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Towards a SUSTAINABLE BLUE ECONOMY

Conference Proceedings

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Preface

MARLOG conference is one of the most important and yearly awaited events by meany each year, this year, the MARLOG 11 represents a powerful and successful comeback after a few difficult years dealing with the Pandemic. Through its ten editions, the MARLOG conference has evolved into more than just an annual conference, but also a remarkable forum that includes an outstanding technical program, an active social program, workshops, joint courses and the well-known International Maritime Exhibtion.

This year, MARLOG 11 sheds the light on a timely and important topic, which is Sustainable Blue Economy. The conference's key themes are discussed through a rich technical programme that includes eight sessions, 20 research papers, and 16 esteemed Keynote speakers from more than 14 countries, who provided us with the most recent updates and knowledge, anticipated challenges, and future opportunities related to this pressing topic through their valuable research papers, presentations, and interactive discussions.

MARLOG 11 Conference Proceedings contains 26 research papers, 20 of them were presented in the conference technical program and 6 are submitted only in the conference proceedings. This year, 43 abstrats were submitted to MARLOG 11 from more than 14 different countries around the world, and according to the full paper submitted, the double blind peer review adapted by the conference and the scientific committee thorough review, 26 research papers were accepted for the conference proceedings.

Finally, we would like to thank everyone who has made MARLOG 11 possible. I would like to first thank the conference chairman and the president of AASTMT, our esteemed session chairmen, panelists, keynote speakers, Sponsors, Partners, Co-organizers, The organizing committee, The technical committee, Reviewers, all participants, and our team of organizers whose hard work, support and dedication was the main factor that helped in holding such a unique event.
We hope that you have enjoyed your time at the conference and that you managed to gain fruitful and valuable information.

Prof. Akram Soliman Elselmy
Chief Program Editor

Theme:

Towards a Sustainable Blue Economy

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"Blue Economy
Management and Synergies"

OPPORTUNITIES FACING THE EGYPTIAN BLUE ECONOMY

Mohab Gaber

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Keywords: Fisheries and Aquaculture, Maritime Tourism, Infrastructure, Eastern Mediterranean, Intelligence seaports.

1.ABSTRACT: In recent years, the blue economy has been considered a hot spot topic worldwide because of the shortage of land resources and finding offshore energy resources. Egypt's rising population will necessitate more food and energy. This demand can be met by making sustainable use of marine resources. This paper discusses The Egyptian Blue Economic Model is a long-term development strategy that looks to the seas for new economic prospects, poverty reduction, food security, and long-term livelihoods. And discuss challenges facing the development of the Egyptian blue economy and how to beat these challenges. The government begins a package of steps to promote blue energy, which addresses some of the challenges highlighted in this article, such as aquaculture development, tourism, and natural gas, resulting in the increased military and naval troops for Maritime Surveillance.

2. INTRODUCTION

The theory of "Blue Economy" or "Oceans Economy" is lately and originates from the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012[1].

The phrase "blue economy" is increasingly being used to denote economic activity dependent on marine habitats or the seabed. While the term "Blue Economy" is gaining popularity (some people say, instead of "blue," use "ocean or sea," and "industry" instead of "economy."), there is no clear structure for categorizing it [2].

The Blue Economic is a long-term development strategy that looks to the ocean for new economic prospects, poverty reduction, food security, and long-term livelihoods. As a result, the Blue Economy is considered a strategy for advancing numerous Sustainable Development Goals (SDGs)[3].

The blue economy is defined by future economic growth and broad agreement on several sectors that contribute to it, such as fisheries and aquaculture, marine mining, offshore oil and gas, shipping and ports (along with related services), marine tourism, and marine infrastructure (construction and maintenance), as well as the potential value of emerging sectors like renewable energy, marine biotechnology, and pharmaceuticals.[4, 5].

In Egypt, the blue economy accounts for only 2.2 percent of Egypt's GDP. that is notwithstanding Egypt's strategic geographic location, including 3,000 kilometers of coastline on the Red and Mediterranean Seas, the Gulf of Aqaba, and 50 marine ports with 197 terminals spanning 37.5 kilometers.

A 2020 report issued by the Containerization International magazine and U.K. Lloyds Banking Group found that despite their importance to Egypt's global trade. Egypt's ports are still ranked middle of the pack in marine transportation and customs services in the 2019 Global Competitiveness Report and 2020 report, respectively.

The Major Opportunities for Economic Sectors of Blue Economy shown in Figure 1 are as follow:

- Aquaculture and Fisheries
- Maritime Transport
- Renewable Energy from the Sea
- Maritime Nutrient Pollution
- Coastal sea Tourism
- Sea Minerals
- Marine Non-Traditional Species Culture
- Transportation, shipping, and marine trade.
- Marine Research and Education.
- Surveillance at Sea.
- Sea Salt Production
- Blue Carbon Sequestrations.

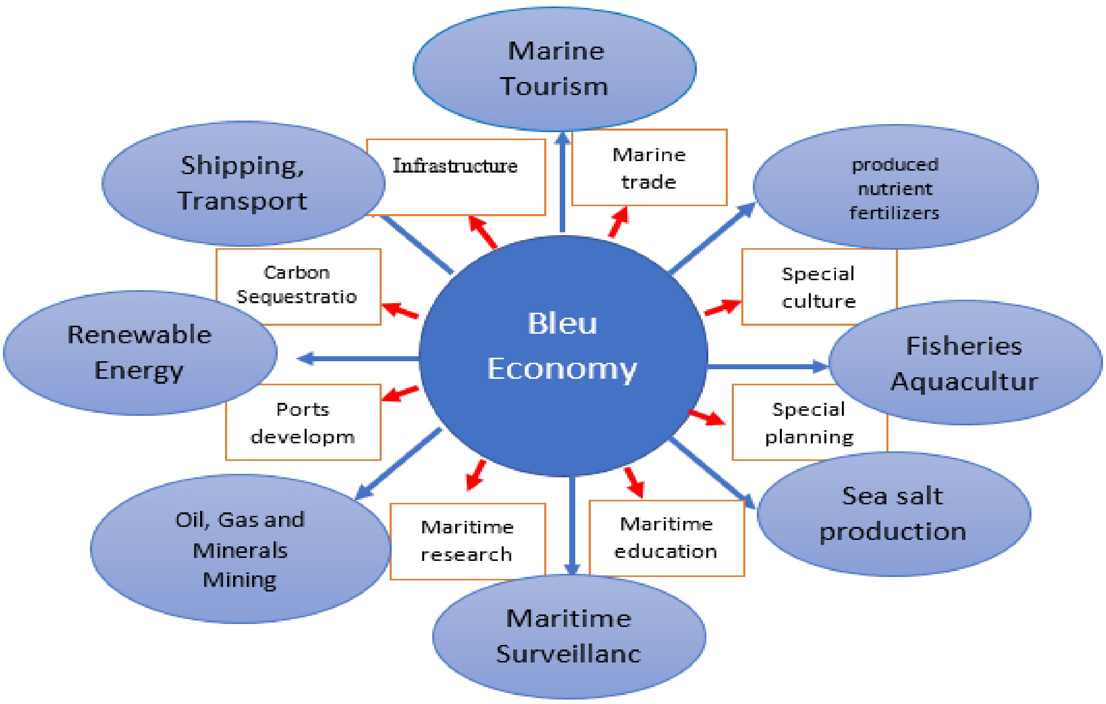

Figure 1 Major Opportunités for Economic Secutors of Blue Economy.

The above topics are significant opportunities in the blue economy and vary according to each project and country's priorities. The Port of San Diego (Port) developed its Aquaculture & Blue Technology Program (AQ&BT) in 2015, recognizing the Blue Economy sector's growth possibilities and strategic position within one of the world's premier seaports clusters of blue technology. In 2018, the project Indian Ocean Rim "Building an Indian Ocean Region" was under geopolitical terms, for 27 countries are rebranding themselves from the 'Ocean of the South' to the 'Ocean of the Center' and the 'Ocean of the Future. The primary economic sectors that can contribute to the development of the blue economy and the impediments to achieving this goal are leveraging the marine environment's untapped potential by implementing practical solutions and innovations that improve food security, poverty alleviation, nutrition and health, job creation, and trade and industrial profiles while protecting ecosystem health and biodiversity, as well as regional security and peace[6, 7].

3. BLUE ECONOMY in EGYPT

Only 2.2 percent of Egypt's GDP comes from the blue economy. Despite Egypt's strategic geographic location, which includes 3,000 kilometers of coastline on the Red and Mediterranean Seas, the Gulf of Aqaba, and 50 marine ports with 197 terminals extending 37.5 kilometers, the country continues to struggle.

Despite their importance to Egypt's global trade, Egypt's ports are ranked in the middle of the pack in marine transportation and customs services in the 2019 Global Competitiveness Report and 2020 Report, respectively, according to Containerization International magazine and the United Kingdom's Lloyds Banking Group.

The government has begun activities to generate blue energy, which is fraught with problems. The following sections will show how important developments in the blue economy, such as aquaculture expansion and oil and gas exploration, lead to increased military and navy forces for Maritime Surveillance.

4. AQUACULTURE in EGYPT

Although Egypt has had an aquaculture industry for millennia, modern management measures to increase production output have only lately been devised. Because of a paradigm shift away from old, extensive to semi-intensive aquaculture systems. Egypt's aquaculture industry has risen quickly toward modern, intense aquaculture systems during the last two decades. Aquaculture production increased due to the foundation and growth of small and medium-sized businesses operated by the private sector.[8]. Although Egypt has had an aquaculture industry for millennia, modern management measures to increase production output have only recently developed. Egypt's aquaculture industry has risen quickly during the last two decades because of a paradigm shift away from old, extensive, semi-intensive aquaculture systems and toward contemporary, intensive aquaculture systems. The private sector's emergence and small and medium-sized businesses have expanded aquaculture production.[9].

Egypt's aquaculture industry uses a variety of production systems, but semi-intensive earth ponds produce the majority of freshwater aquaculture output. Aquaculture production systems, both intense and extensive, exist and are developing. Semi-intensive and extended production methods, on the other hand, are widely accepted and use earth ponds, whereas extreme production systems frequently use concrete tanks.[10].

Table 1 Egypt's aquaculture production volume by species in 2014[9]

Fish species	*Production quantity (tons/year)*
Nile tilapia	*759,601*
Carps	*198,829*
Mullet	*119,645*
Gilthead Seabream	*16,967*
European Seabass	*15,167*
Catfish	*14,109*
Penaeus shrimp	*7235*
Meager	*5884*
Total	*1,137,437*

Cage aquaculture was introduced in the Nile river catchment in the early 1990s to produce Nile tilapia and silver carp; thus, floating cages are a significant aquaculture production system, with over 37,000 operational cages throughout the country approximately 249,385 tonnes of fish annually[11, 12].

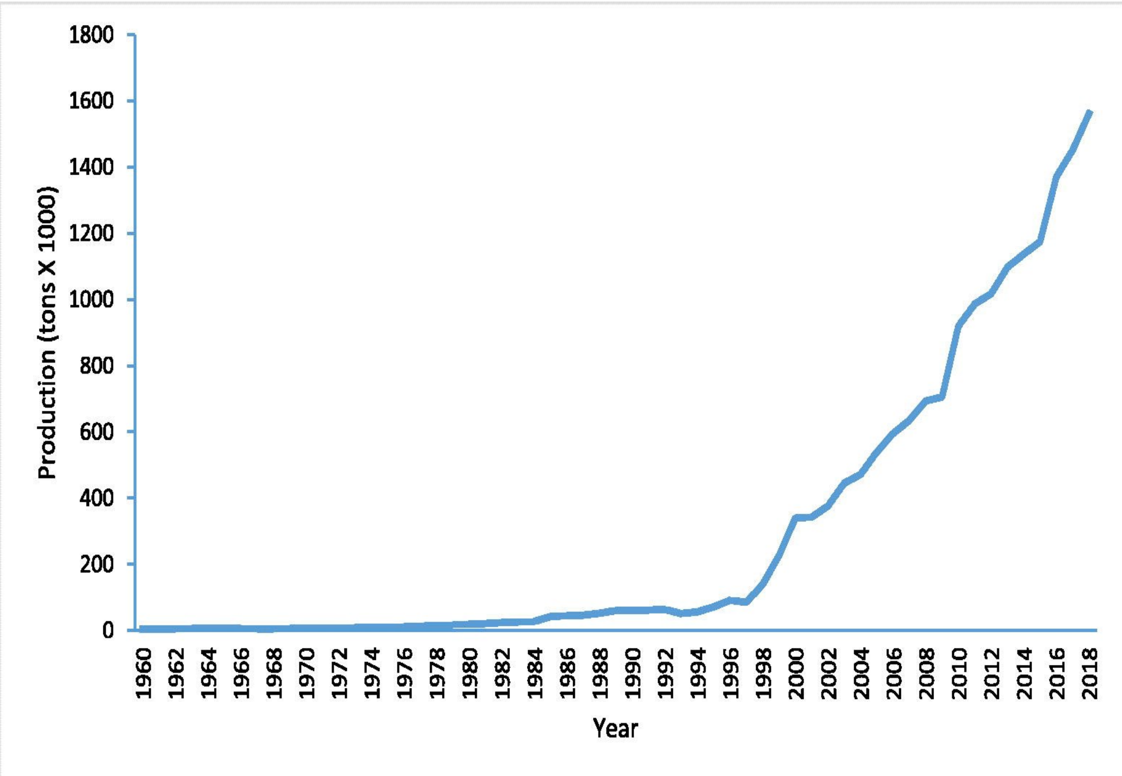

Figure 2 Aquaculture production in Egypt (1960–2018 in tons ×1000)[12]

5. MARITIME TOURISM.

Egypt's marine sector is vital to the country's economic development. As indicated by Egypt's 15 Mediterranean Sea seaports and 33 Red Sea seaports, Egypt's Geographically, it is situated at the crossroads of three continents: Europe, Asia, and Africa., with the Nile River and the Suez Canal connecting them, is crucial. To enhance Egypt's maritime industry, the government has drawn out a long-term plan to improve the efficiency and competitiveness of the country's marine ports. Despite the global threat posed by the Covid-19 pandemic, Egypt's maritime sector has continued to grow at a steady pace.

The Egyptian Mediterranean region is the world's most popular tourist destination; for beach tourism, the lack of rain is more important than a "pleasant temperature," with only a few respondents finding "high temperatures" to be a negative factor. This is consistent with the findings that "heat waves" are considered "not too awful" and have the slightest impact on climate change. Beachgoers consider temperatures of roughly 28°C, a "soft breeze," and a blue sky to be "perfect weather"[13]. Although there is no specific data on tourism in the Egyptian Mediterranean Sea during COVID-19, figure 3 depicts international tourism arrivals in Italy from European and South Mediterranean nations (2019-2020), indicating that COVID-19 has a significant impact on tourism.[14].

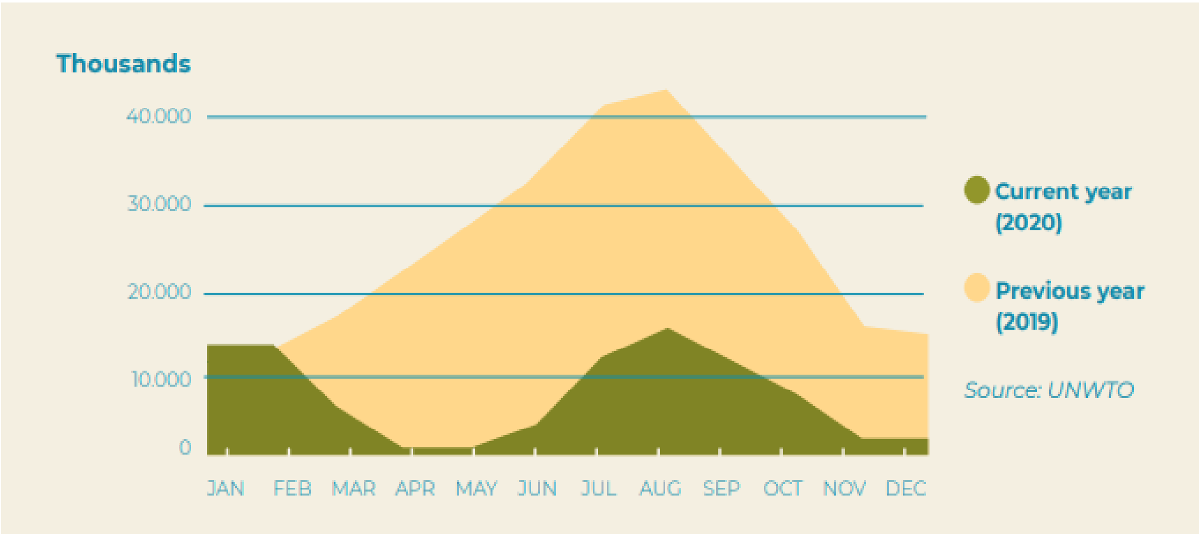

Figure 3 International Tourism Arrival in Italy in European South Mediterranean Countries (2019-2020)[14].

