuade port users to switch to environmentally friendly operating practices and reduce adverse effects on the port environment. Using the carrot-and-stick approach to reward and punishment
Human	Green port operators must have a thorough understanding of potential environmental concerns, limit resource pollution, and exhibit corporate social responsibility in the port environment. Building suitable connections with stakeholders in port communities is helpful in implementing green port policy. Resource dependency theory states that any environmental policies must have the backing of shipping operators to lessen policy implementation hurdles.

Prepared by authors for research from: (Tseng, P.-H., Pilcher, N., 2019)• Jusoh *et al.* (2017; Jasmine *et al.* 2019; RUSJUNA, 2020; Yahya, 2019).

European countries at European Sea Ports Organization (ESPO) have developed evidence and code for green port handling and have identified three top environmental priorities for EU ports: air quality, energy consumption and climate impacts. While some states in North America and Canada focused on supporting the sustainability guide to their ports. There have also been many successful experiences in African countries that have recently begun an ambitious effort to develop a common environment policy or "green port" policy for the region as a joint initiative of the Association of Regional Ports (PMAWCA). The United Nations Environment Programme (UNEP) and the environmental network of non-governmental ports in Africa PENAF have built the green port Network which aims to be one of the world's first ports to implement the Green Ports Strategy in 2009.

It is not unexpected that there are significant regional, temporal, and geographic variations in the ways ports implement green port policies; this shows

that the set of measures ports might embrace evolves as environmental objectives do. Since ports operate in distinctive commercial, political, environmental, and social contexts, their green practices may vary, reflecting factors such as various economic circumstances, significant regulatory priorities for the nation, the availability of funding, and significant environmental priorities. Determining universal criteria to define or characterize a green port is therefore a very political and delicate issue that has the potential to preserve or establish a new hierarchy amongst ports, disadvantageously affecting late arrivals despite their best efforts (Lawer *et al.*, 2019).

### III-The current situation in Egyptian ports

The harmful impacts of several operations that have not considered the environment, particularly in ports with intense activity, continue to harm Egypt's ecosystem. Although the coastal region of Egypt is significant economically and

environmentally, it is also plagued by heavy industrial and agricultural pollution in addition to the effect of noise on the social and cultural environment (Abdel Moneim *et al.*, 2020).

The port sector in Egypt faces numerous challenges, including: (1) shifting global shipping markets; (2) integrating shipping lines; (3) gaps in institutional and political frameworks connected to best practice standards; (4) poor access and limited roads; (5) external obstacles like switching to larger vessels in pursuit of achieve economies of scale; and (6) internal problems such as the need to improve spatial and operational efficiency and introduce modern information technology systems (Martin *et al.*, 2019).

A review of previous studies reveals that environmental quality management systems have a lack of application. The environmental impact of air, water, and the ground surface is not taken into account, similar to the ports of Alexandria and Ain Sokhna (Sobhy *et al* (2020). Pollutants that are solid, liquid, and gaseous are increasing as well. The following issues were identified by Sobhy *et al.* (2020) at Alexandria and Ain Sokhna:

- The Port Authority does not have the capacity to prevent ships from disposing of ballast water in the docks during loading and unloading operations
- Vessels do not use the power platforms on the docks.
- Inability to prevent ships from carrying out their own maintenance work on loading and unloading docks.
- Non-use of LNG in machinery and equipment operations.
- Maintain the use of old devices and diesel instead of electric.
- Not using clean and environmentally friendly energy such as; Solar and wind energy.

#### **IV-Egypt's port strategies to achieve greener concept**

In order to increase investments by generating new investment opportunities and helping to raise the terms of trade between Egypt and its trading partners to support the export file, Egypt's ports have been successful in adopting a number of necessary actions and measures to change their classification from grey to green ports, as follows:

##### **1- The development and modernization of Egyptian ports became at the Centre for Research and Consulting for the Maritime Transport Sector**

SWAT analysis was carried out to know how the Egyptian ports respond to competition factors from other ports in the region to determine their competitive position. In order to improve operational efficiency and lessen reliance on government support, the study analyses the need to adopt a commercially formulated competitive management format while highlighting the significance of increasing private sector participation in port activities. The restructuring of Egypt's ports was the most significant of the 20 economic studies that were compiled on the list, which also included the Egyptian Port Backyard Development Study, Egyptian Maritime Company Fleet Development Study, Human Resources Development in the Maritime Transport Sector, and Economic, Trade and Development Aspects of New Technology in Egyptian Seaports. (aast.edu, 2023).

