The Outcomes of Applying Smart Green Port Concept in Egyptian Ports (Case Study: Alexandria Port)

Mohamed Elhussieny[1] *, Ola Arafat[1], and Ahmed El Kassar[1]
[1]Arab Academy for Science and Technology, Maritime Transport, Alexandria, 1029, Egypt
* Corresponding author: hosinymohamed@aast.edu ; Tel.: +201011581167.

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ABSTRACT:

The awareness of preserving the environment and the tendency to apply the concept of "smart" and "green" ports have increased during the last decade of the twenty-first century to prevent further pollution, whether inside the ports or in the hinterland. The researchers studied the experiences of several ports in the field of environmental preservation and transformation into smart green ports and achieved real environmental protection using modern technological techniques. Researchers studied the current environmental situation of Alexandria port and conducted a comparative study with several international ports to identify the gap that needed to be filled to reach a set of practical proposals for an actual application of the concept of smart green ports in Alexandria port. Sustainability is no longer a luxury but rather a strategic issue as the shipping industry has moved in the direction in recent years and has begun to take advantage of geospatial data and artificial intelligence to achieve the goal of a green port. Geospatial technology tools can be used in smart green ports in various ways to improve efficiency, safety, and sustainability.
This paper explores the use of geospatial technology tools in smart green ports to improve efficiency, safety, and sustainability. The paper discusses various ways in which geospatial technology tools can be employed, including real-time tracking of vessels, optimizing berth allocation, monitoring air and water quality, managing waste, predicting maintenance requirements, and planning emergency response procedures. By leveraging these tools, ports can reduce their environmental impact and improve their overall performance. The paper concludes that geospatial technology tools have significant potential for enhancing the efficiency and sustainability of Smart green ports.

1. INTRODUCTION

1.1 New Concept for Smart Green Port.

The maritime industry and ports worldwide face a significant challenge to reach the increasingly stricter environmental regulations. At the same time, competition for maritime ports is more challenging than ever. The awareness of preserving the environment and the tendency to apply the concept of smart and sustainable green ports have increased during the twenty-first century. Smart green ports are part of innovative solutions to environmental problems. Ports must be environmentally friendly with integrated control of the gases emitted from dredging, buildings and facilities, drainage, electricity, garbage collection places, stores, and services, followed by parking spaces, passenger entry buildings, and administration buildings and facilities, then port extensions and port-related services.
Geospatial data plays a pivotal role, and AI is increasingly becoming the engine fuelled by the data to accelerate ports and the maritime industry to a greener future.

Port development and transformation have changed from port informatization to automatic port to digital port to smart port (Rodrigo Garcia Motta, Angélica Link, Viviane Aparecida Bussolaro *et al.*, 2021)

The following figure, smart passes through many steps: first, a port introducing informatization that reduces the use of paper documents and manual processing; then, an automatic port, which is a semi-automated port that is applying to e-documents and using information systems; then, a digital port, which is an automated port that provides interoperability by information sharing and real-time service by RFID (Radiofrequency identification); finally, a smart port, which is a fully automated port that uses nascent and innovative technologies and performs digital transformation (Rodrigo Garcia Motta, Angélica Link, Viviane Aparecida Bussolaro *et al.*, 2021)

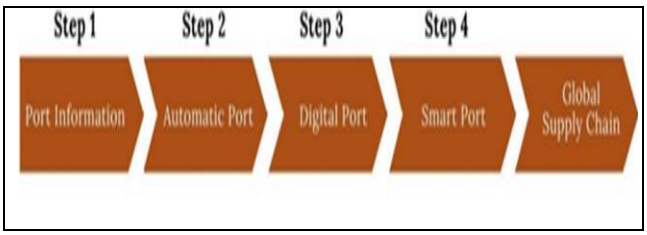

Figure 1. Smart Port Levels
Source: (Rodrigo Garcia Motta, Angélica Link, Viviane Aparecida Bussolaro *et al.*, 2021)

1.2 Progress in the generation of ports.

Port efficiency and productivity are frequently the primary goals of any port. The fourth generation of ports has emphasized the integrative function of ports in linking to global supply networks and fostering integration with information services. The fifth-generation ports have connectivity between the green port and the smart port. The importance of technical innovation has grown, stressing the importance of port production and service fitting into an integrated notion of environmental preservation.

the first four generations of ports sought increased focuses on port technology(Radwan *et al.*, 2019) as well as attention to concepts such as environmental protection, green development, control of carbon emissions, environment sustainability, and pollution prevention.(Molavi, Lim and Race, 2020).
The following figure shows the Functional composition of smart port.