On the Mediterranean's northern shore, El Alamein is a fresh and promising location in Egypt. It stretches 46 kilometers from El Hammam (E) to Al Alamein (W), with longitudes of 28°56′20" E and 29°22′41.9″E, respectively, and latitudes of 30°37′0.5″ N and 30°53′34″ N. The boom of this region began in the 1980s, with a concentration on the creation of tourism settlements and resorts. The project is promoted by high-end hotels and resorts, such as Marina El Alamein. Tourism activities are seasonal due to the pleasant weather, with the peak season lasting from June to September, with July and August being the busiest months. The activities will continue since the new tourism centers in Al Alamein village will make it the crown of the Mediterranean cities. [15].

The Red Sea's major attraction is the coral reef. This vital and still-expanding industry employs people, earns the government's cash, and provides much-needed foreign revenue. In comparison to other nations, Egypt has several coral beaches, and nature-based tourism from a single ecosystem still has a low incoming tourism and revenue stream.[16].

Every year, approximately 1.2 million tourists visit the Red Sea shore, bringing in over $1.2 billion in foreign currency and supporting over 275,000 employments. The Red Sea has become one of Egypt's most popular tourist destinations due to its unique and endangered marine biodiversity[15].

Nile cruises are now widely recognized as an emerging tourism activity, and they have become one of the most important components of Egypt's tourism industry. Now in Egypt, the target is to provide a broad and present overview of Egyptian Nile Cruises and demonstrate their resuscitation's prospects for and difficulties [17]. The coronavirus (COVID-19) pandemic, which killed millions and infected millions more, is the first. At the same time, cruise ships were stranded at sea due to the closure of ports and border crossings to prevent the disease from spreading. The pandemic affected daily life, including the economy, and tourism was no exception. The other issue was the impact of terrorism on tourism, which the Egyptians could successfully address even though terrorism had resulted in significant losses.[18, 19].

6. The EASTERN MEDITERRANEAN: An EMERGING GAS PROVINCE.

The Eastern Mediterranean has grown into a significant natural gas processing hub. Egypt has successfully developed it, and the region's resources can radically alter the energy landscape in the Mediterranean. To develop these resources, a plethora of significant geopolitical barriers must be overcome. Egypt held several bidding rounds after 2013, and over 100 gas exploration and production concession agreements were inked. Numerous discoveries have resulted from successful bidding rounds and price policy changes. The Zohr field, discovered in August 2015 and had recoverable reserves ranging from 651.4 to 736.3 billion cubic meters, is the most famous. This is the largest gas discovery ever made in Egypt and the Mediterranean Sea. It has been heralded as a game-changer for Egypt's and the region's gas development.[20].

Egypt, Israel, the Republic of Cyprus, Palestine, Italy, Jordan, and Greece will meet in January 2020 to discuss energy issues. In addition, the Eastern Mediterranean Gas Forum was founded by representatives from France, the European Union (EU), and the World Bank. The EMGF intends to remove barriers to the region's exploitation of gas resources and improve regional cooperation within a multilateral framework. The key obstacles are as follows:

I. Reducing the cost of supplying gas from the eastern Mediterranean on regional and worldwide markets.

II. Markets are being opened to allow for hub activities and price discovery.

The World Bank assists efforts to address the second difficulty while also addressing the first. [21].

Infrastructure is required to transport gas created in individual countries to regional and global markets, whether in the EU or Asia, to make the natural gas export promise a reality. The region's countries, with the exception of Egypt and Israel, lack gas export infrastructure.

Egypt is both a market and an export route for East Mediterranean gas due to its domestic gas market and export infrastructure. Egypt's gas export infrastructure is well-developed, with pipelines and LNG terminals[22]. The discovery of natural gas has impacted geopolitical contacts in the Eastern Mediterranean Sea. The establishment of gas ownership is a crucial component determining whether

We foresee a scenario for rebuilding power relationships around the Eastern Mediterranean Sea, in which Competition or collaboration exists. [23].

The seven countries' ties differ in corporations and rivalry, resulting in the geopolitics of gas discovery and changes in regional and global energy markets that have standardized the implementation of viable development alternatives and the accomplishment of desired results.[24, 25].

7. DEVELOPMENT OF SEAPORTS.

Egypt has around 40 seaports, with 15 of them being commercial. On the other hand, Egypt's ports are dispersed due to a good planning and development strategy and restricted geographical connectivity. The maritime industry in the country is expected to have a $49 billion infrastructural gap. Nonetheless, government and corporate institutions have invested heavily in the industry throughout the last decade, notably through taxation, privatization, and attracting major foreign direct investment.

In this study, many problems confront port growth; the focus will be on the lake of ports' area and how the Egyptian navy resolves this problem in Abu Quir ports. The port's management in the smart management system is another critical topic.

7.1 ABU-QUIR TERMINAL CONTAINER DEVELOPMENT.

On 27 August 2020, Hutchison Ports and the Egyptian Navy inked a mega-contract to build and operate a new container port in Abu Qir, Egypt. Members of the management team traveled from Egypt, Hong Kong, and the United Kingdom to participate in the online signing ceremony. The new port will have a handling capacity of 2 million TEUs, a total quay length of 1,200 meters, and an 18-meter draught capable of handling future mega boats when it is finished. A 60-hectare container terminal yard and 100-hectares of land explicitly reserved for future growth are included in the project.

The major goal of this project is to address a lack of port facilities in the area by utilizing the fantastic position of Abou-Quir Bay to build one of the largest and most promising container terminals in the Mediterranean Sea, which the DEME group will carry out.

This vast project includes the reclamation of 1,000 hectares of new land, the deepening of the port's approach channel to 23 meters, and the dredging of a turning basin to a depth of 22 meters. Dredging will be done on a massive scale, with over 150 million m3 of water involved.

This ambitious megaproject's hive of economic activity provides extra space for Abu Qir's expansion and development, and it is expected to become a bustling financial center to complement Alexandria. A large multipurpose port complex could be built next to the Abu Qir Container Terminal.

In addition, the port terminal infrastructure will be constructed by developing a new Abo Quir village. The new terminal will be housed within Abu Qir Naval Base, naturally protected by the Abu Qir peninsula.

The greenfield project will be connected to the national road network as well as a new two-way highway with three lanes on each side and a residential bypass that will connect it to Alexandria in less than 20 kilometers, which will connect it to Cairo, the country's capital, and other major cities. In addition, close to the Abu Qir Container Terminal, which is currently under construction, a major multifunctional port complex could be built. Some countries have succeeded in overcoming the limitations of lake land ports by focusing on dry ports[26].

7.2 WORLD PORT SUSTAINABLE TECHNOLOGY PROGRAM.

Artificial intelligence, robots, the Internet of Things, motor vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing are all emerging technology breakthrough sectors that must be addressed to advance port management. It would significantly impact global trade and Competition, especially in seaports and logistics centers, essential parts of the global supply chain. The following fields should exist to build international ports:[27].

Artificial Intelligence (AI) Computers that are capable of "thinking" by recognizing complex patterns, interpreting data, forming conclusions, and making recommendations are referred to as "thinking."

The blockchain is a decentralized, secure, and transparent data recording and sharing system that does not rely on third-party intermediaries. The most well-known blockchain application is Bitcoin.

Computational technologies have improved computer intelligence to the point where they can process massive volumes of data at a faster rate than ever before. The introduction of the "cloud" has, on the other hand, enabled organizations to securely store and retrieve their data from any location with internet access at any time.

Virtual reality (VR) simulates the real world through immersive digital experiences, whereas augmented reality combines the digital and physical worlds.

Sensors, cloud computing platforms, Big Data analytics, Artificial Intelligence (AI), GPS tracking systems, radars, drones, real-time monitoring stations, and smart grids are all used in this forward-thinking approach to port logistics to collect, process, monitor, and analyze data and information about the economic, environmental, social, and technological aspects of port cities.[28].

For example, a single port officer is in charge of many jobs managed remotely using remote-control cranes, self-driving trucks, and IoT sensors.

These advantages are tempered by the emergence of a cyber threat that jeopardizes the security of global ports. The need of port facility security officers (PFSOs) to strengthen their cybersecurity knowledge and skills has been emphasized by cyberattacks on port facilities around the world continually [31].

8. THE BLUE ECONOMY and MARITIME SECURITY.

Maritime security and a strong naval force are essential for the blue economy to prosper. Several maritime security conferences, particularly in the Mediterranean Sea region, have backed the Blue Economy concept. The Eastern Mediterranean region's co-evolution and interdependence of maritime security and blue economy agendas establish two key linkages between blue economy and maritime security concerns.

To begin with, maritime security aids the Blue Economy by preserving routes of navigation, protecting rights to profitable marine resources and activities within claimed maritime authority zones and providing crucial sea graphic data to marine businesses.

Second, a source of economic development and expansion, marine security contributes to the blue economy in an often-ignored way. The demand for marine security capabilities will increase as the blue economy expands, increasing investment and expansion in these capabilities.

The expanding and increasingly diverse function of maritime security in the Blue Economy can be seen in many sectors of the Eastern Mediterranean region.[29].

The events in the eastern Mediterranean drew primarily unilateral responses from states, such are naval battles, increasing efforts to locate and extract natural gas, and legal and military measures to secure exclusive economic zones or EEZs. A few marine activities in this area sought wide, multiparty collaboration, and those formed limited, power-based quasi-alliances. This dynamic is insufficient to enhance regional maritime security or state maritime objectives. A regional maritime security plan is required to address regional attractions such as infrastructure development for the delivery of natural resources, risk management, effective migration regulation, and the resolution of border demarcation issues. Despite this, the region's current reality contradicts both theory and material incentives[30].

One of our neighbor east countries is also modernizing its fleet as part of its transition to the sea. Notably, it is acquiring a new class of German-built corvettes, the Sa'ar 6, the Israeli fleet's most advanced surface vessel. Israel is also modernizing its older Sa'ar 4.5 and Sa'ar 5 corvettes and has acquired highly capable German Dolphin 2–class submarines.

Another north neighbor country has embarked on a transformational expansion of its fleet—which is already the most powerful in the region. By 2023, Turkey will deploy twenty-four new ships, including four frigates and the country's first aircraft carrier. Additionally, it is expanding its domestic submarine program and retrofitting existing ships and submarines with modern navigation, weapon, and propulsion systems.

The Egyptian navy also expanded its fleet considerably over the past decade, including acquiring several German-built submarines due to Russia's seizure of two Mistral-class helicopter carriers in 2014. Egypt stepped in to buy the two ships, which it now operates as Gamal Abdel Nasser and Anwar el-Sadat[31].

9. CONCLUSIONS

The blue economy studies the marine environment's exploitation, preservation, and regeneration. The extent to which it can be interpreted differs depending on the organization. However, when discussing a sustainable development approach to coastal resources, the word is most employed in the context of international development. Traditional fisheries, aquaculture, maritime transport, coastal, marine, and maritime tourism, or other formal uses, to more emerging areas like coastal renewable energy, marine ecosystem services (i.e., blue carbon), seabed mining, and bioprospecting, the blue economy can cover a wide range of economic sectors.

Covid-19 had a bad impact on all maritime fields and stopped developing worldwide, although it hadn't had a bad impact because of its strategies and the lag contacts.

The Egyptian government has already embarked on a comprehensive scheme to upgrade its seaports, at the forefront of which is the Alexandria Port, and began establishing the promising seaports in the Mediterranean Sea Abu quirk port.

Aquaculture, maritime tourism, and the Eastern Mediterranean gas province are the hot issues dealing with the Egyptian governments. Besides developing the seaports infatuations and going toward smart and green ports.

Blue economy had changed the political geography in the eastern Mediterranean and nowadays the impact to the world economy due to latest development of the Russian- Ukraine war.

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Sustainable travel and tourists' satisfaction. The Case of Constanta, Romania

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ABSTRACT: The development of tourism is essential for the economic growth of maritime or mountainous areas. Lately, the emphasis is on the development of sustainable tourism, which will bring benefits to both the community and the planet. However, to achieve this goal, a series of measures and investments are needed, which must be applied by all stakeholders. The purpose of this paper is to analyse the relationship between the measures that support sustainable travel and the tourists' satisfaction. The results of the study show that not all the investments and efforts made by the accommodation units are favourably appreciated by tourists, because they prefer comfort, even if it is not necessarily sustainable. However, it seems that the investments aimed at the dimensions of nature, energy and greenhouse gases, and also waste are those that positively influence the sustainable tourist experience. The results of this study may be the starting point for other extensive research, as well as directions that the authorities could develop to promote pleasant sustainable tourism.

INTRODUCTION

In the last 2 years, the Coronavirus pandemic has created global problems, affecting not only human health, but also the economic, cultural or natural environment (Muhammad et al., 2020). The restrictions imposed with the declaration of the pandemic have closed many borders, the tourism sector being directly affected by these measures. Many people have turned their attention to domestic tourism, and have begun to visit more of the tourist attractions in their own country. With this phenomenon, there has been a growing awareness among consumers, companies, and governments about the need to prioritize not only profit but also people and the planet (Trends HRB, 2021). A solution could be to ensure sustainable tourism strategies that contribute to the promotion of rural and regional tourism in the main tourist cities. In addition, in countries such as Sweden, Finland, and Austria, sustainable tourism is complemented by the development of efficient transport infrastructure and alternative forms of travel, with an emphasis on transforming traditional accommodation into sustainable ones (Trends HRB, 2021).

At the European Union level, several projects support the growth of responsible and sustainable tourism, some of them targeting the development of some training programs that teach people to develop their "green" and digital skills that can be implemented in tourism, the implementation of mechanisms to reduce the impact on the environment, to obtain eco-certificates and eco-labels to certify the sustainable efforts of the accommodation units, to promote the destinations less known by tourists, to avoid the overcrowding of certain cities (Wall-street, 2019).

In Romania, the creation of a sustainable tourist experience is just at the beginning, this being noted especially by the potential developed in the area of agro-tourism (pottery workshops, visits the sheepfold, beekeeping, various craft workshops). Many of the houses are transformed into spaces of accommodation for tourists, it is practically an approach and a greater integration of the tourist in the local life (Life&travel, 2021). Ensuring sustainable tourism is conditioned by the generation of a minimal impact on the environment, being necessary to focus attention on the exploitation of resources below the limit of its renewal. However, the population of Romania is still not very educated in terms of sustainability, Romania is spending and wasting more than other European countries (Foodwaste, 2016). In addition, during travel, unfortunately, tourists do not always use trash cans to dispose of food waste, nor do they selectively collect waste, or do not behave carefully with the environment. However, tourists consider that the problem is not necessarily their behaviour, motivating the fact that there are not the necessary facilities to behave responsibly neither around the tourist objectives nor around the accommodation units. Thus, they are the ones who signal dissatisfaction regarding the tourist experience (Protv news, 2014).