##### **2- Strategy for the development of the maritime transport sector and ports in Egypt**

By building transportation and logistics hubs connecting seaports, dry ports, and logistics hubs, the Ministry of Transport seeks to transform Egypt into a global energy, trade, and logistics hub at the

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regional, African, and global levels. The development plan is based on the integration of Egyptian ports through the creation of an integrated scheme that includes an investment map of Egyptian ports, the full geographic coverage of Egypt's maritime transport services, and the establishment and development of infrastructure and superior seaports in accordance with market economics and international standards. (JICA, 2023) and General Commission for Information Egypt (sis.gov.eg, 2023).

In addition to qualifying and developing human resource capacities, developing the legislative structure in line with local and global developments, keeping up with international treaties and commitments, securing seaports, and working to upgrade the international

environmental classification of Egyptian seaports to green ports for investment, the National Road and Transport Network links Egyptian ports to investment areas. 25% of Egypt's foreign trade volume can be transferred thanks to the growth and support of the Egyptian maritime merchant fleet, which also helps to advance maritime tourism (JICA, 2023; sis.gov.eg, 2023).

### V-Implementation of green port policies for the sustainability of Egyptian ports on the case study of Damietta port

#### 1- Site Identification

As one of the cornerstones of Egypt's international trade, Damietta Port is one of the most significant Egyptian ports. It lies about 8.5 km west of the Damietta branch of the Nile River, west of Ras Al-Bar, north-east of Damietta New City, and 70 km west of Port Said (Fig. 5).

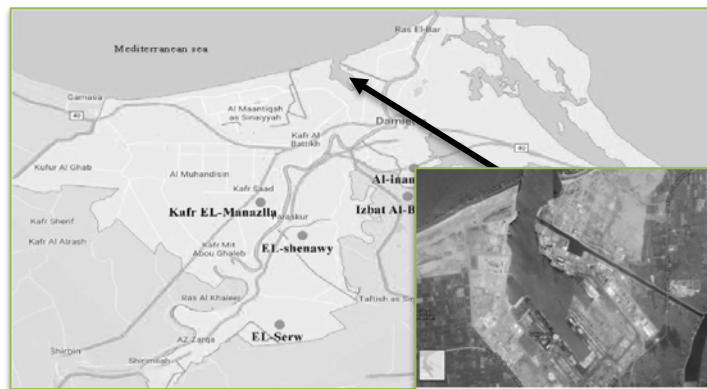


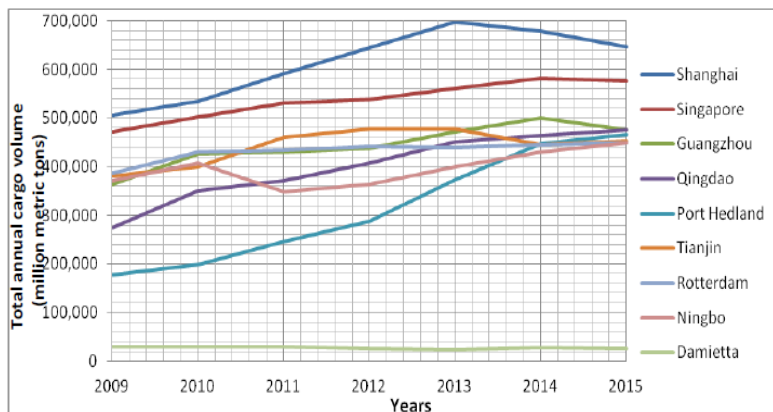
Fig. (5). Map to show the location of Damietta port. Source: (www.dpa.gov.eg)

### 2-Sustainability Challenges at Damietta Port

The port of Damietta experiences numerous environmental issues that keep it from reaching the idea of sustainability, which falls under the following categories:

- Hazardous Waste and General waste:

In comparison to other ports as shown in Figure (6), Damietta Port's annual cargo has decreased over time, and this could be for a number of reasons, including a lack of interest in tailings treatment and the spread of air and water pollution.