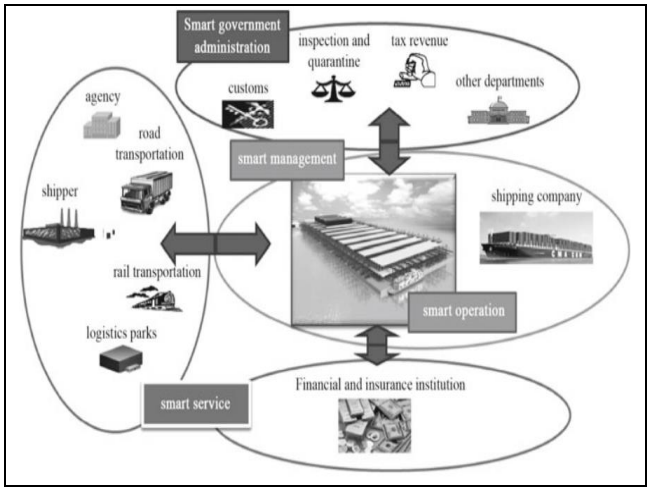

Figure 2. Functional composition of smart port
Source:(Mi and Liu, 2022)

A Smart Port is defined as "a system with cyber-physical systems as a structural framework, in which suppliers and claimants perform logistics engaged in an integrated system of collection, distribution, and transportation through the innovative application of high and new technologies." It has considerably improved. The port's and linked logistical regions' capacity to handle information extensively and enhance resource allocation.

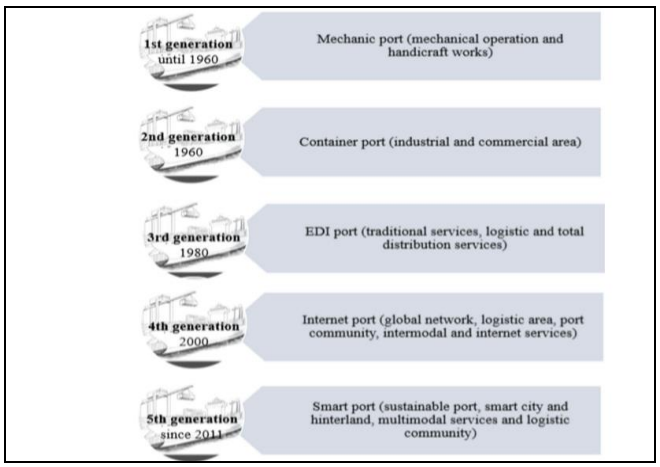

Figure 3. Evolution of seaport
Source:(Battino and del Mar Muñoz Leonisio, 2022)

The above figure shows that Ports have changed in many aspects such as operational aspects, throughput, infrastructure, and governance. The adoption of modern technologies and activation of new business partnerships/strategies has been important. Thus, all port activities have become more sustainable and interconnected, and this has become accompanied by the development of digitization, and all this has become to reach a complete concept of a smart green port.

Global climate change is one of the most important concerns confronting humanity, and to save energy and minimize emissions, it must be addressed in all parts of life. Port pollution has a severe environmental impact. Most pollution is created during development of ports and cargo operation. At the port's shoreline, about three quarters of global marine emissions occur in the oceans., with the remaining 60–90% generated during the port's handling activities, additional kinds of pollution, such as dust and noise also occur. As previous generations of ports integrated port logistics function, the fifth generation of ports is focusing on leveraging smart technology and achieving sustainable green development (Chen, Huang, *et al.*, 2019).

Smart green ports are a component of the green economy, which is represented in six sectors, including transportation, housing, agriculture, industry, energy, and infrastructure. It is the key link in the sustainable transport chain and plays a vital role in advancing economic development and supports the 2030 vision and strategy to achieve sustainable development. The concept of generalizing sustainable green ports has several characteristics, which are zero pollution, changing the fuel in a way that does not pollute the environment, and does not pollute the port on which it docks, and recycling solid wastes, which have a recycling system, as well as liquid wastes and chemicals. Environmental impact assessment is related to the green port concept, and it has a significant impact on plans, programs, and investments, as well as on construction proposals, activities, and technologies, and their modifications or expansions. An environmental impact assessment is developed along with procedures to prepare and approve the investment proposal (JPA, 2014).