However, in recent years, the owners of accommodation units in Romania have started to invest in various methods that will contribute to the achievement of sustainable tourism (Horeca, 2021). In this context, this paper aims to analyze the factors that influence the level of tourists' satisfaction visiting a tourist city in Romania and identify those measures to ensure a sustainable trip that influences the level of tourists' satisfaction.

LITERATURE REVIEW

Sustainable tourism

Sustainable tourism refers to all measures taken to protect the environment, to improve the quality of life, to ensure cultural diversity, and also a dynamic economy that can provide jobs and prosperity for all stakeholders (The Tourism Sustainability Group, 2007). Sustainable tourism is also defined as "all forms of activities, management, and development of tourism that preserve natural, economic, and social integrity and guarantee the maintenance of natural and cultural resources" (Niedziolka, 2012). The keywords used to describe sustainable tourism are also responsible tourism, ecotourism, green tourism, fair trade tourism, or conscious tourism (Smith, 2017).

The concept of sustainable tourism is based on 3 important pillars: ecological, economic, and social sustainability (Lozano & Huisingh, 2011). These dimensions should be treated together and not separately, creating a unitary framework to support sustainable tourism (Voinov & Smith, 2008), minimize the negative tourism impacts, and also maximize the positive impact on the environment, economy, and society (Mitra, 2018). These 3 pillars can also stay at the basis of the tourists' satisfaction. This statement can be supported by several studies, which analyze the relationship between various factors associated with sustainable tourism and tourists' satisfaction. In 2021, Jasrotia et al. (2021) analyzed sustainable tourism in India and the impact of sustainable tourism on tourists' satisfaction. The results of this study highlighted a positive relationship of environmental, sociocultural, and institutional sustainability dimensions on tourists' satisfaction. Awang et al. (2018) studied how green practices affect customer satisfaction. The results of their study revealed that tourists' educational background moderates the relationship between green practices and customer satisfaction. Even if the investments in green technology can positively affect customer satisfaction, the existing organizational culture within the accommodation units can play a partially mediating role acting as a significant intermediate variable between customer satisfaction and investments in green technology (Barbu et al., 2018). Thus, the emphasis on employees and the development of an organizational culture based on the values and principles of ensuring sustainable tourism can positively affect customer satisfaction (Barbu et al., 2018). In an official report on Best Environmental Management Practice in the Tourism Sector (Styles et al., 2013), the following important directions are mentioned on which nations must focus if they wish to achieve sustainable tourism: environmental education, green area management, energy efficiency, water efficiency, waste minimization, wastewater management.

Whether or not the accommodation units invest in measures to ensure sustainable tourism, they prefer to post their offers on tourism platforms due to the marketing advantages offered by them (David-Negre, et al., 2018). The Booking.com platform is one of the favourite platforms for tourists in Romania who want to book a stay in the country, or abroad, as they can see much easier the availability of the accommodation units, their prices, the facilities offered, they can read reviews from other tourists and can book the desired accommodation at any time. The Booking.com platform also offers the possibility to select the properties that have made investments to ensure a sustainable trip for tourists (Booking.com, 2021). To categorize the accommodation units into ones that offer sustainable travel, the Booking.com platform analyzed the actions undertaken by the accommodation units on 5 main categories: Waste, Water, Energy and greenhouse gases, Destination and community, and Nature (Booking.com, 2021).

The case of Constanta, Romania

Constanta is one of the most important cities in Romania, being the capital of Constanta county, the 5th in Romania in terms of the number of inhabitants (758,186 inhabitants, on July 1, 2021), in 2020 registering a total number of 1,004,521 tourists (Constanta County Directorate of Statistics, 2021). The city of Constanta has a very important social, economic, political, and cultural role for Romania, being also one of the most famous tourist cities from the Romanian Black Sea coast (Moraru et al., 2021). This is the main attraction for tourists both because of the nearby beaches and because of the tourist attractions, such as The Holiday Village Mamaia, Dolphinarium, Aquarium, Constanta Casino, Telegondola Mamaia, Aqua Magic Mamaia, Tomis Yachting Club and Marina, Museum of National History and Archeology, Neversea music festival. In addition, Constanta is also a port city, being the most important seaport in Romania, but also the fourth largest in Europe (Romania Tourism, 2021).

The beaches of Constanta stretch for about 13 km, from Tomis Port to Mamaia resort (Moraru et al., 2021). Both due to these beaches and due to the tourist attractions, Constanta stands out as an important destination for tourists, both for Romanians and foreigners. Regarding the number of tourist arrivals in the accommodation units in Constanta, it is found that until 2019, the number of foreign and Romanian tourists has been increasing since year after year, the Romanians continue to visit the coast even at the beginning of the pandemic. Instead, foreigners were more reluctant to leave the country and visit the city of Constanta and the coastal area, their number being almost 6 times lower than that recorded in 2018 (National Institute of Statistics, 2021).

Being such an important city on the map of Romania, the city of Constanta went through an analysis process to determine the main aspects that could be implemented to transform the city into a sustainable one. The process is long and difficult, but especially bureaucratic, aimed at creating additional green spaces in the city, increasing the energy performance of buildings, high-efficiency cogeneration, and eco-efficient street lighting, using the local potential of renewable energy sources and eco-urban mobility achieved through intelligent and secure traffic management, including the implementation of electro-mobility (Covenant of Mayors, 2016). The actions carried out by the authorities regarding the promotion of the Sustainable Energy Action Plan of Constanta municipality, also took into account the encouragement of the accommodation units to offer sustainable travels (Covenant of Mayors, 2016), by reducing water consumption, electricity, food waste (Barbu et al., 2018). Thus, the accommodation units in Constanta were able to participate individually in creating an improved level of sustainable tourism in the area.

METHODOLOGY

The authors' research consisted of four stages. Firstly, the authors conducted secondary research, analyzing data on tourism in Constanta on specialized websites and in statistical publications related to Constanta County (e.g. National Institute of Statistics), as well as in the papers of other authors who addressed the topic of sustainable tourism, consulting international databases (e.g. Scopus, Springer). Secondly, the authors focused on the online platforms used to book tourist accommodation, choosing the Booking.com platform for this case study. In this regard, the authors selected the accommodations from Constanta that offer sustainable travel, collecting data on the appreciation and satisfaction of tourists who were accommodated in these units. Thirdly, the authors analyze the reviews on Booking.com, as well as analyze the descriptions and pictures posted on this platform, after which the authors determined what were the types of measures that the analyzed accommodation units implemented to ensure a sustainable trip. Fourthly, the collected data were processed and analyzed using SPSS statistical software. To analyze the relationship between tourists' satisfaction and sustainable travel measure, correlation tests and t-tests for independent samples were applied.

RESULTS

By searching accommodations units from Constanta on the Booking.com platform, there were identified 486 accommodation units. By selecting the filter with the properties that have made investments to ensure a sustainable trip for tourists, the authors found that out of the 486 accommodation units listed on Booking.com, only 9 of them implemented practices that ensure the sustainability of travel. For the 9 accommodation units that offer sustainable travel, the following variables were followed: type of property, number of reviews, the overall score of satisfaction, the minimum number of rooms offered for rent, price per night for 2 people both in the off-season, and in peak season, distance from the city center, distance from the beach, the average rating for the evaluation by tourists of employees, location, cleanliness, comfort, facilities, free Wi-Fi, and the overall rating for the value for the proposed price. For the off-season price, 1-night accommodation was analyzed for the period March 22-23, and for the price for the summer season, the period July 22-23 was analyzed (Table 1).

Table 1. The characteristics of the 9 accommodation units that offer sustainable travel

No	*Type of property*	*R*	*Sc*	*Ro*	*P.ES*	*P.S*	*DfC*	*DfB*	*S*	*L*	*Cl*	*Co*	*V*	*F*	*W*
1	H	370	9.7	1	88	358	1.7	1	9.8	9.6	9.8	9.8	9.8	9.7	9.7
2	H	805	9.6	1	306	483	1.4	1.3	9.7	8.9	9.7	9.7	9.5	9.7	9.9
3	Gh	476	9.4	1	148	290	4.1	3.2	9.6	8.7	9.6	9.5	9.5	9.4	9.4
4	Gh	15	9.8	1	100	400	2.3	2	10	9.5	10	9.8	9.8	9.8	9.9
5	Ap	5	8.7	2	2536	2818	5.1	1.5	9.5	6.5	9.5	8.5	9.5	9	8.7
6	Ap	37	9.5	2	98	334	1.3	0.2	9.4	9.5	9.5	9.5	9.3	9.5	9.8
7	Gh	5	9.8	2	527	607	0.3	750	10	10	9.5	10	9.5	10	9.9
8	Ap	66	8.5	2	300	300	5	1	8.5	8.8	8.8	8.5	8.5	8.4	8.2
9	Ap	66	8.5	2	2930	2930	5.1	1.5	8.5	8.4	8.2	8.7	8.7	8.5	8.8

Note: 1-Victory Sea House, 2-JMR Royal, 3-Relax Eaza - Casa cu Hamac, 4-Pensiune Mirada, 5-City Living Apartments Constanta, 6-Tomis 105, 7- Casa Goldring, 8-Apartament in Constanta, 9-Constanta Residence Apartments; H- Hotel; Ap-Apartament; Gh-Guest house; R- Reviews; Sc-Score; Ro- Number of rooms; P.ES-Price per night, off-season; P.S-Price per night, peak season; DfC-Distance from the center; DfB-Distance from the beach; S-Staff; L-Location; Cl-Cleanliness; Co-Comfort; V-Value for money; F-Facilities; W- Free Wi-Fi.; The data were valid on 20 December 2021

Source: adapted from Booking.com, 2021

The results show that all 9 units have implemented additional measures for health and safety, 2 of these units being hotels, 3 guest houses, and the rest apartments. If in the case of apartments, the price did not vary much, for many remaining even constant, it is noticeable that in the case of other accommodation units, the difference in season makes the prices increase up to 4 times.

To see if certain actions of the accommodation units influence the tourists' satisfaction (which is analyzed by the overall score of satisfaction and the value for money score), the correlations between the collected variables were analyzed (Table 2).

Table 2. Correlations between the analyzed variables

	R	*Sc*	*V*	*P.ES*	*P.S*	*DfC*	*DfB*	*S*	*L*	*Cl*	*Co*	*F*	*w*
Sc	0.309	1	0.819**	-0.703*	-0.660	-0.892**	0.355	0.894**	0.692*	0.822**	0.980**	0.977**	0.956**
V	0.269	0.819**	1	-0.373	-0.291	-0.588	0.130	0.955**	0.198	0.912**	0.732*	0.872**	0.773*
P.ES	-0.338	-0.703*	-0.373	1	0.995**	0.618	-0.085	-0.474	-0.726*	-0.634	-0.677	-0.583	-0.545
P.S	-0.337	-0.660	-0.291	0.995**	1	0.595	-0.116	-0.409	-0.749*	-0.559	-0.650	-0.533	-0.502

*Note: N=9, **. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed); R- Reviews; Sc-Score; P.ES-Price per night, off-season; P.S-Price per night, peak season; DfC-Distance from the center; DfB-Distance from the beach; S-Staff; L-Location; Cl-Cleanliness; Co-Comfort; V-Value for money; F-Facilities; W-Free wifi.*

Thus, it is found that there are very strong positive correlations between the overall score of the satisfaction and the value for money score ($r=0.819$, $p<0.01$), the score for interaction with staff ($r=0.894$, $p<0.01$), the score for cleanliness ($r=0.822$, $p<0.01$), comfort score ($r=0.980$, $p<0.01$), facility score (0.977, $p<0.01$) and Wi-Fi score ($r=0.956$, $p<0.01$). Negative correlations (at least strong) can be noticed between the general score of satisfaction and the price per night in the off-season ($r=-0.703$, $p<0.05$) and the distance from the center ($r=-0.892$, $p<0.01$). The value for money is very strongly influenced by the grade for interaction with employees ($r=0.955$, $p<0.01$), the grade for cleaning ($r=0.912$, $p<0.01$) and the grade for facility ($r=0.872$, $p<0.01$). The value for money is also strongly influenced by the comfort level ($r=-0.732$, $p<0.05$) or Wi-Fi ($r=0.773$, $p<0.05$). It is found that the price, the location, the distance from the beach or the city center do not influence the value for money, tourists putting more emphasis on the efforts that the accommodation units make to ensure a more beautiful experience. Regarding the price per night, it seems that the accommodation units set these prices depending on how appreciated the unit is in terms of location ($r=-0.726$, $p<0.05$; $r=-0.749$, $p<0.05$), being willing to offer a lower price to attract customers faster, if they appreciate the position of the accommodation unit and not necessarily the other facilities.

Next, the authors focused on analyzing how the tourists' appreciation is influenced by the actions taken by the accommodation units to ensure a sustainable trip. The tourists' appreciation was analyzed through the general score of satisfaction, but also through the value for money score. For the actions related to ensuring a sustainable trip, the actions undertaken by the accommodation units in terms of 5 important dimensions were analyzed: Destination and community, Nature, Energy and greenhouse gases, Waste and Water.

For the Nature dimension, the authors analyzed whether the overall score of satisfaction and the value for money score are influenced by the following 2 variables: green spaces such as gardens/rooftop gardens on the property, most food provided is organic (Table 3).

Table 3. Independent Samples Test for the score, value for money, and Nature

			Levene's Test for Equality of Variances		*t-test for Equality of Means*						
Sustainable measures	*Tourist's perception*	*Variance*	*F*	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
										Lower	*Upper*
Green spaces such as gardens/rooftop gardens on the property	Score	E.v.a	15.829	0.005	-2.474	7	0.043	-0.715	0.289	-1.398	-0.032
		E.v.n.a			-2.731	5.138	0.04	-0.715	0.262	-1.383	-0.047
	Value for money	E.v.a	12.153	0.01	-2.203	7	0.063	-0.55	0.25	-1.14	0.04
		E.v.n.a			-2.424	5.275	0.057	-0.55	0.227	-1.124	0.024
Most food provided is organic	Score	E.v.a	0.819	0.396	-0.72	7	0.495	-0.275	0.382	-1.178	0.628
		E.v.n.a			-0.705	5.929	0.508	-0.275	0.39	-1.233	0.683
	Value for money	E.v.a	0.009	0.927	-0.108	7	0.917	-0.035	0.325	-0.803	0.733
		E.v.n.a			-0.109	6.764	0.917	-0.035	0.322	-0.801	0.731

Note: E.v.a.- Equal variances assumed; E.v.n.a.- Equal variances not assumed

The results of the t-test (t(5.13) = -2,731, p <0.05) indicated that the average overall score of satisfaction is higher for those accommodation units that have green spaces such as gardens / rooftop gardens on the property (M = 9.68, SD = 0.189), compared to those who do not ensure green spaces (M = 8.96, SD = 0.546).

For the Waste dimension, the authors analyzed whether the overall score of satisfaction and value for money are influenced by the following 6 variables: recycling bins available to guests and waste is recycled, the property makes efforts to reduce their food wastage, single-use plastic stirrers, straws, beverage bottles, plastic cups/ cutlery/plates not used (Table 4).