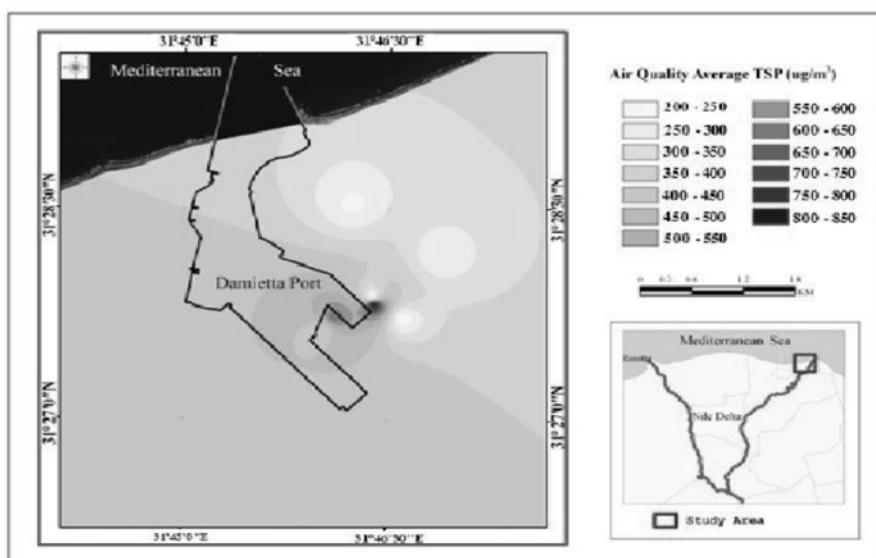
**Fig. (6). Decrease in Damietta port's annual cargo compared to other ports**  
**Source: (Elgohary, 2018)**

- **Water pollution:** the port of Damietta experiences water contamination as a result of sewage waste being dumped nearby, fuel spilling from ships, the flow of cooling water from the electrical plant, and the improper disposal of irrigation drains.

Also, higher seawater exchange rates result in higher total outstanding solids, which disrupt water flow and prevent sunlight from penetrating the water, hurting fish food supplies. Water-stuck solids have an adverse effect on human health, raise the

temperature of the water, reduce the amount of dissolved oxygen, and disseminate an unfavourable environment for aquatic and marine creatures.

- **Air pollution:** The air quality at Damietta Port and the adjacent areas is getting worse, with all registered levels exceeding the AQL (230 mg/m<sup>3</sup>) as shown in Figure (7).
- **Noise pollution:** The proximity of Damietta port to the surrounding urbanization (Fig. 8) causes the spread of noise pollution as shown in.



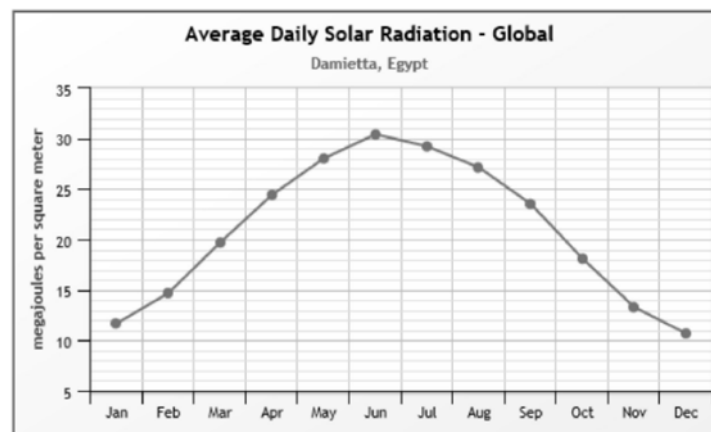
**Fig. (7). Air Quality Index of Port Damietta and Surrounding areas.** Source: (Damaty and Ghanem, 2020)

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**Fig. (8).** Damietta port's proximity of Damietta port to the surrounding urban areas.  
Source: prepared by authors.

- Deterioration of marine life: In vicinity of the port and navigation canal, pollutants alter the chemical and physical characteristics of the water and sediment. Additionally, it caused a swift decline in the quantity of fish larvae and a gradual increase in ammonia, which had a detrimental moral effect on fish farms (egyptindependent.com).
- Energy consumption: The port's average electrical power consumption was 8 MW/day. In the direction of green ports, consumption of conventional and renewable energy will decrease. The average estimated daily solar energy in Damietta is about 4 kWh/m<sup>2</sup> (Fig. 9).