1.3 Digitalization and Smart Green Port.

The importance of digitalization in ports has increased as the global shipping industry moves towards a more efficient, cost-effective, and sustainable future. Digitalization in ports can help to reduce costs, improve safety, and increase efficiency. Digitalization has the role in improving customer services, reducing paperwork, and providing better access to data. Furthermore, digitalization in ports will reduce emissions control and improve the quality of the environment sustainability (González-Cancelas *et al.*, 2020).

Since seaports have an active role in the sustainable development of coastal areas, it is also important to transform them into smart outlet ecosystems. The first three generations of ports typically place a strong emphasis on port services and production. The fourth generation of ports gives priority to information services and enhances the integration of ports within global supply chains. All the services available in the fourth generation of ports are available in the fifth generation of ports, and the fifth generation of ports integrates green and smart technologies (Philipp, 2020).

Innovation, emphasizing the importance of green environmental protection and cutting-edge technology in port production and service. The last four generations of ports failed to achieve green and low-carbon growth and ignored issues

such as climate change and pollution. The idea of the smart port revolves around enhancing the collection, distribution, and transportation systems through new technology, the integration of supply and demand for logistics, and the ability of the collection, distribution, and transportation systems to optimally allocate resources. This allowed the basic form of a new environmental port will be intelligent supervision, intelligent service, and self-loading and unloading. The number of automated ports established has expanded since the turn of the twenty-first century because of the quick development of high- and new-level technologies, including communication, networking, and intelligent technology (Mi and Liu, 2022).

1.4 Geospatial Technology Tools and Smart Green Port.

Geospatial technology tools can be used in Smart Green Ports in various ways to improve efficiency, safety, and sustainability. Here are some ways to use geospatial technology tools in the Smart Green Port:

1. Real-time tracking of vessels: Geospatial technology tools such as the Automatic Identification System (AIS) can be used to track vessels in real-time. This helps in optimizing vessel traffic management and reducing the waiting time for vessels, which reduces fuel consumption and emissions.

2. Optimizing berth allocation: Geospatial technology tools can be used to analyse the availability of berths, water depths, and other factors to optimize berth allocation. This helps reduce the turnaround time for vessels and improve the port's efficiency.

3. Monitoring air quality: Geospatial technology tools can be used to monitor air quality in and around the port. This helps in identifying areas with high pollution levels and taking corrective measures to reduce emissions.

4. Managing waste: Geospatial technology tools can be used to manage waste generated in the port. This includes identifying areas where waste is generated, tracking the movement of waste, and managing waste disposal.

5. Monitoring water quality: Geospatial technology tools can be used to monitor water quality in and around the port. This helps in identifying areas with high levels of pollution and taking corrective measures to reduce pollution.

6. Predictive maintenance: Geospatial technology tools can be used to predict maintenance requirements for port infrastructure such as cranes, quay walls, and other equipment. This helps in reducing downtime and improving the efficiency of the port.

7. Emergency response: Geospatial technology tools can be used to plan emergency response procedures in case of accidents or natural disasters. This includes identifying evacuation routes, emergency shelters, and other resources required for emergency response.

In conclusion, geospatial technology tools can be used in various ways to improve the efficiency, safety, and sustainability of Smart green ports. By leveraging these tools, ports can reduce their environmental impact and improve their overall performance.

Geospatial technology tools have been increasingly used in the development and management of smart green ports. These tools provide a range of benefits, including improved efficiency, cost savings, and environmental sustainability. This literature review will explore the use of geospatial technology tools in smart green ports.

Geographic Information Systems (GIS) are one of the most used geospatial technology tools in smart green ports. GIS allows for the collection, analysis, and visualization of spatial data related to port operations. This includes data on vessel traffic, cargo movements, and infrastructure. By using GIS, port operators can identify areas where improvements can be made to increase efficiency and reduce environmental impacts.
Another geospatial technology tool used in smart green ports is Remote Sensing (RS). RS involves the use of satellite imagery and other remote sensing technologies to collect data on port operations. This data can be used to monitor and manage environmental impacts, such as water quality and air pollution. RS can also be used to monitor vessel traffic and cargo movements, providing valuable information for port operators.