Table 4. Independent Samples Test for the score, value for money, and Waste dimension

			Levene's Test for Equality of Variances		*t-test for Equality of Means*						
Sustainable measures	*Tourist's perception*	*Variance*	*F*	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
										Lower	*Upper*
Recycling bins are available to guests and waste is recycled	Score	E.v.a	25.562	0.001	-3.182	7	0.015	-0.805	0.253	-1.403	-0.207
		E.v.n.a			-3.575	4.375	0.020	-0.805	0.225	-1.410	-0.200
	Value for money	E.v.a	12.153	0.010	-2.203	7	0.063	-0.550	0.250	-1.140	0.040
		E.v.n.a			-2.424	5.275	0.057	-0.550	0.227	-1.124	0.024
The property makes efforts to reduce their food wastage	Score	E.v.a	25.562	0.001	-3.182	7	0.015	-0.805	0.253	-1.403	-0.207
		E.v.n.a			-3.575	4.375	0.02	-0.805	0.225	-1.41	-0.2
	Value for money	E.v.a	12.153	0.01	-2.203	7	0.063	-0.55	0.25	-1.14	0.04
		E.v.n.a			-2.424	5.275	0.057	-0.55	0.227	-1.124	0.024
Single-use plastic stirrers not used	Score	E.v.a	14.328	0.007	-1.468	7	0.186	-0.607	0.414	-1.585	0.371
		E.v.n.a			-2.809	6.572	0.028	-0.607	0.216	-1.125	-0.089
	Value for money	E.v.a	1.496	0.261	-1.095	7	0.31	-0.393	0.359	-1.241	0.456
		E.v.n.a			-1.678	4.417	0.162	-0.393	0.234	-1.019	0.234
Single-use plastic straws not used	Score	E.v.a	21.907	0.002	-1.854	7	0.106	-0.633	0.342	-1.441	0.174
		E.v.n.a			-2.65	5.585	0.041	-0.633	0.239	-1.229	-0.038
	Value for money	E.v.a	3.845	0.091	-1.235	7	0.257	-0.383	0.31	-1.117	0.35
		E.v.n.a			-1.666	6.692	0.142	-0.383	0.23	-0.933	0.166
Single-use plastic beverage bottles not used	Score	E.v.a	12.354	0.010	-1.095	7	0.310	-0.479	0.437	-1.512	0.555
		E.v.n.a			-2.101	6.523	0.077	-0.479	0.228	-1.025	0.068
	Value for money	E.v.a	1.496	0.261	-1.095	7	0.310	-0.393	0.359	-1.241	0.456
		E.v.n.a			-1.678	4.417	0.162	-0.393	0.234	-1.019	0.234
Single-use plastic cups/ cutlery/plates not used	Score	E.v.a	10.11	0.015	0.928	7	0.384	0.414	0.446	-0.641	1.47
		E.v.n.a			1.383	4.001	0.239	0.414	0.3	-0.417	1.246
	Value for money	E.v.a	1.496	0.261	1.095	7	0.31	0.393	0.359	-0.456	1.241
		E.v.n.a			1.678	4.417	0.162	0.393	0.234	-0.234	1.019

Note: E.v.a.- Equal variances assumed; E.v.n.a.- Equal variances not assumed

The results of the t-tests indicated that there were significant differences between the overall score of satisfaction and the following variables: recycling bins available to guests and waste is recycled (t(4.375)= -3.575, p<0.05), the property makes efforts to reduce their food wastage (t(4.375)= -3.575, p<0.05), single-use plastic stirrers not used (t(6.572) = -2.809, p<0.05), single-use plastic straws not used (t(5.585)= -2.65, p<0.05). Thus, these results indicate that the average overall score is higher for situations where recycling bins are available to guests and waste is recycled (M=9.73, SD=0.96), the property makes efforts to reduce their food wastage (M=9.73, SD=0.096), single-use plastic stirrers are not used (M=9.75, SD = 0.071), and single-use plastic straws are also not used (M=9.7, SD=0.1) than the overall score where the accommodation units would not make these efforts.

For the Energy and greenhouse gases dimension, the authors analyzed whether the overall score of satisfaction and the value for money score are influenced by the following 4 variables: most food provided at the property is locally sourced, most lighting throughout the property uses energy-efficient led bulbs, offsets a portion of their carbon footprint, key card or motion-controlled electricity (Table 5).

Table 5. Independent Samples Test for the score, value for money, and Energy and greenhouse gases

			Levene's Test for Equality of Variances		*t-test for Equality of Means*						
Sustainable measures	*Tourist's perception*	*Variance*	*F*	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
										Lower	*Upper*
Most food provided at the property is locally sourced	Score	E.v.a	0.072	0.796	-1.583	7	0.157	-0.567	0.358	-1.413	0.28
		E.v.n.a			-1.545	3.851	0.2	-0.567	0.367	-1.6	0.467
	Value for money	E.v.a	0	1	-0.815	7	0.442	-0.267	0.327	-1.041	0.507
		E.v.n.a			-0.86	4.712	0.432	-0.267	0.31	-1.079	0.546
Most lighting throughout property uses energy-efficient LED bulbs	Score	E.v.a	0.007	0.936	-0.569	7	0.587	-0.220	0.387	-1.135	0.695
		E.v.n.a			-0.562	6.259	0.593	-0.220	0.391	-1.168	0.728
	Value for money	E.v.a	0.000	0.994	-0.170	7	0.870	-0.055	0.324	-0.822	0.712
		E.v.n.a			-0.171	6.692	0.870	-0.055	0.323	-0.825	0.715
Offsets a portion of their carbon footprint	Score	E.v.a	21.907	0.002	-1.854	7	0.106	-0.633	0.342	-1.441	0.174
		E.v.n.a			-2.65	5.585	0.041	-0.633	0.239	-1.229	-0.038
	Value for money	E.v.a	3.845	0.091	-1.235	7	0.257	-0.383	0.31	-1.117	0.35
		E.v.n.a			-1.666	6.692	0.142	-0.383	0.23	-0.933	0.166
Key card or motion-controlled electricity	Score	E.v.a	12.354	0.010	-1.095	7	0.310	-0.479	0.437	-1.512	0.555
		E.v.n.a			-2.101	6.523	0.077	-0.479	0.228	-1.025	0.068
	Value for money	E.v.a	1.496	0.261	-1.095	7	0.310	-0.393	0.359	-1.241	0.456
		E.v.n.a			-1.678	4.417	0.162	-0.393	0.234	-1.019	0.234

Note: E.v.a.- Equal variances assumed; E.v.n.a.- Equal variances not assumed

The results of the t-tests indicated that there was a significant difference only between the overall score of satisfaction and Offset a portion of their carbon footprint (t(5.585)= -2.65, $p<0.05$). Thus, this test indicates that the average overall score of satisfaction is higher for those units that offset a portion of their carbon footprint (M=9.7, SD=0.1), compared to those who do not ensure this (M=9.07, SD=0.568).

For the Destination and community dimension, it was analyzed whether the overall score of satisfaction and the value for money are influenced by the action of the staff in the accommodation units in terms of providing guests with information regarding local ecosystems, heritage, and culture, as well as visitor etiquette (Table 6).

Table 6. Independent Samples Test for the score, value for money, and Destination and community dimension

		Levene's Test for Equality of Variances		*t-test for Equality of Means*						
Tourist's perception	*Variance*	*F*	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
									Lower	*Upper*
Score	E.v.a	1.003	0.35	-1.613	7	0.151	-0.545	0.338	-1.344	0.254
	E.v.n.a			-1.58	5.959	0.166	-0.545	0.345	-1.391	0.301
Value for money	E.v.a	23.002	0.002	-2.755	7	0.028	-0.62	0.225	-1.152	-0.088
	E.v.n.a			-2.489	3.575	0.075	-0.62	0.249	-1.345	0.105

Note: E.v.a.- Equal variances assumed; E.v.n.a.- Equal variances not assumed

The results of the t-test indicated that the average overall score of satisfaction and the average value for money score do not depend on the actions taken by the representatives of the accommodation units in terms of providing guests with information regarding local ecosystems, heritage, and culture, as well as visitor etiquette.

For the Water dimension, the authors analyzed whether the overall score and the value for money score are influenced by the following 4 variables: water-efficient toilets, water-efficient showers, the option to opt-out of daily room cleaning, option to opt-out of daily room cleaning (Table 7).

Table 7. Independent Samples Test for the score, value for money, and water dimension

			Levene's Test for Equality of Variances		*t-test for Equality of Means*						
Sustainable measures	*Tourist's perception*	*Variance*	*F*	*Sig.*	*t*	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
										Lower	*Upper*
Water-efficient toilets	Score	E.v.a	2.414	0.164	-1.126	7	0.297	-0.410	0.364	-1.271	0.451
		E.v.n.a			-1.073	5.053	0.332	-0.410	0.382	-1.389	0.569
	Value for money	E.v.a	20.366	0.003	-1.369	7	0.213	-0.395	0.289	-1.077	0.287
		E.v.n.a			-1.227	3.397	0.298	-0.395	0.322	-1.355	0.565
Water-efficient showers	Score	E.v.a	.219	0.654	-0.200	7	0.847	-0.083	0.416	-1.067	0.900
		E.v.n.a			-0.207	4.469	0.845	-0.083	0.402	-1.155	0.988
	Value for money	E.v.a	3.845	0.091	-1.235	7	0.257	-0.383	0.310	-1.117	0.350
		E.v.n.a			-1.666	6.692	0.142	-0.383	0.230	-0.933	0.166
Option to opt-out of daily room cleaning	Score	E.v.a	38.955	0	1.13	7	0.296	0.433	0.384	-0.474	1.34
		E.v.n.a			1.53	6.637	0.172	0.433	0.283	-0.244	1.111
	Value for money	E.v.a	3.514	0.103	0.871	7	0.413	0.283	0.325	-0.486	1.053
		E.v.n.a			1.101	6.963	0.308	0.283	0.257	-0.326	0.893
Option to opt-out of daily room cleaning	Score	E.v.a	38.955	0	1.13	7	0.296	0.433	0.384	-0.474	1.34
		E.v.n.a			1.53	6.637	0.172	0.433	0.283	-0.244	1.111
	Value for money	E.v.a	3.514	0.103	0.871	7	0.413	0.283	0.325	-0.486	1.053
		E.v.n.a			1.101	6.963	0.308	0.283	0.257	-0.326	0.893

Note: E.v.a.- Equal variances assumed; E.v.n.a.- Equal variances not assumed

The results of the t-tests indicated that there were no significant differences in averages between the overall score of satisfaction or the value for money score and the actions taken by the accommodation units to reduce water consumption.

CONCLUSIONS

The results of this study present the factors that influence the tourists' level of satisfaction regarding their sustainable travel. Firstly, the overall score of their satisfaction and the average value for money score were analyzed. On one hand, the overall score of tourists' satisfaction was influenced by the interaction with staff, the cleanliness of the rooms, the comfort, the Wi-Fi, and the facilities offered by the accommodation units (in a positive way) but also by the price per night in the off-season and the distance from the center (in a negative way). On the other hand, the value for money was mostly influenced by the interaction with staff, the cleanliness of the rooms, and the facilities offered by the accommodation units. Furthermore, the value for money perception strongly influences the overall score of satisfaction. Those results highlight the fact that investing in different facilities and maintaining a high level of cleaning could be the basis of ensuring a good perception in terms of tourists' satisfaction. Moreover, the accommodation units would have a lot to gain if they hire friendly staff who are empathetic and attentive to the needs of their clients. Even a simple training of existing staff could make the difference in terms of a pleasant accommodation.

Secondly, the results of this study show that the tourists' perception regarding the value for money is not influenced by the sustainable travel measures, however, the overall score is the one that can be positively affected by these actions. Even though staff plays an important role in increasing the overall score and the value for money score, it seems that this factor is not perceived as being an important part of ensuring a pleasant sustainable trip. Thus, even if the employees provide guests with information regarding local ecosystems, heritage, and culture, as well as visitor etiquette, as part of supporting sustainable tourism, tourists do not consider this measure necessary in assessing their tourism experience. Also, their overall score of satisfaction is not influenced by the actions taken by the accommodation units to reduce water consumption.

Among the factors necessary to ensure sustainable travel that could influence the tourists' satisfaction, the following dimensions can be mentioned: nature, energy and greenhouse gases, and also waste. The results of this study highlight the fact that the overall score of tourists' satisfaction can be positively influenced by the following sustainable measures: ensuring a green space near the accommodation unit, offsetting part of the accommodation unit carbon footprint through various investments, providing more recycling bins, recycling waste, making efforts to reduce food wastage, and replacing all that disposable plastic objects with sustainable ones.

Thus, it is found that despite the efforts made by the accommodation units in ensuring sustainable travel, not all of them are appreciated by tourists. It seems that they are more focused on the accommodation facilities that offer them comfort, even if those facilities are not necessarily the most sustainable. This sad situation can also be explained by the lack of tourists' education in terms of sustainability and sustainable tourism. If the authorities manage to make some tv-spots or promotional materials that show the effects of sustainable tourism or the difference between sustainable and regular accommodation, maybe then tourists would appreciate more the investments made by accommodation units that want to ensure sustainable travel. Thus, these units would be more motivated to implement more measures to offer tourists the experience of sustainable travel.

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"Innovative Investments in

Blue Economy "

CONTAINER TERMINALS COLLABORATION: THE CASE OF NATIONAL CONTAINER TERMINALS OF EGYPT.

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Key words: Horizontal collaboration, Co-option, Container terminals collaboration.

ABSTRACT: The benefits of collaborating can be classified into efficiency / cost reduction, knowledge and competency, positioning of the terminal, as well as marketing and service benefits. This study investigates the horizontal collaboration initiatives of container terminals, the case the three National Container Terminals of Egypt. It also examines how collaboration initiative can be managed effectively.

At first a literature review has been conducted. Secondly, an in-depth case study based on semi-structured interviews with managers from the three National Container Terminals of Alexandria, Port Said and Damietta have been carried out. Both (literature and case study) have been compared and discussed.

This paper shows that terminals may collaborate in the field of marketing and business development, operations, administrative and regulatory. It also handles joint purchasing, joint coordination of operational sequences and consulting, as additional activities.

This study provides useful strategies and recommendation for decision makers in three National Container Terminals of Egypt. It also, makes several contributions to the limited available literature of horizontal collaboration in the container terminal industry.

1. INTRODUCTON

Today, ports cannot maintain a monopoly status as in the past. Many changes and several trends, such the growth of shipping alliances, the growing numbers of mega container ship, and overcapacity in the supply side leads to severe competition among ports and terminals in Egypt and East Mediterranean region. To comply with such increasing competition phenomena, ports and terminals are forced to apply new strategies. One approach to stay competitive in such business environment is the implementation of collaborative initiatives between ports and terminals. By collaborating, ports, can gain benefits that cannot be obtained in standalone basis.

With regard to National Container Terminals of Egypt (NCTE), the good news come from the ownership structure of these container terminals. They are running under to the same umbrella which is the "Holding company for maritime and land transport" (HCMLT). This key factor can greatly facilitate the implementation of proposed collaboration initiatives and achieve a competitive advantage using its unique ownership structure.

1.1. Research objectives

The main objective of this research is to investigate the horizon of collaboration between the National Container Terminals of Egypt (NCTE). This includes the identification of drivers for collaboration as well as potential benefits, and barriers. Finally, to search how to manage such collaboration initiatives effectively.

1.2. Research questions

With refers to the NCTE, the research questions are:

- What are the collaboration initiatives currently applied in the port and terminal industry?
- What are the drivers for collaboration initiatives?
- What are the main barriers that hinder application of the collaborative initiatives?
- How to effectively manage the collaboration initiatives?

2. LITERATURE REVIEW

2.1 Concept of collaboration

The definition of UNCDAT describes collaboration as "joint activities carried out by at least two parties who are mutually committed, and gain benefits from the co-operation such as financial savings, improvements in quality of services, increased market share, etc..".
According to Daugherty et al. "collaboration involves two or more independent companies working together to jointly achieve greater success ". This definition is clearly focused on the objective, which is supposed to be a "greater success".

2.2 Forms of collaboration

Basically, there are two forms of collaboration; vertical and horizontal. Beside the vertical and horizontal form, Sitatunga and Sridharan (2002) defined the lateral form of collaboration.

In a supply chain context, the vertical type includes collaboration with customers and suppliers. Vertical collaboration within the port industry mainly deals with supply chain integration of ports and includes activities like integration between transport modes, providing value added services, information technology systems, strengthen the relationship with maritime shipping companies, and inland transport service providers (Song and Panayides, 2008) as well as providing dedicated terminals to shippers (Bichou and Gray, 2005).

The horizontal form of collaboration is a relationship between competitors, non- competitors or internal departments or business units. The lateral form of collaboration is a combination of the horizontal and vertical form and mainly aims "to gain more flexibility by combining and sharing capabilities".