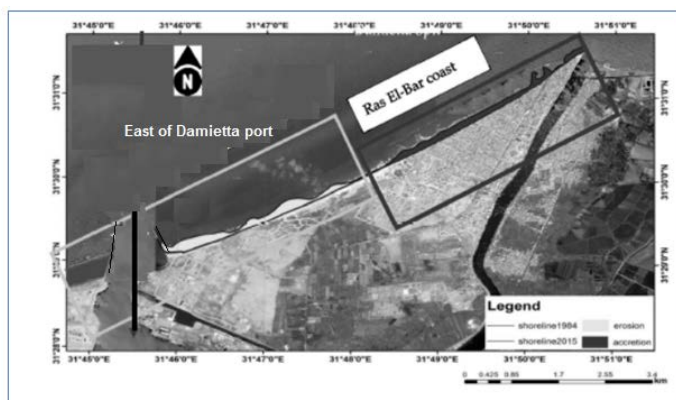


**Fig. (9).** Average daily solar damaging radiation  
Source: (www.weatherbase.com)

- Socio-economic challenges: The surrounding community of Damietta Port needs education and training from port leaders and staff on the concept of green port and how to deal with modern technologies to achieve sustainability (HABITAT, 2001).
- Climate changes and erosion factors: The net annual rate of coastal drift on the western side of the port is about

$1.43 \times 10^5 \text{ m}^3$  (accumulated at an average of 2.13 m/year) while the net annual rate of coastal drift on the east side is about  $2.54 \times 10^5 \text{ m}^3$  (92 m average erosion over the past 45 years). Therefore, the port is threatened by erosion problems along its eastern berth and sediments along

its navigational route (Fig. 10). The direction and depth of the navigation channel is a sinking area that receives more drifting deposits from west to east, reducing the channel's depth from 14 metres to 10 metres, hindering the navigation of ships along the channel (El-Asmar and White, 2002).



**Fig. (10). Erosion and accretion rates on the sides of Damietta port**  
Source: (ZED, 2007)

### 3-Damietta Port Redevelopment in Light of Green Port Policies

The redevelopment of Damietta Port in the context of green port policies is based on tying the existence of advantageous environmental, social, and economic potential to the existence of dangers and constraints that must be handled through attempting to localize the following policies:

#### a- Proposed port operating policies

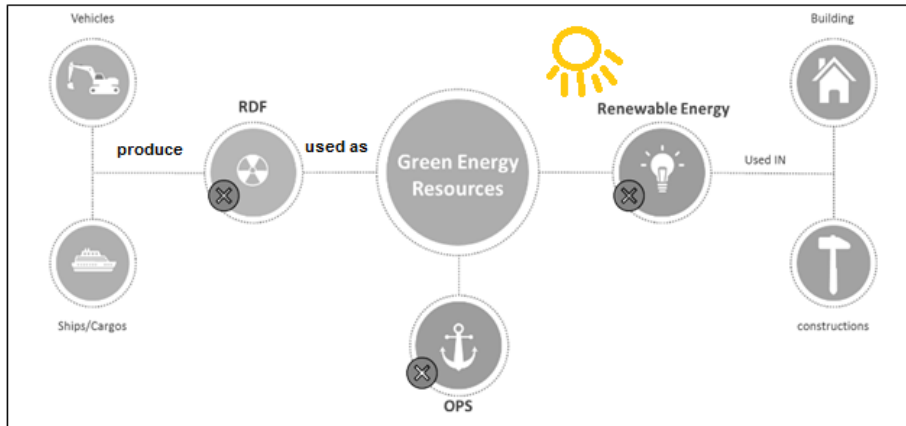
Damietta Port must be managed well, and the proposed policies for port operations must be implemented through the following:

- The problem of ship congestion at the port and the relative lack of development space must be resolved by raising the depth of the docks to 21 metres, allowing ships to receive 18 thousand containers, while also paying attention to the management of shipping and handling operations, which requires taking into account the poor productivity of

containers and public shipping operations.