Global Positioning System (GPS) is another geospatial technology tool used in smart green ports. GPS allows for the tracking of vessels and cargo movements in real-time. This information can be used to optimize shipping routes and reduce fuel consumption, resulting in cost savings and reduced emissions.
In addition to these tools, there are also emerging technologies that are being used in smart green ports. For example, Unmanned Aerial Vehicles (UAVs) are being used to monitor port operations and collect data on environmental impacts. Augmented Reality (AR) is also being used to visualize port operations and identify areas for improvement.

Overall, geospatial technology tools are essential for the development and management of smart green ports. These tools provide valuable information on port operations, environmental impacts, and opportunities for improvement. As the technology continues to advance, it is likely that more innovative solutions will emerge, further enhancing the sustainability and efficiency of smart green ports.
The shipping digitalisation process is heading towards a totally autonomous and at the same time safe and reliable ship targeting smart green port (Scarlat, Ioanid and Andrei, 2023).

2. LITERATURE REVIEW

2.1 Smart Green Port Structure and Sustainability.

According to Alamoush, Lçer, and Ballini (2022), the United Nations established and ratified 17 Sustainable Development Goals (SDGs), with the goal of achieving them by 2030. Port sustainability research is expanding quickly and is increasingly focused on environmental issues. The United Nations'
Sustainable Development Goals (SDGs) are highlighted. Port sustainability includes both internal (portside) and external (ships and land transport) operations and initiatives. The United Nations Sustainable Development Goals (UN SDGs) were provided in order to demonstrate the relationship between these UN SDGs and port actions(Alamoush, Ölçer and Ballini, 2022).

Figure 4. 17 Sustainable Development Goals (SDGs)
Source: (Obaideen *et al.*, 2022).

Twrdy and Zanne (2020) defined the green port as "it is a port in which the port authority and port users pro-actively and responsibly develop and operate, based on an economic green growth strategy". In recent decades, ports have seen a large growth in cargo flow, but the number of ships calling at ports has not expanded at the same rate. Ports are prepared to handle ever bigger ships and ensure that their stays are as short as possible (Twrdy and Zanne, 2020).

Chen, Huang, et al. (2019) declared specific governance policies for building green and smart ports, as well as drawing a model map for the structure of building green and smart ports, and contributed to providing a theoretical basis for governments to develop smart green port policies and establish effective systems, methods, and means for the port industry to benefit from smart port technologies to develop ports (Chen, Huang, *et al.*, 2019).

According to the case study of the port of Wismar, Philipp et al. (2021) declared that digitization of ports and greening of ports go hand in hand successfully, that the presence of a green and smart seaport makes a significant contribution to development, and that the provision of planned investments in ports leads to significant improvements in the performance of these ports in order to complete the processes of converting them into green smart ports (Philipp *et al.*, 2021).

Sadri et al. (2022) have declared that, establishing green ports with the application of international maritime standards, agreements, and regulations leads to a move towards applying the concept of smart ports, which can increase the speed of transporting goods by sea, increase the quality and capacity of ports, and reduce costs. (Sadri *et al.*, 2022) have added that traditional performance evaluation methods, on the other hand, are incapable of providing a comprehensive, multidimensional assessment of the state of the ports.

Paulauskas et al. (2021) found that port processes and operations should be automated and digitalized, but on the other hand, they must be economically useful and sustainable. Digitalization of the management system has integrated the following parameters and activities in the port:
- Marine port operations.
- Safe methods of navigation.
- Depths in the port.
- How to deal with emergency situations in port.
- Navigational regulations, etc.
- How to determine port dues.
- Determine port times for ships in the port (ETA and ATA of the ships).
- Cargo handling operations.
- Activities and services of companies in port.
- Statistics of the port.
- Reports on port activities.
-Sustainability and digitalization strategies of the port (Paulauskas *et al.*, 2021).

(Molavi, Lim and Race, 2020)added that one of the significant unifying aims is to enhance efficient operations and logistics through automation and the spread of technology, as well as through changing strategies and regulations. All these environmental and energy related concerns are central to the future projects such as installing renewable energy, lowering energy usage, and enhancing operations to be more ecologically friendly.