2.3 Horizontal collaboration in the maritime industry

There are two types of port co-operation which are: complementary co-operation and co-opetition. Hwang and Chiang (2010) explain that "complementary co-operation existed when a port needs another port(s). Relationships between hub and spoke ports are one example mentioned by Yap and Lam (2004).

Co-opetition can be defined as a mixture of cooperation and competition. Co-opetition is a strategic approach for organizations in the same market to reach a win-win situation and strengthen each other against outsiders. Researches in this area confirms that there is a positive correlation of the level of co-opetitive relationships and the ability to remain competitive. Co-opetition based on the theory, that beside the group of suppliers, customers and competitors, there is another group interacting in business which can be called "complementors" (Brandenburger and Nalebuff, 1996). So, complementor as a player whose products or services are complementary to the company´s production".

2.4 Collaboration initiatives:

UNCDAT (1996), stated that collaboration initiatives like exchange of know-how, standardization of statistics and tariffs, training, and participation in the activities of regional and international port associations are quite often. These findings are also cope with Brooks et al. (2011) who mentioned 21 initiatives of port collaboration in more than 70 ports worldwide. Ports located in the same geographical region often apply initiatives include joint regional marketing and joint development of infrastructure. Common collaboration practices for ports located far from each other are technical co-operation, sharing of information on port development, joint training, and common positions at international fora.

Song (2004) claimed that collaboration in the way of co-opetiton is a new concept in the port industry. Scholars divide collaboration initiatives to formal and informal. Formal collaboration based on written contracts. while, Informal collaborations are usually a react to a specific situation. As per Brooks et al. (2011), The categories of collaboration initiatives are: Administrative, regulatory, operations, marketing and business development. This research uses these categories as a basic overview of initiatives.

2.5 Drivers and benefits

A driver can be considered as a reason of why ports participate in collaboration initiatives. Song (2004) summarized co-opetition reasons in five different categories, namely strategic, economic, financial, operational, and marketing motivations. The results show that strategic motivations, which relate to port's market position, are the main reasons for co-opetition.

Shipping lines practice big pressures on container terminals. The fierce competition in the shipping market leads to confirmation of shipping alliances which have a strong bargaining power on ports and terminal operators. Alliances of shipping lines are jointly negotiating with ports for lower prices and better conditions. Losing one alliance, often results in a big loss of sales and revenues. Also, the penetration of shipping lines in terminal operations business strengthened their market power against common terminals. As a reaction, container ports are forced to provide high level quality services by all possible means including collaborating with other ports".

Furthermore, Song (2003) mentioned that increased ship size is influencing the competition of ports. Due to draft limits of most ports, only few ports are able to accommodate and efficiently operate such mega container ships. Technological development of port facilities is another driver for collaboration. These factors are the main reasons for ports collaboration. Ports should react by forming "alliances with their competitors as a co-operative strategy".

Brooks et al. (2011) identified the following benefits of port co-operation: (1) Better use of assets in terms of efficiency, scale and scope; (2) Increase competencies; and (3) Gain positional advantages.

Efficiency / cost reduction

These benefits are gained in the form of financial performance, stability and efficiency. The benefits of economies of scale and scope achieved through capacity utilization as identified by several authors in the port literature.

Knowledge and competency

As a result of knowledge transfer and the leverage of complementary skills and operational procedures performance can be improved (Song, 2004). Ports may complement one another´s competitive advantage and thereby help to increase performance".

Positioning of the company

In order to reshape their position in the market, terminal operators can apply co-operative strategy as a useful option. Song (2004) states that not only expansion but also maintaining market shares is a benefit of collaboration.

Marketing and service

Joint marketing and promotion activities could lead to increase in traffic for the whole collaboration members. Within marketing category, Song (2004) mentioned the area of benefits in terms of customer services and improving service-quality.

2.6 Barriers

Co-operation based on market forces does not necessarily mean limited competition. In reality when ports collaborate "to create a common tariff-structure, this does not mean that they will apply the same prices or commercial attitude towards shipping lines". Ports can collaborate in some areas while compete in other areas. There is no possibility for ports to collaborate in all areas. Every port has its own routes, cargoes, decision makers and customers. UNCDAT (1996) mentioned different economic interests and commercial attitude as a barrier of collaboration of ports in different countries.

2.7 Determining and dividing the gains

Costs and gains from the collaboration initiatives should to be fairly shared. Many initiatives have been failed due to mistrust and a lack of fair specified rules of sharing the gains. Having clear and transparent fair rules are important and a sharing mechanism is necessary for a fair distribution of gains.

Negotiations between the partners should always result in a win-win situation. A positive approach to negotiations will have a positive impact to the collaboration initiative. Stressed negotiations would lead to a negative relationship.

2.8 Effective management of collaboration initiatives

There are four groups of horizontal relationships, namely information sharing, incentive alignment, relationship management, and information & communication technology.

Information sharing

Without proper sharing of information, collaborating parties will lack plans and consequently the initiative will not be managed well.

Incentive alignment

It is important that all parties are willing to share costs, risks and benefits, in order to achieve common goals.

Relationship management and contracts

Verstrepen et al. (2009) identified best practices for a successful collaboration in terms of relationship management which are regular face to face meetings, writing a record of each meeting and sending it to all partners, also differentiate between conflicts concerning strategic, operational, financial issues (hard conflicts), and conflicts concerning interpersonal or business cultural aspects (soft conflicts).

Many argue that a more open contract fits better to collaboration initiatives, as such initiatives mainly base on unpredictable future conditions which cannot be captured by a contract. That the most successful collaboration initiatives are based on a simple contract outlining only the basics. Nothing more is required if the parties are truly committed to each other. Capturing all detailed agreements with a contract may have a negative effect in practice and can lead to problems.

Information technology

As already mentioned, information sharing is crucial for the success of a collaboration initiative. To ensure information sharing, efficient communication must exist between both partners. Thus, contribute to a successful collaboration.

3. RESEARCH METHODOLGY

Due to the clearly qualitative nature of the topic, the study is mainly based on the "mono method" and data are collected using the qualitative procedure. Anyhow, in order to reduce the "method effect", a simplified quantitative analysis procedure called "content analysis" has been applied.

3.1 Data collection

For this study, primary and secondary data have been used.

3.2.1. Secondary data

The secondary data is "data that have already been collected for other purpose". In this paper, secondary data have been used for both, the literature review and the practical part of this research. The literature review is a proper part of a study and helps to answer the research questions.

This study basically uses company information, consulting reports and research studies to collect secondary data, in addition many other sources i.e., Internet databases have been scanned in order to find appropriate journal articles and papers.

3.2.2. Primary data

Primary data can be defined as new data, which is collected for the research propose. Several collecting methods can be used in case studies, including interviews, observation and document analysis. The primary data collection method used in this study are interviews.

Interviews

Saunders, Thornhill and Lewis (2009) distinguished interviews into structured, semi-structured and unstructured interviews. This study uses semi-structured interviews. The researcher takes a guideline of questions and topics to be covered, While the detailed questions vary from interview to interview. According to the flow of the conversation some questions may be skipped and others may be added. This form of interview has been carefully chosen to generate qualitative data and therefore fits into the qualitative case study approach of this study.

3.3 Sampling procedure

Managers from the three NCTE companies as well as from Holding Company for Maritime and Land Transport (HCMLT) in addition to some industry's expertise from shipping lines and port authority have been interviewed and classified. Those managers represent main departments of each company, namely: (1) top management, (2) operations, (3) engineering, (4) marketing, and (5) research & development. In addition to outsider experts. The researcher plan was to conduct 20 interviews 5 from each company of NCTE and 5 from outsider. The actual interviews reduced to 12.

3.4 Data analysis

The interviews have been transcripted and summarized in order to present a condensed overview for further analysis. The next step was to break down the interview data into categories to facilitate the analysis process. To bring all findings of the interviews together, a simplified form of content-analysis has been applied. In a following analysis, the research findings have been compared with the findings of the literature review to answer the research questions.

3.5 Research reliability

According to Saunders, Thornhill and Lewis (2009) reliability is proved when the same research project, conducted by another researchers results in nearly the same outcome. To avoid threats related to participant bias, anonymity has been guaranteed to each participant. Furthermore, each transcript has been sent to the participant for content-check. To overcome the information bias, secondary data such as organizational publications and reports have been used to reinforce and confirm the data provided from the interviews.

3.6 Research Validity

Biggam, (2008) states that research is valid when it is "acceptable to the research community". This research can be claimed as valid as it is based on data collection methods and analysis procedures that are carefully evaluated and chosen to be appropriate to this research. In addition, secondary data (company reports, consulting reports, scientific papers and press-releases) are used to complement the primary data and to foster the validity as well.

3.7 Research limitations

The main limitation of this study is the distinction of NCTE ownership structure. Also, the literature and the findings of the field research have been collected and analyzed qualitatively. Only a simplified form of content analysis has been applied to quantify data from the interviews.

4. CONTENT ANALYSIS

This section puts together the findings of the interviews. The interviews are analyzed using content analysis to quantify the findings. To use content analysis in a constructive way, it is necessary to create categories. Thus, the categories already created in the literature review have been used. The findings for each research subject are quantified and ranked.

4.1 Initiatives

NCTE companies used to cooperate in the area of development studies and market researches. Such activities usually coordinated by the principal HCMLT. Knowledge transfer is also a common practice between NCTE members, but it still needs more and needs to be executed in a systematic and more coordinated manner.

Until now, collaboration initiatives in terms of joint advertising and promotional activities are not exist. The three NCTE companies usually represents themselves as different organization at international exhibitions i.e., Marlog conference and exhibition organized by AASTMT. With regard to public relations the collaborative joint ventures are practiced occasionally, through the principal organization HCMLT.

The exchange of know-how is common collaboration practice between NCTE members, but it needs to be more organized and more systematic i.e., Applied Information systems. NCTE, in case of emergency, cooperate in the area of spare parts for different terminal equipment. One NCTE member can borrow or purchase a spare part until the ordered one arrive from foreigner supplier.

NCTE are part of what so called "Integration platform" which is a cooperation initiative to support and facilitate transactions between all companies under the umbrella of HCMLT; It gives the priorities and preference for transactions between these sister companies in their different business field, as per many of conducted interviews this initiative does not applied in a large scale due to many reasons out of this research scope. The three interviewees mentioned that common terminal development is mainly conducted to reduce cost and prevent duplication i.e., ERP System or TOS.

As a conclusion: NCTE already work together during the previous years, but in tight scale. they are still in an early stage of collaboration.

4.2. Drivers and benefits

Maintaining and extending the market position have been mentioned in all interviews as drivers. Nearly, most interviewee from NCTE members stated that the main reasons for conducting collaboration initiatives are the increasing competition and achieving more cargo volume. 8 out of 12 interviewees mentioned that collaboration could increase efficiency and utilization and therefore achieve more cargo volumes, while increased competition was mentioned by 10 interviewees. In most cases, it was not possible to separate the drivers from the benefits as the motivation are mainly of a beneficial nature. Companies collaborate in order to get the benefits like cost-reduction, improving competition position, joint protection of interests etc.

Cost reduction is ranked on the third position. Cost saving could be reached through economies of scale when jointly purchasing and jointly plan and conduct exhibitions presences (Interviews no. 1, 3, 4 and 6, 9, 10 and 11)

According to them, the benefit is more intangible i.e., improving competition position. Maintaining and increasing the market share can be treated as overall benefit as well. All interviewees mentioned this benefit. In addition, improving the market position is the major driver. Also reduce spare parts inventory.

Improving the service quality for customers have been mentioned four times mentioned in four interviews. From the analysis, service quality improvement can be reached by coordinating the operational and commercial activities.

In addition, knowledge transfer of market developments helps to adjust the service according to the needs of the customers. The majority of the respondents focused on benefits from a business and economic viewpoint.

4.3. Barriers

The willingness to collaborate has been mentioned many times, but the reasons behind collaboration come from different point of views. Three interviewees reported that many terminal operators are still working on internal improvements. According to one interviewee, the companies should start to see NCTE as one unit, where joint actions are more productive. The reason of unwillingness to collaborate is of more social nature. According to a managing director, sometimes there are interpersonal differences, which prevent working together. In addition, three interviewees did not see any barrier. Further barriers that have been mentioned are the special nature of each terminal, cargo composition i.e., transhipment/ local cargo, different interests (Interview no. 3, 4,7, 9, and 10), missing trust, lack of transparency. unwillingness to collaborate, missing rules and missing deadlines. In addition, the barriers of determining and dividing the gains, and negotiation have not been confirmed.

4.4 Effective Management

Most interviewees stated that information sharing and regular face to face meetings are the most important factor for effective collaboration process. Also, trust and transparency has been mentioned as an important facilitator as per interview no. 2, 4, 5, 9 and 12. It can be noted that NCTE follow a softer form of collaboration, where only oral agreements or principal (HCMLT) instructions have been made.

There was a proposal to form a cooperation team or a joint coordination committee to overcome problems which have their nature in different management styles Interview no. (5). Finally, the willingness to collaborate has been mentioned as a facilitator. Interviewee no. (1) stressed on the importance of leaving "old" pattern of thought of improving only internal performance and approach a more collective thinking.

5. CONCLUSION AND RECOMMENDATION

This part concludes the research by bringing together all the work; the findings of the literature review, the findings of the interviews and the findings of the comparison. The conclusion addresses all research questions. In addition, the researcher provides suggestions for colleagues who might wish to undertake future research in this area.

5.1. Summary of findings and results

There are some collaborative practices between the NCTE "in Damietta, Alexandria and Port Said". Both, the literature as well as this field study found many different initiatives which fit into the categories of marketing and business development, operations, administrative, and regulatory. Strong evidence of collaboration in the field of joint advertising and promotional activities has been found in this field research. Other interesting findings are the initiatives which have been mentioned rarely in the literature: Consulting, joint purchasing and joint coordination of operational sequences. Moreover, both sources indicate that collaboration between terminals is relatively a recent trend.

For the second research question about "drivers of the collaboration initiatives", the major driver is the increased competition. Other drivers are the bargaining power of shipping lines, increased efficiency in the maritime industry, larger ship size, technological development and increased requirements of shippers and shipping lines. Furthermore, the drivers "increasing amount of cargo volume".

The benefits that have been found in literature and have been confirmed in the interviews can be classified in the sections: efficiency / cost reduction, knowledge and competency, positioning of the company, and marketing & service benefits. Positioning the company in terms of market share has been strongly proved by the results of the field research. In addition, the benefit of cost reduction has been highlighted by the case study as an important benefit as also mentioned in the literature.

The third question regarding the main barriers: differences in management style and believes, missing trust, and different interests has been emphasized. differences of interaction between senior management, the unwillingness to collaborate, missing rules and missing time deadlines. Apart from that, the barriers of determining and dividing the gains, and negotiation have not been confirmed.

The last research question is about the effective management of collaboration initiatives. The most important three factors are: regular face to face meetings, information sharing and trust. In addition, this study has found that clear rules greatly facilitate collaboration initiatives, which are based on integration and merger activities like joint ventures, whereas "soft" agreements are more adequate for the remaining types of relationships. Moreover: The willingness to collaborate by leaving "old" pattern of thought.

At the end , the research questions have been answered theoretically by the literature review , also these questions answered by the case study of (NCTE) and by comparing both. It can be concluded that the overall findings of the literature are similar to the findings of the case study. Only some issues have not been confirmed i.e., environmental issues. In addition, the field research generated additional data to extend the academic literature of horizontal collaboration initiatives in the container terminal industry.

5.2 Recommendations:

- A port cannot maintain a monopoly status as in the past; One approach to stay competitive in such business environment is the implementation of collaborative initiatives between ports and terminals.

- The increasing bargaining power of shipping line alliances is increasing; Ports should react by forming "alliances with their competitors as a co-operative strategy".

- Benefits of port co-operation: (1) Better use of assets in terms of efficiency, scale and scope; (2) Increase competencies; and (3) Gain positional advantages.