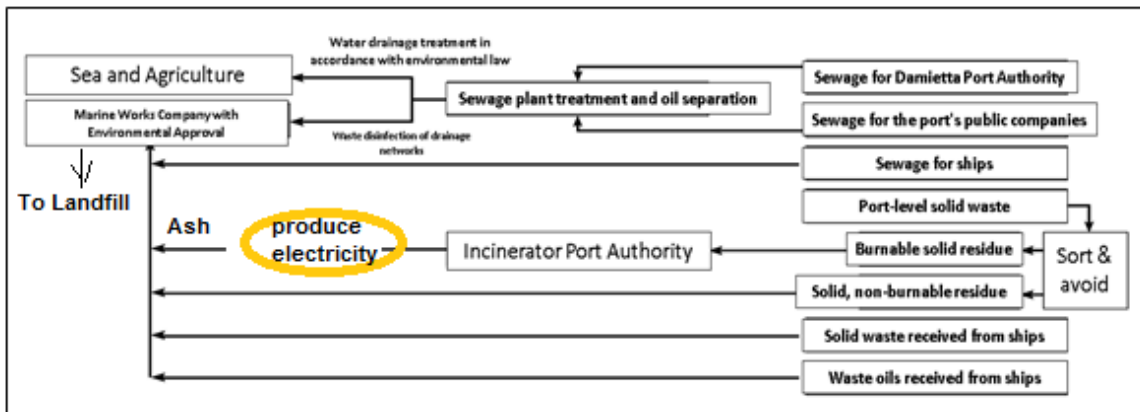
- Boost training or competence in the usage of contemporary technologies or cargo handling systems. Work to supply equipment that controls various processes and incompatible operating systems. Provide incentives to operating organizations to increase productivity.
- Create a new energy strategy that involves working on Damietta's green energy port as a prototype for an ecologically friendly electrical power generation unit and the progressive replacement of conventional electricity sources with renewable energy sources, which can be used to create and consume electricity in port operations using biomass and wastes (RDF) from and photovoltaic cells as indicated in Figure (11).

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**Fig. (11). Green Power to Operate Damietta Port**  
Source: prepared by authors.

- Develop a waste management strategy to ensure the acceptance of all ship wastes, the final safe disposal of ship tailings, sewage tailings, and solid tailings, the promotion of
- environmental awareness in the administration of all waste management-related activities and services, and the adoption of best international waste management practices (Fig. 12).



**Fig. (12). Waste Management Plan at Damietta Port**  
Source: prepared by authors.

**b- Proposed Environmental Policies**

Green port policies strive to improve the environment by reducing air and water pollution and environmental deterioration through the following:

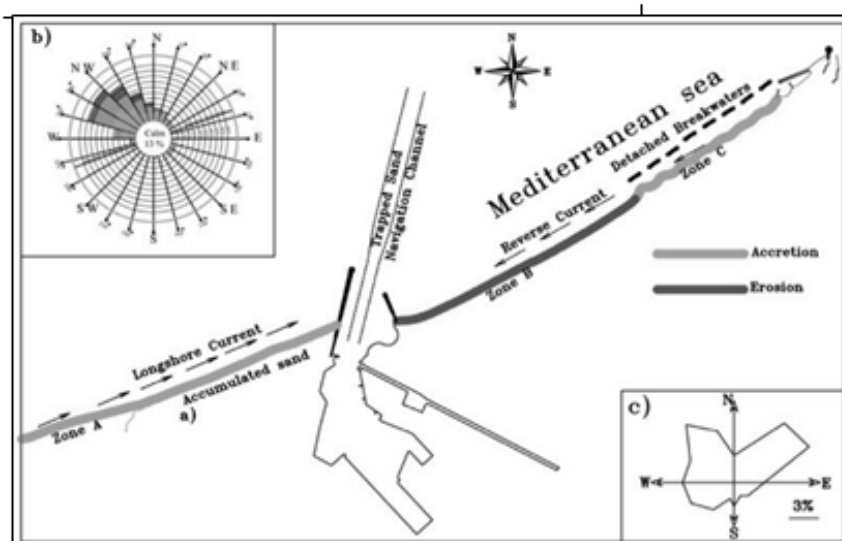
- The requirement to address the erosion phenomenon that contributes to the sedimentation at Damietta Port and to maintain the

depth of the Port as shown in Figures (13 &14) indicated that shoreline will retreat by 390.0 m in some points with an average regression of 280.0 m in 2060 if no sustainable solution for this area is applied.