2.2 Green Port Sustainability

One topic, the greening of maritime education and training (MET) is vital to meeting the goals of the "sustainable maritime transport system" and to effectively support the fulfilment of other targets of the SDGs.
More specifically, port efficiency and productivity are frequently the primary goals of any port. The fourth generation of ports has emphasized the integrative function of ports in linking to global supply networks and fostering integration with information services. The awareness of preserving the environment and the tendency to apply the concept of green ports have increased during the twenty-first century. Green ports are part of innovative solutions to environmental problems. Ports must be environmentally friendly with integrated control of the gases emitted from dredging, buildings and facilities, drainage, electricity, garbage collection places, stores, and services, followed by parking spaces, passenger entry buildings, and administration buildings and facilities, then port extensions and port-related services.
Accordingly, the need to switch to sustainable green ports is a general trend for seaports all over the world. Environmental management is, therefore, becoming the most important role in the operation of the port. Environmental management has advantages that include not only satisfying customers but also saving costs and protecting the environment(Teerawattana and Yang, 2019).

2.3 Information technology and Maritime Transport.

GIS technology has been utilized for a number of applications in several sectors of the marine industry.They employ informati on obtained throughdifferent methods, as well as concepts from other technology fields, to aid in the resolution of marine envir onment dynamics.Directors and administrators must engage in the use of GIS as a decision support system, presenting a huge opportunity for GIS applications in management processes.GIS may be able to present data in an accurate and detailed manner to all users.

Successive generations of information technology have affected the maritime transport industry and the logistics industry through the following:
- Improving, facilitating, and speeding the transfer of information to improve the routes and schedules of ship movement to and from ports, considering factors such as cargo size, weight, destination, and ship capabilities, can help reduce fuel consumption and improve efficiency (Arifin, 2023).

- Using Smart Sensors and the Internet of Things (IoT):
To monitor the operation of the ship, sensors and IoT devices such as fuel consumption, cargo temperature, and engine performance can be used, and this data can be used to improve the efficiency of the ship and reduce operating costs (Arifin, 2023).

- Location monitoring using geospatial technologies and databases through technologies such as GPS and GIS to track the location and movement of vessels

-AI-based decisions:
Machine learning and artificial intelligence can be used to analyse large amounts of data and make smart decisions based on that data that has been entered and can include decisions related to improving the navigational routes of ships, predicting the needs of ships of different types of maintenance, and determining the required spare parts according to the needs, and thus achieving in operating costs.
All these aforementioned factors help in creating what is known as smart, sustainable maritime transport.
Innovation, emphasizing the importance of green environmental protection and cutting-edge technology in port production and service. The last four generations of ports failed to achieve green and low-carbon growth and ignored issues such as climate change and pollution. The idea of the smart port revolves around enhancing the collection, distribution, and transportation systems through new technology, the integration of supply and demand for logistics, and the ability of the collection, distribution, and transportation systems to optimally allocate resources. This allowed the basic form of a new environmental port will be intelligent supervision, intelligent service, and self-loading and unloading. The number of automated ports established has expanded since the turn of the twenty-first century because of the quick development of high- and new-level technologies, including communication, networking, and intelligent technology (Mi and Liu, 2022).

The Internet of Things (IoT) is one of the most powerful features of smart green ports. It is an excellent instance of the marine industry's digital transformation, providing significant benefits from important insights gathered in port management. The smart port concept places a strong emphasis on the application of smart and green technologies that improve port efficiency, performance, innovation, flexibility, environmental safety, and economic competitiveness (Costa et al., 2021). Ports on the European Transport Network (TEN-T) such as Rotterdam and Antwerp are already accustomed to digital database technologies such as blockchain and the Internet of Things (IoT), and as a result, they continue to rely on the sustainable expansion of these cutting-edge technologies that promise security, process optimization, and sustainability (Philipp, 2020).

Port development trends are an important responsibility for port development because they support sustainable development and increase overall operational efficiency. This allows ports, multimodal transportation agencies, and cities to work together to make better use of internal and external resources, promote long-term economic growth, and decrease environmental impact. It enables lower environmental impacts from port activities, increased renewable energy uptake in use cases at small, medium, and large ports, and lower operational and infrastructure costs through improved port-city integration(Chen, Zheng, *et al.*, 2019).