- National Container Terminals of Egypt (NCTE) are running under one umbrella (HCMLT). This unique ownership structure can greatly facilitate more strategic, economic, financial, operational, and marketing collaboration initiatives and achieve a competitive advantage.

- Ports may complement one another´s competitive advantage and thereby help to increase performance".

- Joint marketing and promotion activities could lead to increase in traffic for the whole collaboration members.

- Ports can collaborate in some areas while compete in other areas. There is no possibility for ports to collaborate in all areas. Every port has its own routes, cargoes, decision makers and customers.

- Having clear and transparent fair rules are important and a sharing mechanism is necessary for a fair distribution of gains.

- Negotiations between the partners should always result in a win-win situation. A positive approach to negotiations will have a positive impact to the collaboration initiative. Stressed negotiations would lead to a negative relationship.

- Without proper sharing of information, collaborating parties will lack plans and consequently the initiative will not be managed well.

- It is important that all parties are willing to share costs, risks and benefits, in order to achieve common goals.

- Best practices for a successful collaboration in terms of relationship management are regular face to face meetings, writing a record of each meeting and sending it to all partners.

- It is important to differentiate between conflicts concerning strategic, operational, financial issues (hard conflicts), and conflicts concerning interpersonal or business cultural aspects (soft conflicts).

- The most successful collaboration initiatives are based on a simple agreement outlining only the basics. Nothing more is required if the parties are truly committed to each other. Capturing all detailed agreements within a contract may have a negative effect in practice and can lead to problems.

- There is a proposal to form a cooperation team or a joint coordination committee to overcome problems.

5.3. Further research opportunities:

The literature and the findings of this case study (NCTE) have been collected and analyzed qualitatively. Therefore, further research should concentrate on quantitative research methods and assess the findings statistically.

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THE IMPACT OF APPLYING SMART PORT CONCEPT ON ENHANCING THE PERFORMANCE OF AL-FAW GREAT PORT IN IRAQ

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ABSTRACT:

Generally speaking, Iraq suffers from the lack of a port that applies the concept of smart port management; which has led to putting Iraqi ports out of competition as a result of using paper management system. Hence, this has affected the productivity and efficiency of Iraqi ports, causing great losses with the long-time factor. In achieving the objectives of this research, the researcher has relied on descriptive-analytical approach. Therefore, an electronically designed questionnaire is used to achieve the aim of knowing the possibility of applying modern technology to Al-Faw great port.

An electronic questionnaire was distributed and analysed using SPSS program. Researchers have employed the international experiences applying smart ports concept to identify the most important requirements for its implementation. This research is limited to Al-Faw great port in Iraq for the year 2021.

Keywords: Smart port, SPSS, Al-Faw great port, Iraq.

1. INTRODUCTION:

In recent decades, according to the development that occurred in the ports by becoming a centre for value-added activities, these ports have become in need of a central base for electronically exchanging information in order to become an integrated logistical point. There has become an urgent need to connect the port community with an electronic network that provides port workers with all information and procedures accurately and timely. In the appropriate time in this context, electronic information systems are applied at every stage of port operation, which positively affects the traffic of ships, gate management, shipping operations, customs procedures, and the exchange of documents. Accordingly, this increases the quality of services provided to all parties dealing with the port.

Definitely, application of technology will contribute to the increase in the efficiency of the port; subsequently, this would help reduce the time of keeping the ship on the berth. Eventually the productivity of the port will be enhanced with the same potential. Thus, applying information technology will increase the port's competitiveness, and the importance of adopting the concept of smart ports has actually emerged and is of great interest to today's ports as it is the basis for its future development and survival (Belfkih and Sadeg, 2017).

In fact, employing modern technologies will transform traditional port services into interactive and dynamic services and increase their transparency. The electronic port management system is intended to manage the operations of the movement of ships, goods and containers that take place inside the port through an integrated electronic system.

This system provides advance planning of operations and real-time follow-up of their implementation from the site of the operation with the achievement of an electronic linkage and information communication among all authorities and institutions in port.

Al-Faw port project is a part of the dry canal project that connects the Arab Gulf to northern Europe and will have a significant impact on the Iraqi economy as it can play a major role in pushing the wheel of the Iraqi economy forward. Al-Faw great Port is distinguished by a privileged location that makes it capable of being a sustainable smart port for the transfer of trade from the East to the West through the dry canal in the Al-Faw peninsula to Turkey and from there to Europe. Moreover, Al-Faw great port contains 96 berths varying between containers, general cargos, and oil berths. A draft for all berths amounts to 19 meters and the area of the port is 54 square kilometres. Figure 1 shows the general plan of Al-Faw great port based on the plan of the Iraqi Ministry of Transport to develop Al-Faw great port.

2. LITEREATURE REVIEW:

In the information age of the global economic system, information and communication technology and efficient information flow have become a vital role in stimulating growth, promoting trade, attracting investments, and improving competitiveness and environmental factors. Therefore, it is important to determine the impact and importance of applying information and communication technology in ports and the transformation of ports from the traditional concept to smart ports.

El-Sakty (2016) explained that the importance of the concept of smart ports has increased in being strategic in recent years as a future direction in the maritime industry. This is due to the fact that the new trend of smart ports will lead to dependence on new administrative energy models that are based on low environmental impacts and embed innovations in both processes and technologies. Thus, smart ports will contribute to sustainability growth. Consequently, most countries and unions such as the European Union have issued new transport infrastructure policies with the purpose of strengthening transport networks around the world, removing technical bottlenecks and barriers, and reaching distant markets in a far lesser time than before. Undoubtedly, all these trends depend on investing in new technologies.

Implementation of modern technologies will make the port easy and smooth in applying the procedures for ships and goods, as well as saving time and effort and minimizing the procedures that workers have to go through in the port to perform and complete the transactions related to ships or goods. As a targeted result, the port's productivity rates will rise. Therefore, the main objective of smart ports is to be capable of meeting the needs and requirements of users and customers with a guarantee of sustainability, and generating high quality services (Jarda et al., 2018).

In this context, Dounioui et al., (2019) provided a model for the concept of the smart port by identifying its basic pillars as well as the basic components for the success of each pillar. It is known that technology and innovation, such as the Internet of Things (IoT) are a driving force behind the productivity of smart ports. Thus, this type of technology in the form of physical infrastructure and IT infrastructure may be the best way to see the benefits in a smart port environment.

The Internet of Things (IoT) aims to support and develop the transportation industry in general and ports in particular. Therefore, ports are looking for a smart concept in order to improve operations in the port and support the flow of transportation within the port. Actually, the presence of IoT in ports has become necessary.

Among its tools are sensors, communications and cloud computing to ensure that all elements of the port are connected together, which would help to make intelligent decisions as well as provide intelligent solutions for data collection and monitoring of the port.

Yau et al., (2020) focused on new areas of investigation in smart ports, including the use of the Internet of Things platform, technologies to reduce emissions and enhance efficiency. New technologies will facilitate port trade operations and make it possible to reduce port operations costs. Accordingly, ports will require the new processes of information technology, the absorption of highly skilled workers, the improvement of the social level of society, and finally all environmental problems should be taken into account.

Ismail (2021) studied the importance of future projects in Al-Faw great port in Iraq and its impact on increasing the competitiveness of Al-Faw great port. This research classified as descriptive research; where it relied on using SWOT during the year 2021; in order to define strengths and weaknesses, as well as opportunities and threats facing future planning operations of the Al-Faw port.

GAP ANALYSIS AND CONTRIBUTION

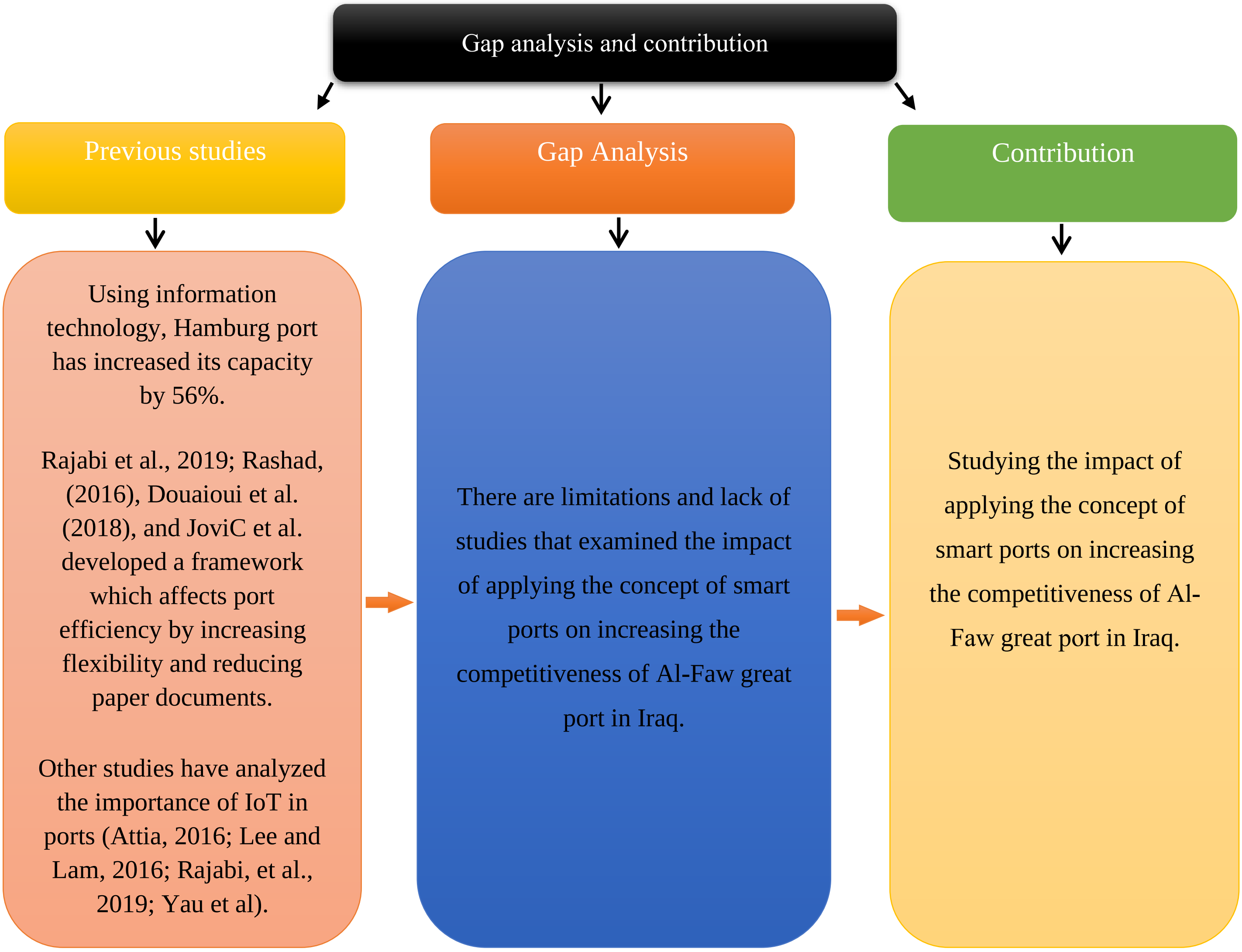

Figure (1) Gap analysis and research contribution.
Source: By authors.

3. RESEARCH PROBLEM

Iraq suffers from the lack of a port that applies the concept of smart port management. This led to excluding Iraqi ports of competition as a result of using the paper management system, which affected the productivity and efficiency of ports. Consequently, this has caused great losses with the long-time factor. To sum up, the research problem is the absence of an electronic management system that deals with parties of commercial interests and the movement of ships dealing with Iraqi ports, which suffer from intense competition with the neighboring ports. So far there are no smart ports in Iraq and some of them do not rise to the implementation of the concept of the smart port. Therefore, the construction of the great port of Al-Faw great port with a draft of 19.8 meters and a distinct strategic location, will help to receive all modern ships that operate with a modern electronic management system.

4. RESEARCH QUESTIONS

To achieve the goal of the research, a number of questions were put forward, which the researcher answered in the study, as follows:

1. How is it possible to switch from the current traditional paper-based system to the proposed electronic system?
2. What are obstacles that face implementing the concept of electronic management?
3. How will the use of the electronic administration of Al-Faw great port affect the quality of service, customs procedures and the time factor?

5. RESEARCH AREA

With the development of global trade, maritime transport and the expansion of the fields and horizons of maritime navigation, Al- Faw has become the key to the East and the West. In other words, at present it is capable of linking the continent of Asia with the continent of Europe and linking the countries of the South with the countries of the North. The city of Al-Faw is the last Iraqi city in the south. Its benefits will spread to the entire region. Through the port of Al-Faw, the Gulf countries will be able to transfer their oil to Turkey at the lowest possible cost and in the least time, and vice versa, the Turkish goods that depend on it will reach them in record time. Al-Faw great port will connect these countries with oil sources and commercial markets in the Gulf region.

Figure (2) The location of Al-Faw great port in the Republic of Iraq.
Source: Iraqi ministry of transport (2021).

6. RESEACH METHODOLOGY

In achieving the objectives of this research, the researcher depends on a descriptive-analytical approach; as a main approach, as it is compatible to the achievement of this research objectives. In order for the researcher to achieve the desired goals of his study, the researcher will analyze the research studies to apply the concept of smart ports to Al-Faw great port in Iraq as well as the recommendations with the aim of connecting Al-Faw great port to become a pivotal port that competes regionally and internationally. The researcher will use the international experiences of one of the smart ports "Jebel Ali port" to determine the most important requirements for the implementation of smart ports concept.

7. RESEARCH VARIABLES

The research variables are divided into dependent and independent variables. According to the research objectives, the dependent variable is (TEUs) and ships call number. Independent variables are storage area, handling equipment, berth depth, berth length, as shown in the next figure No. (3).

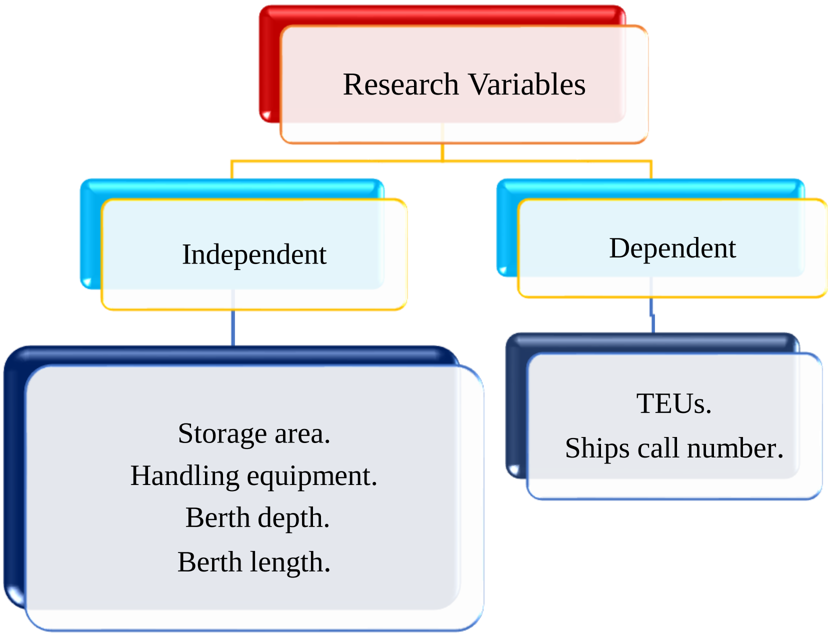

Figure (3) Research variables.
Source: By authors.

8. EMPIRICAL ANALYSIS

Results of the questionnaire for Al-Faw great port

When analyzing responses of the employers who answered the questionnaire (total number of the questionnaire was 228 forms), it was found that the largest percentage of the questionnaires' responses belong to the port's management category with a percentage of 40%, followed by the port workers' category with a percentage of 36%. It was followed by external customers with a percentage of 16%, and freight agents by 5%, while the lowest percentage of customs brokers was at 3%.