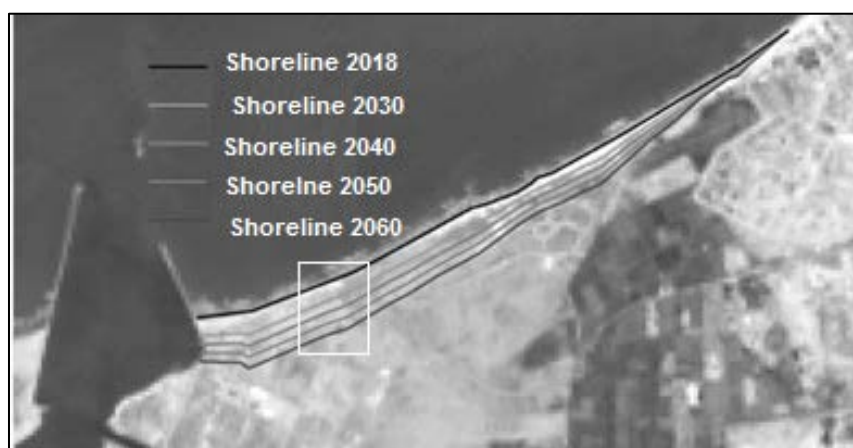
- Enhance water and air quality indicators and increase community

environmental awareness in port region.

- Conserve the ecosystem and fisheries of the area.



**Fig. (13). Addressing erosion in the port of Damietta**  
 a) Erosion/accretion pattern of the study area, b) Wave rose at Damietta harbour;  
 c) Current rose recorded at Damietta port. Source: Ezzeldin *et al.* (2020)



**Fig. (14). The predicted shoreline evolution**  
 Source: Ezzeldin *et al.* (2020)

### c- Proposed workplace and human resources policies

In light of the concern for the sustainability of buildings, operational sites, and work in the port as well as the efficiency in the administration of the port's business operation and based on resources and human cadres trained in environmental awareness, the policies will be designed to achieve safety at the workplace and getting use of the human resources at

Damietta Port in accordance to ILO code of practice: Safety and health in ports (2018).

### d- Proposed port planning and operation policies

A variety of policies need to be implemented with regard to inland and peripheral land uses, as well as the supply chain and communication networks of the port as shown in Table (6).



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**Table (6). Proposed land use recommendations**

Land use		Recommendations
Terminals	container	Construction and operation of the proposed new container station
	general cargo	Optimization of the station's space while allocating more land to the station
	Casting goods (dry and liquid)	Optimization of storage space with increased silos
	grain	Increase vertical storage areas while allocating more land to silos and warehouses
	Gas and petrochemical services	Restart idle gas plants with new plants to reach maximum design capacity in accordance with the Industrial Development Authority's objective
	passenger	Non
	free industrial zone	Complementary industries for logistics services
	Versatile area	Allocate space for multi-use pavement
	overall area	Dependence on planned land for extension
Maximum depth in meters	Increase the depth of port and navigational corridor to receive giant containers	
Length of port docks in meters	Increase the length of the port's docks to 6680 meters	
Warehouses 1000sqm	Exploitation of Land Areas for Warehouses	
Capacity in million TEU	Non	

Source: prepared by authors.

### e-Proposed Port Community Policies

There are a variety of policies public interest engagements of all stakeholders and community in Damietta Port in case the port of

Damietta has been redeveloped in the light of the green port policies in order to achieve the following targets given in Table (7) and Figure (16).

**Table (7). Proposed Policies for Transforming Damietta Port to Green Port.**

Port operations	<b>Emissions</b>	<b>Energy</b>	<b>Waste</b>
	Reduce emissions from port charging and discharges (High pollution but not hazard)	Contribution of new and renewable energy to energy production, 4 megapixels of solar cells, 4 Mega Solar Farm, 4 MW of Wave Plant, 4 megapixels of power stations	<ul style="list-style-type: none"> <li>- An integrated waste management plan</li> <li>- Processing stations conforming to the requirements of the Egyptian Ministry of Environment</li> <li>- Existence of an oil spill management plan</li> </ul>
Environment	<b>Safety</b>	<b>Geology</b>	<b>Shipping</b>
	<ul style="list-style-type: none"> <li>- Application of the requirements of the International Ship and Field Facilities Safety Code</li> <li>- Application of the requirements of the International Maritime Transport Organization</li> <li>- Presence of Fire-fighters, Customs, Investigations, Communications Tower, Naval Forces, Air Defence</li> </ul>	<ul style="list-style-type: none"> <li>- Study geology in drilling and cricketing</li> <li>- Non-utilization of resources resulting from cricketing work such as salt and black sand</li> </ul>	<ul style="list-style-type: none"> <li>- Port receives all kinds of vessels (containers-dry casting - liquid casting - general goods-liquefied gas Charging) and discharge rates are productive and competing for Mediterranean rates</li> </ul>
Workplace / people	<b>Bathymetry</b>	<b>Habitats</b>	<b>Waves</b>
	The right depth to receive large vessels Mother Ships	Do not affect any existing marine neighborhoods and take advantage of existing fisheries	Full response to the highest possible wave within the port
Workplace / people	<b>Phenomena</b>	<b>Human resources</b>	
	Addressing certain natural phenomena Failure to address sea level rise	<ul style="list-style-type: none"> <li>- Provide job opportunities to reach the highest quality and efficiency of productivity.</li> <li>- Sufficient numbers on equipment and monasteries to achieve the highest possible productivity</li> </ul>	
Workplace / people	<b>Building Sustainability</b>		
	<ul style="list-style-type: none"> <li>- Reliance in new construction on environmentally friendly building materials and the sustainability of enterprises.</li> <li>- Port docks achieve high storage (containers- general cargo - dry casting - liquid casting)</li> <li>- Wavelength barrier suitable for wavelength and preventing siltation.</li> <li>- Channel entrance with suitable depth and appropriate number of shampoos</li> </ul>		