Green and intelligent designs are both important trends and goals for port development in the future, and they are intrinsically intertwined. The major objective of port development is to establish a "smart green port," in which port production and operation are designed to be environmentally friendly. Based on the green port premise, smart ports encourage technology innovation and application in port production companies to decrease pollution and accomplish the objective of sustainable green port development.

3. RESEARCH AREA (ALEXANDRIA PORT)

Alexandria Port is the primary and most important port in Egypt, in terms of trade volume; it handles around 60% of Egypt's international commerce. Alexandria is situated on the Nile's western bank, between the Mediterranean Sea and Lake Mariout. Alexandria is also the second-most significant city in Egypt (Yahya, 2022).

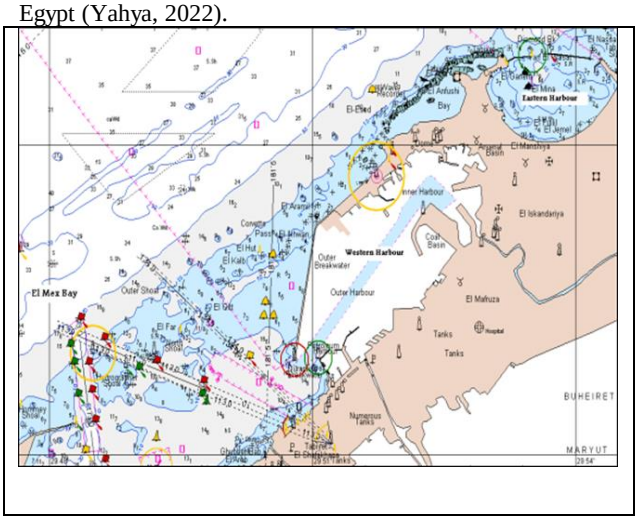

Figure 5. Eastern Harbor, Western Harbor and El Mex Bay, Alexandria, Egypt
Source: Alexandria Port Authority | Alex-map-location (2022)

3.1 Alexandria Port Authority Information Technology Systems.

There is a great need for Alexandria Port to be transformed into a smart green port to deal with ships automatically and simultaneously, deploying artificial intelligence software, Internet of Things, and implementing the "Blockchain" electronic document transfer system, which raises the classification of Alexandria port in international port rankings. The International Maritime Organization (IMO) urges the

implementation of smart port standards to be completed by 2023 (Philipp *et al.*, 2021).

According to Alexandria port officials, they have built 12 modules, including: a ship/berth planning module; container handling (for terminal operators); registration of truck visits; and registration of truck and cargo weight. However, the Declaration of Goods module is still under development. These modules offer comprehensive data management features, such as basic and customized reports. Shipping agencies and forwarders can use the system via the port's website, using their own unique and secure log-in information. Alexandria port has joined the ISFP (Integrated Solutions for Ports) SPS (Smart Port Solution) program, which is rolling out standardized port community software to various Egyptian ports. The SPS is composed of several modules that are implemented based on the specific needs of the respective ports. The Port Simulator, General Cargo, Stevedoring, Warehousing, Gates, Rails, River, and Licenses SPS modules have been installed at Alexandria Port (Mahmoud and Awad, 2021).

3.2 The Concept and Practices of "Smart Green Ports" in Egyptian Ports (Alexandria Port).

Egypt's communication and information technology industry witnessed an exceptional precedence. The new Tahya Misr Multipurpose Terminal will contribute to Alexandria Port's growth as a regional and global trade and logistics hub.

The project has a capacity of 15 million tons per year, total berth lengths of 2.5 kilometres, and depths of up to 17.5 meters across an area of 155,000 square meters, according to them. Alexandria Port was awarded for employing smart technology since they already utilize several technologically complex technologies, OCR (automatic container code recognition) and radio terminal data are two examples (RTD)(Othman, El Gazzar and Knez, 2022).

Alexandria Port has implemented several green initiatives to reduce its environmental impact, such as installing solar panels on its buildings, using LED lighting, and investing in energy-efficient equipment. The port also has a comprehensive waste management system that includes recycling, composting, and reuse of materials. Additionally, the port has implemented an environmental monitoring system to ensure compliance with international regulations.

3.3 Need for geospatial technology tools in Alexandria Port.

In general, using geospatial technologies to gather location information provides us with data that can give a deeper understanding of many issues. This spatial data can answer questions, and help with predictions, analysis, and decision-making.