When analyzing years of experience, it was found that the percentage of the category of less than five years of experience was 27%, the percentage of the category of years of experience ranging from five to Ten was 17%, the percentage of the category of years of experience ranging from ten to fifteen years was 18%, and the percentage of the category of years of experience ranging from fifteen to twenty years was 18%. The percentage of groups over twenty years in relation to years of experience was 20%. As for the analysis of the percentage of holders of higher degrees and knowledge of the certificates obtained by all those who were reluctant to respond to the questionnaire, it was found that the highest percentage of the answered questionnaires belonged to those with a bachelor's degree by 57%, next those who hold a master's degree with a percentage of 18%, followed by those with a doctorate degree with a percentage of 6%. Finally, those who hold a diploma or any other certificates with a percentage of 19%.

According to the analysis of the research, Alpha Cronbach's is used to measure the stability of choice, which is a measure of internal consistency, that is, the extent to which a group of items are closely related. The Alpha Cronbach's scale is a simple way to measure whether the result is reliable or not. Reliability refers to the amount of true variance that can be calculated by the observed variance. As a normal procedure, several coefficients have been proposed to estimate the reliability of the internal consistency. In fact, Alpha Cronbach's is one of the most widely used reliability criteria in social and organizational sciences. Thus, Alpha Cronbach's analysis in all the dimensions used in the questionnaire approximates to the correct number one, and there are no negative numbers, and it is higher than 0.5, as illustrated in table No.1; using the SPSS statistical program.

Table: 1. Cronbach's Alpha Analysis.

General direction of port management	0.935
The impact of applying the concept of smart ports on meeting the needs of customers	0.926
The impact of applying the concept of smart ports in sustainable development	0.921
The effect of applying the concept of the smart ports on the marketing aspect	0.927
The impact of applying the concept of smart ports to Al-Faw great port on the economic aspect	0.933
Complete questionnaire	0.982

Source: by researcher.

A. General orientation of port management:

The researcher believes that the highest percentage in the questionnaire strongly agrees to the third and fifth question about the general direction of the port management on the administration's adoption of a strategy of competitiveness and providing high quality services and smart pollution-free ports in achieving economic development in Al-Faw great port. This is achieved by strengthening application of the concept of smart ports and utilizing modern technology which corresponds to the modern era. It goes without saying, satisfying customers and port contractors is an important factor for the success of port management, the navigational movement of ships, the movement of goods flows, and the recovery of trade and economy; as shown in table No. 2; using the SPSS statistical program.

Table: 2. General orientation of port management.

	Q1	Q2	Q3	Q4	Q5	Q6
Strongly Disagree	3	3	4	5	3	2
	1.32%	1.32%	1.75%	2.19%	1.32%	0.88%
Disapproved	2	2	2	1	3	4
	0.88%	0.88%	0.88%	0.44%	1.32%	1.75%
Neutral	7	6	4	11	6	2
	3.07%	2.63%	1.75%	4.82%	2.63%	0.88%
Agreed	50	59	36	44	38	43
	21.93%	25.88%	15.79%	19.30%	16.67%	18.86%
Strongly Agree	166	158	182	167	178	177
	72.81%	69.30%	79.82%	73.25%	78.07%	77.63%

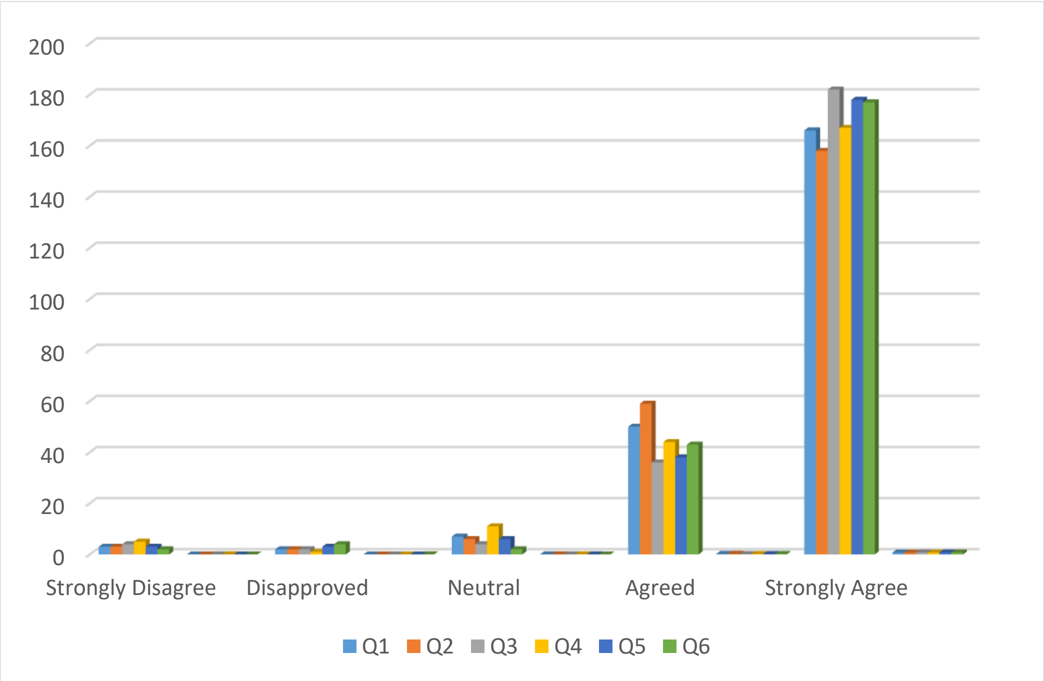

Figure (4) General orientation of port management.

B. The impact of applying the concept of smart ports on meeting customer needs:

The researcher believes that the highest percentage in the questionnaire who strongly agree with the sixth and third questions about the impact of applying smart ports' concept on meeting the needs of customers, will help to implement this concept for Al-Faw great port to abandon paper transactions. In fact. Paper transactions increase the accumulation and loss of many containers as well as favoritism and excellence in the transaction. Hence, the transition to electronic dealing it will help in the long run to receive self-driving ships, which makes Al-Faw great port a smart port applying the concept of smart ports. An analysis of the impact of applying the concept of smart ports on meeting the needs of customers is shown on table No. 3; using the SPSS statistical program.

Table: 3. The impact of the applying of the concept of smart ports on meeting the needs of customers.

	Q1	Q2	Q3	Q4	Q5	Q6
Strongly Disagree	3	2	2	2	2	3
	1.32%	0.88%	0.88%	0.88%	0.88%	1.32%
Disapproved	0	0	1	1	1	1
	0.00%	0.00%	0.44%	0.44%	0.44%	0.44%
Neutral	1	8	5	10	5	5
	0.44%	3.51%	2.19%	4.39%	2.19%	2.19%
Agreed	50	52	44	53	45	42
	21.93%	22.81%	19.30%	23.25%	19.74%	18.42%
Strongly Agree	174	166	176	162	175	177
	76.32%	72.81%	77.19%	71.05%	76.75%	77.63%

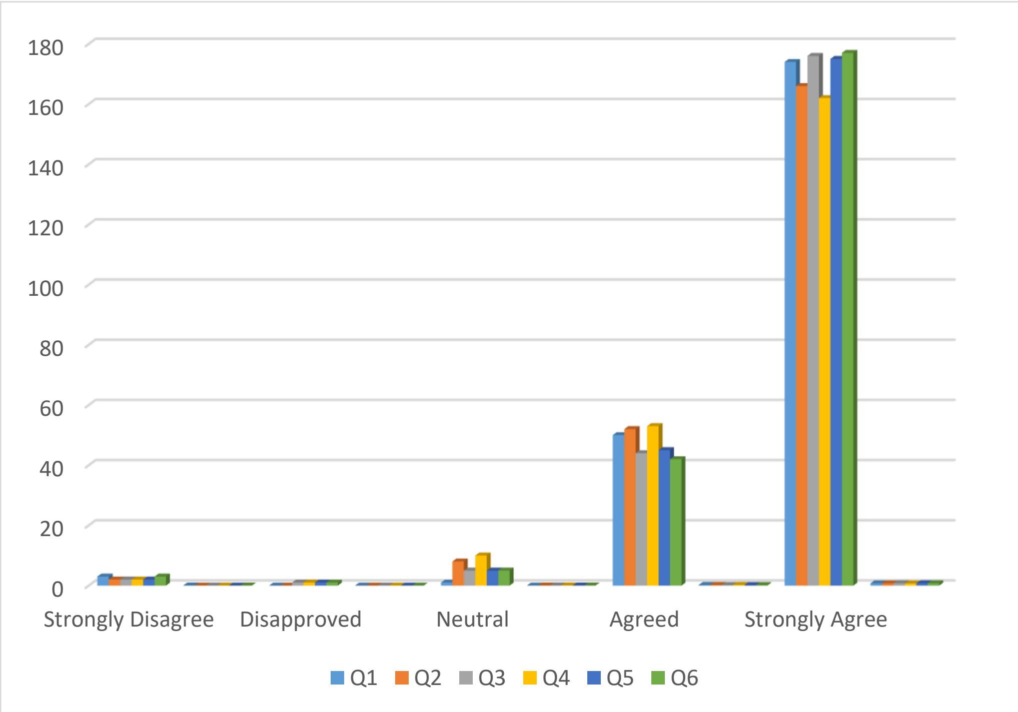

Figure (5) The impact of the applying of the concept of smart ports on meeting the needs of customers

C. The impact of the applying of the concept of smart ports in Al-Faw great port for sustainable development:

In addition, the highest percentage in the questionnaire represents those who strongly agreed to the first question about the impact of the applying the concept of smart ports in Al-Faw great port on sustainable development. It will help to receive the largest number of giant ships and containers, making it a logistic area. Due to the distinguished geographical location of Al-Faw great port, in the north of the Arabian Gulf. Since it serves as a link between the East and the West, it will be the largest transit area for the transportation and flow of goods in the Middle East. Table No. 4 illustrates an analysis of the impact of applying smart ports concept in Al-Faw great port for sustainable development.

Table 4. The impact of applying the concept of the smart port on sustainable development.

		Q13	Q14	Q15	Q16	Q17	Q18
Strongly Disagree		3	2	2	2	2	2
		1.32%	0.88%	0.88%	0.88%	0.88%	0.88%
Disapproved		0	2	1	0	1	1
		0.00%	0.88%	0.44%	0.00%	0.44%	0.44%
Neutral		2	8	4	9	8	8
		0.88%	3.51%	1.75%	3.95%	3.51%	3.51%
Agreed		39	49	46	48	42	51
		17.11%	21.49%	20.18%	21.05%	18.42%	22.37%
Strongly Agree		184	167	175	169	175	166
		80.70%	73.25%	76.75%	74.12%	76.75%	72.81%

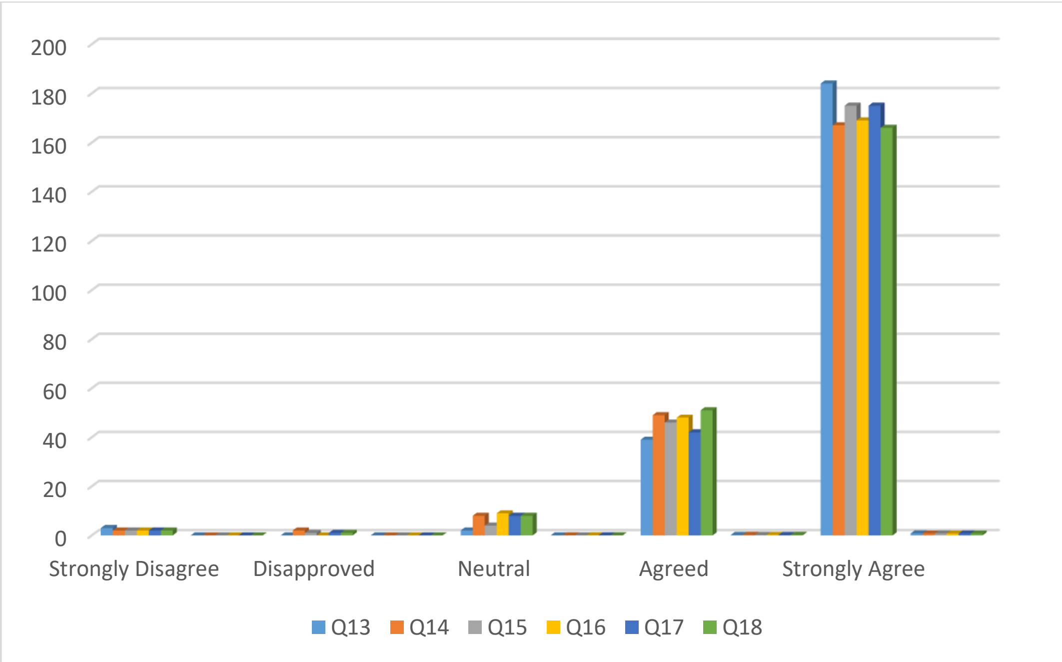

Figure (6) The impact of applying the concept of the smart port on sustainable development.

D. The impact of applying the concept of the smart port on the marketing side:

The researcher believes that the highest percentage in the questionnaire belongs to those who strongly agree with the sixth question about the impact of applying the smart port concept on the economic aspect. Application of this concept will help increase the number of ships and activate the navigational movement in Al-Faw great port.

Thus, the number of ships coming to the port is increased, which activates the marketing aspect in Al-Faw great port and the movement of goods that is second to Iraq and neighboring countries. An analysis of the impact of applying of smart port concept on the marketing aspect is shown in table No. 5; using the SPSS statistical program.

Table 5. The impact of applying the concept of the smart port on the marketing aspect.

	Q19	Q20	Q21	Q22	Q23	Q24
Strongly Disagree	3	2	2	3	2	3
	1.32%	0.88%	0.88%	1.32%	0.88%	1.32%
Disapproved	0	0	0	1	1	0
	0.00%	0.00%	0.00%	0.44%	0.44%	0.00%
Neutral	1	9	5	4	3	3
	0.44%	3.95%	2.19%	1.75%	1.32%	1.32%
Agreed	48	38	37	38	41	30
	21.05%	16.67%	16.23%	16.67%	17.98%	13.16%
Strongly Agree	176	179	184	182	181	192
	77.19%	78.51%	80.70%	79.82%	79.39%	84.21%

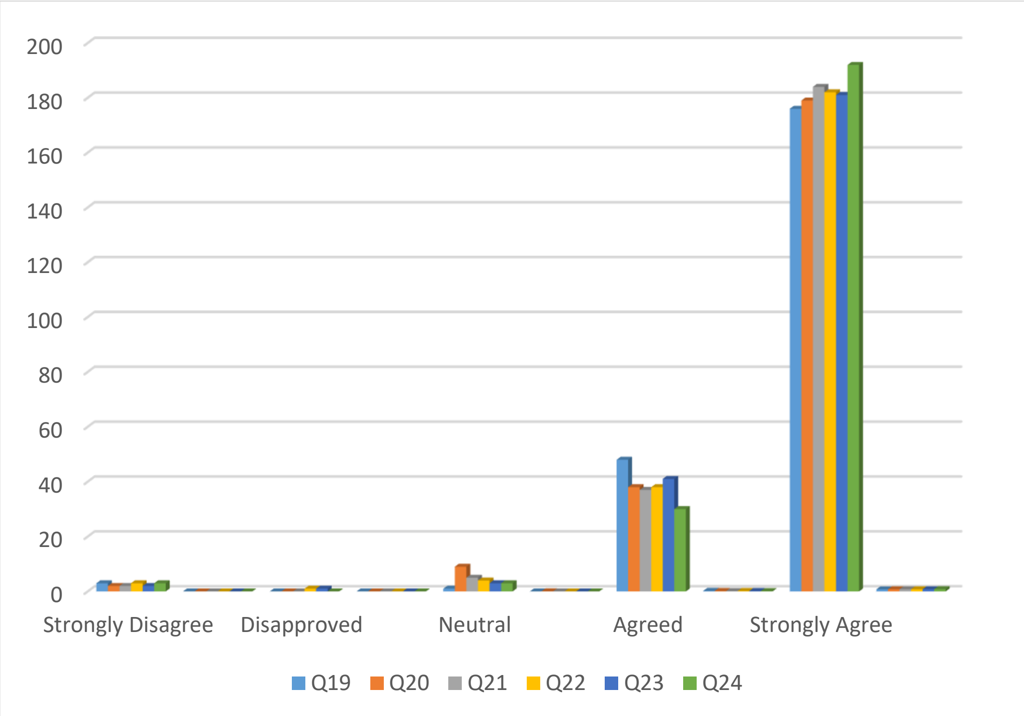

Figure (7) The impact of applying the concept of the smart port on the marketing aspect.