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	- Rotation basin with diameter and depth suitable for container sizes and entrance channel	
	<b>Business efficiency</b>	
	Optimization of land use, Equipment cost is too high and equipment maintenance is weak with a small operating life span, Difficulty in achieving the 2030 port target given the number of containers in circulation	
<b>Planning</b>	<b>Land use</b>	<b>Transport Network</b>
	- Integration of uses - Planned and designed uses with the latest technology as road services	- Presence of all means of transport - Availability of adequate waiting areas - Road design suitable for port entrances - Raising railway efficiency by locomotives
	<b>Supply-Chain management</b>	
	Passage of many of the port's many shipping lines, Implementation of logistical and supply chain concepts	
<b>Port communities</b>	<b>Community Integration</b>	<b>Port Education</b>
	Organizing trips to the port	- Training centers for workers and graduates - Establishment of a specialized logistics institute in Damietta

Source: prepared by authors.

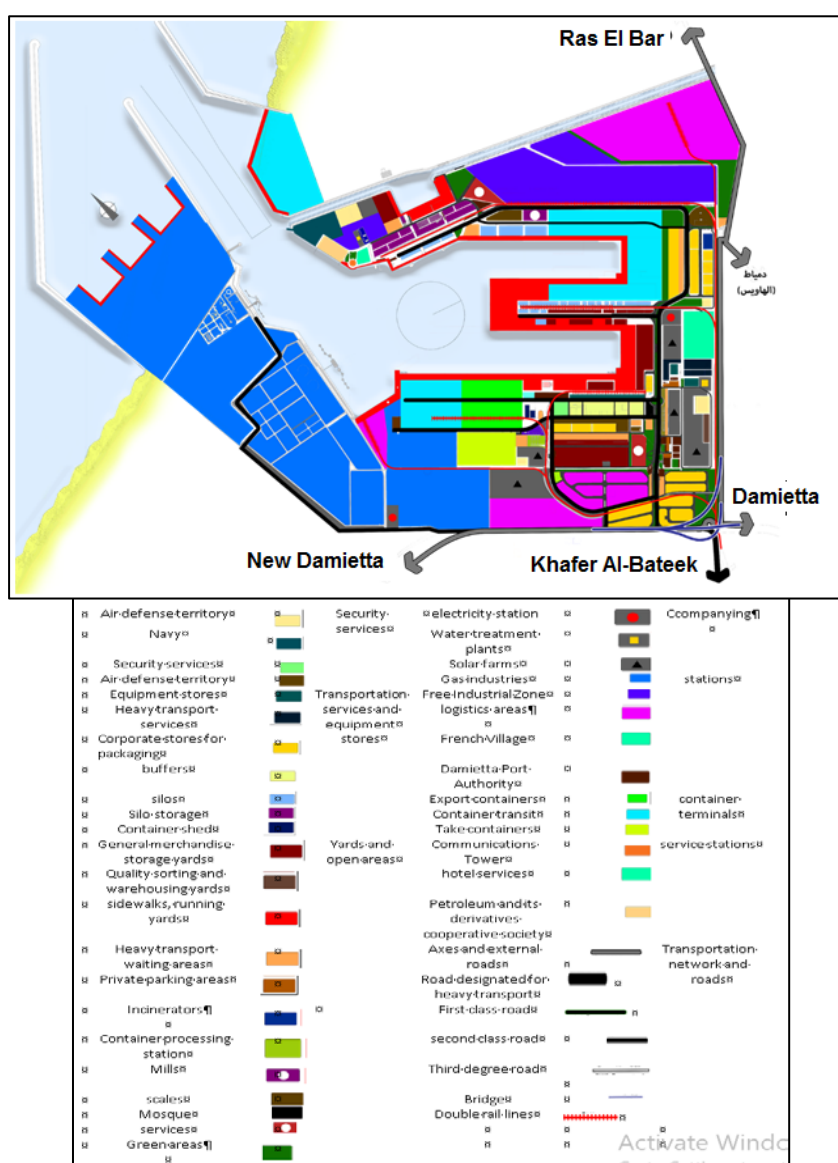


Fig. (16). Proposed Damietta Port Plan as Green Port. Source: prepared by authors.

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### Conclusions

- This study acknowledges the significance of seaports as an important connection to the entire world via shipping networks, but also points out that they are a source of environmental pollution, noise and consumption of energy. Environmental, social, and economic restrictions on a variety of levels and in different contexts, from local to global, are included into port management and operation.
- Seaports also have several negative effects on our natural and physical environments, as well as our social and economic environments. In light of this circumstance, work is needed to design green port policies to minimize environmental degradation, promote optimal use of natural resources, accomplish sustainable urban growth, and improves the quality of life of society and to assist decision makers in addressing port problems and challenges.
- The Green Port is an eco-friendly approach to the port's operations, management, and activities in order to utilize its resources effectively, lessen its negative effects on the local environment, enhance environmental management, and raise the standard of the surrounding terrain.
- In order to solve the difficulties in the environment, the economy, and society of Damietta Port, it needs to establish and implement green port policies. This will enhance the environmental, social, and economic outcomes, and decrease the presence of hazards and constraints that must be handled