Geographic Information System (GIS), designed for gathering, storing, processing, looking through organising, drill-down visualizing location specific information on geographic maps. With GIS technology serving as system of truth, spatial data layered on map can be analysed, and decision-support processes can be greatly assisted.

GIS solutions includes the use of software, hardware, and approved georeferenced data to help users view and understand the relationships between diverse geographic characteristics, analyse terrains, land-use, and population density for respective domains such as Seaports, River ports, Utilities, Railways, multimodal logistics.

GIS enables decision-makers to understand patterns, relationships, and trends in the data with utmost clarity from multiple dimensions, which can help in taking a wide range of important decisions and actions like:

- Planning and management of urban, rural areas, ports, like land-use, zoning, and resource management
- Port operations tracking spatially and port-land use
- Emergency response and disaster management, such as incidents tracking on interactive map, trend analysis of incidents for effective planning measures
- Environmental monitoring and conservation, including monitoring changes in land cover and locating regions at danger of habitat loss or deforestation
- Spatial tools for effective Marketing and market research data capture for analysis, in identifying the most promising locations for new businesses setup or retail stores.
- Transport and logistics, such as optimizing delivery routes and managing traffic flow.

Transmission and Distribution: GIS serves as an effective tool in utilities where complete hierarchical utilities distribution model can be tracked until last level like pole and consumers info on map in both HT & LT networks, with density of respective entities location-wise displayed. This can result further for smart metering and billing purpose.

4. USING GIS TOOLS IN ALEXANDRIA PORT.

Geospatial dashboards in various dimensions plot-status/customers/time helps in strategic and operations planning of port properties rental/lease management, Geo-fencing, Geo-tracking, and location-based info/analysis/analytics.

Tracking vital data: - GIS in seaports helps in tracking location of the container in port, transshipment data on the map and update transit times route planning for vehicles inside the port and tracking same on map.

Make Logistics planning simple: Delivering more sophisticated information to your clients; showing shipment information on a map of the world; and offering excellent customer service.

Intermodal transportation activities in ports, for example, for containers requiring various modes of transportation (vessels/ships, trucks, and rail), can be shown on a map along with the supporting infrastructure, rails, and road network information, including congestion information, etc. It is possible to plan for efficiency-increasing measures and predictive-intelligent measures by doing a spatiotemporal analysis of the same.

Water depth tracking and depiction in Web GIS is highly helpful for port management to guarantee that necessary dredging operations are carried out on a regular basis or as needed to maintain depth levels for safe vessel movement and docking at ports. Predictive decision-making is aided by regular depth assessments and assessments for the individual

vessels, as well as decisions on dredging that are based on spatiotemporal analysis (previous data) and data on water flows.
GIS has almost become a necessity for every company in modern times as an effective decision support system and is part of digital transformation exercise in view of the immense benefits it offers to users and decision makers in every firm.

4.1. Current GIS Tools in in Alexandria Port.

1- LRIT System.

Alexandria Port Authority uses the Egyptian National LRIT Data Centre which enables the port operators to track the vessels flying the Egyptian flag worldwide 24/7 and vessels flying foreign flags in the coastal and port areas along with responding to any SAR request. The data centre feeds 6 terminals in 6 entities that are entitled to monitor and ensure vessels' safety such as, The Search and Rescue Centre and the Egyptian Maritime Safety Authority.

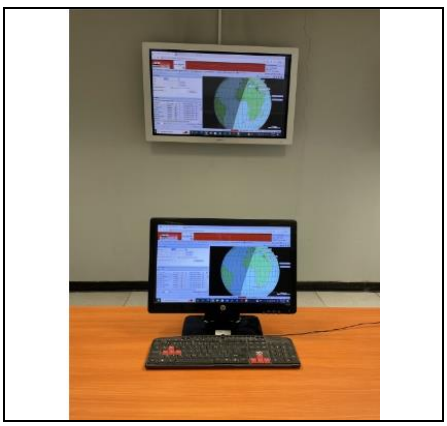

Figure 6. LRIT System in Alexandria Port.
Source: Alexandria Port Authority

2. Automatic Ship Tracking System (AIS):
Alexandria Port Authority has an AIS station that allows for tracking the vessels moving within the port area 24/7. The vessels are monitored and directed accordingly by a team of professional operators. In addition, the station is connected to the operations canter at the Maritime Transport Sector which integrates the data of all ports of Egypt to provide a holistic view of the vessels in the Egyptian water.