- Damietta green port policy includes the process of port operation, management of energy and waste, as well as consideration for the land, water, and air environments, the sustainability of

structures and human resources, and the effective use of land, communication networks, and supply chain networks.

- Using the Green Ports concept in Egypt can addresses the impact of potential environmental risks to the maritime environment, which is a problem that will persist for future generations and has numerous effects on our social, cultural, and economic values as well as our natural and physical environment.

### Recommendations

To attain sustainability of ports, the concept of environmental development has to be taken in consideration. Also, the Egyptian authorities should implement green port regulations and increase funding for scientific studies to find the appropriate engineering and planning solutions for the Egyptian environment and prepare to change toward the concept of green ports to meet their problems and challenges.

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## تطبيق سياسات الموانئ الخضراء لاستدامة الموانئ المصرية : دراسة حالة ميناء دمياط

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### المستخلص

تعتبر الموانئ البحرية صلة الربط بين الدول من خلال شبكات النقل البحري لكافة انحاء العالم، كما انها تعزز التجارة الدولية، وتدعم النمو الاقتصادي العالمي. الا انها تمثل مصدر للتلوث البيئي من خلال الانبعاثات للهواء والملوثات للمياه من أنشطة النقل البحري وترتبط أيضا بالتغيرات المناخية واستهلاك الطاقة والضوضاء المتولدة ، مما يترتب عليه العديد من التحديات التي يواجهها صانعو القرار حول كيفية معالجة آثار المخاطر البيئية المرتبطة بالموانئ بيئيا واقتصاديا واجتماعيا. لذلك فإن مفهوم الموانئ الخضراء يمكن ان يساعد صانعي القرار لمعالجة التحديات والمشكلات المتوقعة حيث يقدم المفهوم الأخضر بشكل أساسي ثلاثة جوانب للعمليات داخل الموانئ وتخطيط التنمية بما في ذلك الحفاظ على الطاقة وحماية البيئة والعناية بها. لهذا جاءت أهمية هذه الدراسة للعمل على محاولة توظيف مفهوم الموانئ الخضراء لمواجهة مدى تفاقم أثر التهديدات البيئية المحتملة للموانئ والذي يمثل تحديا مستمر للأجيال الحالية والقادمة وله تأثيرات متعددة على مجتمعنا ، والقيم الثقافية والاقتصادية وكذلك على بيئتنا الطبيعية والمادية. وقد تم اختيار ميناء دمياط لتطبيق مفهوم الموانئ الخضراء عليه لما يمثله هذا الميناء من أهمية للتجارة المحلية والعالمية.

**الكلمات الدالة:** الموانئ الخضراء - السياسات الخضراء - استدامة الميناء - دمياط - مصر