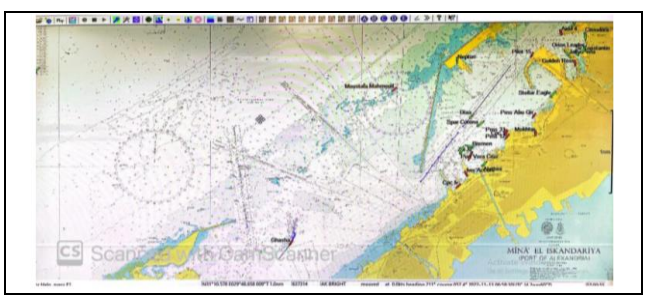

Figure 7. AIS terminal
Source: Alexandria Port Authority

3- AIS-GIS
Alexandria Port Authority has developed a system that integrates AIS and GIS systems to provide complete information to the operators. The AIS system provides a rich interface with newly added features such as filtering, sorting and playback of previously logged vessel movements.
The GIS system provides up-to-date visual information about the depth of berths, the port yards classified based on their status, etc. Such features improved the reliability and visibility of port resources and allows for better monitoring.

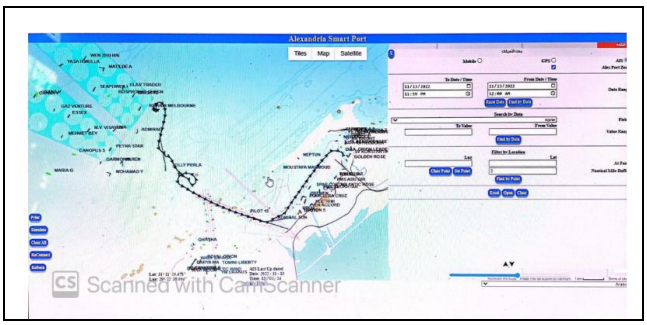

Figure 8. AIS-GIS system
Source: Alexandria Port Authority

Using artificial intelligence technologies, that will provide digitized information data and connection between GIS and RS to and have encouraged an entirely new ecosystem evaluation need to be in smart green port. In recent years, remote sensing and GIS have been commonly integrated for analysing and mapping changes.

5. RESULT AND DISCUSSION

This study investigated whether digital and green goals in ports exist or not and how operations can be automated in Alexandria Port. The case study of Alexandria Port shows that digitization and green port operations may be effectively connected, making a significant contribution to Alexandria Port as a smart green port.
The study also tries to sightsee the use of GIS tools for the environmental sustainability of green port (Alexandria Port) to monitor, acquire data and to apply the outcomes of applying smart green port concept in Egyptian Ports. Environmental sustainability has increased with the use of GIS and RS tools.

6. CONCLUSION

This study aims to examine the performance of ports before and after applying the green port operations. While the main operations of green port consisted of (Envi-ronmental Quality, Use of Energy and Resources, Waste Handling, Habitat Quality and Greenery and Social Participation).

The study also focused on the outcomes of applying smart green port concept in Egyptian Ports (Alexandria Port) by using GIS tools to enhance the productivity and efficiency of Alexandria Port as a smart green port.

A greater understanding and use of the GIS tools may lead to more exploration and prospects in environmental sustainability studies in green ports. It will save time, money, and life, less

labour, and availability of more multiple accurate data information that will improve sustainability.

The implementation of the green port concept raises the port's competitiveness, gives added value to Egypt's geographical location, and would increase port capacity not only to serve adjacent nations but also to become the most significant global logistics canter. In addition, it leads to economies in the use of resources, fuel, and electricity consumption, thus maintaining air quality, water quality, and good ballast water management, as well as reducing noise generated by port operations.

This study investigated whether green goals in ports exist or not exist in Alexandria Port and how green operations can be operated in Alexandria Port. The case study of Alexandria Port shows that green port operations may be effectively connected, making a significant contribution to Alexandria Port as a green port. The recommend-dations of the current research are that the research should focus on other operations that affect the performance of Green Port. Future research will be able to have a better timeframe to be able to collect a larger sample as well as follow the technique of random sampling. More future research is needed to explore the effect of applying the green port on ports performance. This research has several limitations through the study.

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