E. The impact of applying smart ports concept to Al-Faw great port on the economic aspect

Furthermore, the highest percentage in the questionnaire belongs to those who strongly agree to the fourth and fifth questions with the same percentage above. In terms of the impact of the applying of the smart ports concept for Al-Faw great port on the economic aspect, it will help transfer trade from the East to the West, in a far lesser time and lower cost. In addition, this would help to switch to the application of multimodal transport, and thus the port will achieve economic gains not less than the oil revenues. Furthermore, this will achieve great economic development and establish sustainable cities that are compatible with the concept of smart port technology in Al-Faw great port when analyzing the impact of the smart ports concept on the economic side, as shown in Figure No. 6; using the SPSS statistical program.

Table 6. The impact of applying the smart ports concept to Al-Faw great port on the economic aspect.

	Q25	Q26	Q27	Q28	Q29	Q30
Strongly Disagree	3	2	2	2	2	3
	1.32%	0.88%	0.88%	0.88%	0.88%	1.32%
Disapproved	0	1	2	0	0	0
	0.00%	0.44%	0.88%	0.00%	0.00%	0.00%
Neutral	7	7	6	6	3	5
	3.07%	3.07%	2.63%	2.63%	1.32%	2.19%
Agreed	46	48	41	37	40	42
	20.18%	21.05%	17.98%	16.23%	17.54%	18.42%
Strongly Agree	172	170	177	183	183	178
	75.44%	74.56%	77.63%	80.26%	80.26%	78.07%

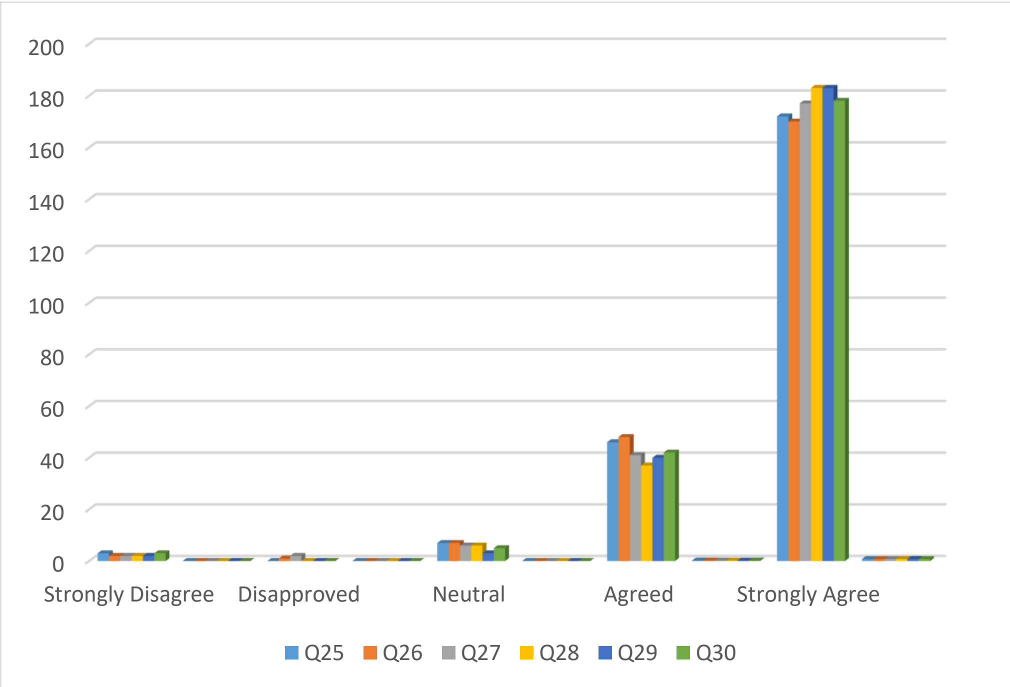

Figure (8) The impact of applying the smart ports concept to Al-Faw great port on the economic aspect.

F. Implementation of the (Zodiac) operating system in Jebel Ali Port

DP World has completed the implementation of the (ZODIAC) operating system, which contributes to enhancing the port's readiness in the future by adopting the techniques of the Fourth Industrial Revolution, to keep pace with the rapid developments and anticipate opportunities and challenges. The operating system includes 18 units. It will increase the utilization of the core competencies and operational assets in the terminal, which is an operating system in container terminal 3 in Jebel Ali port (CT3). This step represents an additional step to achieve the vision of DP World, the Emirates region, leading the smart transformation in its ports. The logistics center includes a fully automated system on advanced solutions for remote control of port facilities. With these achievements, CT3 will be able to integrate with any terminal that implements the same automation system and thus, enhance its ability to ensure smooth operations even during crises, and provide companies with full support to access the global supply chain with efficiency and high capacity.

The application of the ZODIAC system represents the latest version that was implemented in C13 in Jebel Ali port. A qualitative leap from its predecessor to 100% has been completed and CT3 has become one of the most advanced and intelligent port stations in the region compared to the best smart port stations in the world through the application of the ZODIAC system. In the future CT3 will be part of the largest global supply chain network, including DP World terminals around the world, in addition to other major terminals and ports. The digital ZODIAC system consists of 18 integrated internal systems, including crane automation system and dock planning. Moreover, it also manages railways and internal container depot, provides complete fleet management and control of container freight load, real-time container location tracking, clearance and delivery using invoicing systems, and it is powered by the Internet of Things system.

9. CONCLUSION AND RECOMMENDATIONS

Using IT helps to increase the port efficiency, for example, the process of loading and unloading can be carried out simultaneously with the same port equipment and with the same inputs. This helps reduce the time the ship spends on the berth; eventually, it will increase the productivity of the port. In addition, using the smart ports concept will reduce wasted time, therefore using information technology will increase the efficiency of ports as well as increase their competitiveness.

The presence of some internal obstacles, such as weak financial resources and Iraq's economic inability to provide the necessary liquidity to secure its contracts with the implementing companies due to the size and magnitude of the project and its cost. This is in addition to the absence of alternative plans and openness with investment companies with the internal and external private sector and with companies specialized in information technology operation and smart ports. Other obstacles include natural challenges, narrow coasts, non-activation of agreements, maritime border overlap due to the geographical nature with some neighbouring countries (Iran, Kuwait) as well as lack of openness with neighbouring countries and countries in the region. The importance of Al-Faw great port project for these countries lies in the fact that it is capable of achieving economic gains for them and the participation of investment in this project. Furthermore, this port possesses a considerable strategic importance as a land bridge linking the East and the West.

This project faces a set of geographical challenges, as follows: natural challenges: represented by the narrowness of the Iraqi coast and its overlap with neighbouring countries, and the encroachment of the Iranian borders towards regional waters due to mud deposits. This is in addition to the bad weather conditions that impede maritime traffic, as the Iraqi oil pumping often stops because of that for several days. Moreover, there are human challenges: among them are the internal challenges which includes: the lack of a unified will to implement the project at the local level, absence of the secure and legal environment necessary for its success, administrative corruption, absence of an efficient transportation network commensurate with the size of the project.

On the other hand, external challenges include: the turbulent political situation in the region, neighbouring countries' sense of harm, especially Egypt, the Emirates, Kuwait and Iran, and lack of confidence in the Iraqi national system, which prompts companies to hesitate to invest in it. The study of the impact of the application of the smart ports concept on improving the performance of Al-Faw great port concluded to the following recommendations:

- The electronic management application program in Al-Faw great port must be developed comprehensively in line with the concept of smart ports through the distribution of tasks between agencies and authorities operating in ports under the supervision of a higher authority. By linking the smart ports strategy with the general strategy of Al-Faw great port, and during the process of this change will occur through people who have this experience and knowledge in applying this global, regional and local electronic system.

- The necessity of shifting from the traditional paper-based system in the port to the proposed electronic system, by encouraging port workers to switch from paper-based management to electronic management and actually use the smart port concept application, by developing the necessary strategies to rehabilitate and train human resources on the use of information technology and its applications in smart ports, the establishment of training courses for workers in ports outside Iraq and visiting one of the smart ports, as an example of this e.g. Jebel Ali port for all administrative levels and granting distinguished workers in their operation material and moral incentives

- The necessity of addressing the challenges and the current situation that hinder the implementation of electronic management in Al-Faw great port, by reviewing and amending legislations and laws, and reformulating and preparing them in the port to keep pace with the technological developments imposed by the process of smart management of ports. This is because the implementation of electronic management requires changes in procedures and structure, through the combination of Local laws, international laws and ratification of international agreements on trade and the free zone.

- The necessity of completing the international roads linking Al-Faw great port with neighboring countries due to the lack of an efficient transport network equivalent to the size of the project, through a proposed strategy to activate the logistics of multimodal transport by contracting with international companies specialized in this or by investing in the completion of international roads, as required by the modern international transport of goods as they have an impact on the contract of international maritime transport of goods and on the responsibility of the international carrier of goods.

- The necessity of linking the community of workers in Al-Faw great port with an electronic network that provides workers with all information and procedures accurately and timely, which increases the quality of the services provided to all parties dealing with the port.

- The file of the natural challenges represented by the narrow Iraqi coasts and their overlap with neighboring countries (Iran, Kuwait) must be resolved by entering into permanent and long-term international bilateral agreements, in particular with Kuwait, to address the problems that occur in navigation in the entry and exit of ships in Khor Abdullah Canal to Iraqi ports in general, and Al Faw great port in particular.

- The need to encourage investment in Al-Faw great port and investment openness with companies of the domestic and international private sector and increase financial revenues. The universe is a very large project that is not limited to government support only. It is necessary to promote dealing with companies specialized in the work of information technology and smart ports and opening the way for international companies specialized in smart ports and providing opportunities to compete, by providing a place and a ground as well all the requirements, facilities and the security and legal environment necessary for its success and government support for it, given that this project is one of Iraqi projects of political reform and national security.

- The formation of a higher operating committee, and the director general of the ports in it. This committee will speed up and facilitate the procedures by updating the legal legislation related to investments in the ports, following up on the work and completion of the implemented projects that will be implemented, as well as providing the financial funds and the human and technical capabilities necessary to support and implement Al-Faw great port project which is considered as a priority.

- The necessity of communicating with regional countries without causing any harm to these countries, whether they are neighbors or regions, especially (Egypt, UAE, Kuwait and Iran) by providing them with investment opportunities and building roads and connecting railways with them, as well as benefiting from their experience in smart ports for the success of Al-Faw great port project, which will achieve strategic importance as a land bridge linking the East and the West, developing awareness and educational plans and programs for the public, dealing with the port to spread the culture of the concept of the smart port through holding seminars and meetings with specialists, provided that representatives of all influential parties affected by the application of the smart port concept in the port and exporters, importers, the private sector and banks should participate in such seminars and meetings until the facilitation is done

- The need to continue and expedite the implementation of Al-Faw great port project and the application of electronic management to it. This is for the purpose of reaching a smart port, improving service quality, simplifying and facilitating customs procedures, speed factor, shortening time and keeping pace with modern technological developments in the world.

- Senior administrations should not neglect concepts of smart management in the port and educate officials on the importance of relying on smart port applications to provide their services by facilitating the requirements for their applications in an integrated manner, by focusing on the technical and financial aspects and the need to provide an organizational climate that allows creativity and innovation for all administrative levels.
- There is an urgent need to coordinate and benefit from countries that have achieved clear and tangible developments in the regional and global field in the domain of developing and managing the smart ports sector, especially the neighboring countries such as the United Arab Emirates, which have made qualitative leaps in this field through Jebel Ali port.

- The necessity of working on managing the port of Al-Laqaa Al-Kabeer in specialized ways capable of simulating smart management methods in the developed international ports and granting powers that include the various activities of the port, including the administrative procedures, so that it can develop integrated plans for the management and operation of the port. There is a need for more studies and research on the importance of the application impact of the concept of smart ports on Al-Faw great port, because this project is the largest in Iraq. Therefore, it is suggested to pay attention to scientific research on the port using SWOT analysis mastering all the elements of power that can be used to deal with the threats and obstacles facing the port and offering ideas that keep pace with the trend towards establishment of smart ports.

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THE IMPACT OF GLOBALIZATION ON MEDITERRANEAN CONTAINER TERMINALS

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Keywords: Mediterranean container ports, gateway and transshipment container ports, global shipping companies, global container trades

1. ABSTRACT: The Mediterranean basin has always played an important role in the global maritime scenario due to its key positioning along the main East-West trading routes and its centrality with respect to the Atlantic and North European markets, on the one hand, and to those of Asia and Africa on the other. The growth of container traffic has led to the emergence of new routes and the construction of ever-larger ships and ports. These factors have increased the competitiveness among the Mediterranean ports, which must improve their functionality and productivity to meet new needs and acquire ever-higher market rates. It is estimated that in 2020 Mediterranean ports handled almost 40% of worldwide containerized trade flows. The total throughput of Mediterranean ports has risen from 40,5 million TEUs in 2010 to about 59 million TEUs in 2020, with a 46% increase (UNCTAD). The establishment of a limited number of multi-trade strategic alliances in container shipping is concentrating the demand on a few players. Currently, all major container carriers are involved in one of the three global alliances: 2M (Maersk, MSC; capacity 8,475,700 TEU, share 33.8%, 1,363 ships), Ocean Alliance (Cosco-OOCL, CMA CGM, Evergreen; capacity 7,541,341 TEU, share 30.1%, 1,248 ships), THE Alliance (Hapag-Lloyd, ONE, Yang Ming, HMM, capacity 4,799,815 TEU, share 19.2%, 633 ships). These big players often enter terminal operations, mostly investing in pure transshipment hubs along main shipping services, in order to control multiple supply chain phases. Some companies have their own 'terminal operating holding' such as Maersk (APM Terminals) and COSCO Group (COSCO Shipping Ports). The increase of naval gigantism and the reduction of vessel calls due to strategic choices of carriers could influence the competitiveness of smaller container ports that are cut out from the main market trades (e.g. Cagliari) or that have physical limits on their terminals. This paper focuses on the specific case of Mediterranean container ports, analyzing the evolution of the containerized traffic and how the strategies of the main carriers are affecting container terminal policies.

1. INTRODUCTION

In the global maritime scenario, the Mediterranean basin plays a strategic role linked to its key positioning along the major East-West trading routes (known as pendulum routes) and its centrality with respect to both the Atlantic and North European markets, and the Asian and African ones.

Its unique location, incorporated along the main trade routes, offers network advantages to ocean carriers due to the shortened transit times to major emerging markets, in particular to and from the Asian region. It is estimated that Mediterranean container ports as a whole currently handle almost 40% of worldwide-containerized trade flows. Between 2010 and 2020, the global TEU throughput increased by 42%. This trend also involved the Mediterranean ports which saw a 46% increase in their total container volumes (UNCTAD, 2021).

The growth of container traffic has led to the emergence of new routes and the construction of ever-larger ships and ports. In the last years, shipping companies often decide to use the Cape Route to bypass the Suez Canal, due to slow steaming practice and high fees of the Suez Canal. Furthermore, the consolidation of the Arctic Route and the Belt and Road Initiative could cut out Mediterranean ports from the main trading route, the Asia-North Europe-Asia lane. These factors have increased the competitiveness among the Mediterranean ports, which must improve their functionality and productivity to meet new needs and acquire ever-higher market rates (Fancello et al., 2014).

This study considers the 36 main container ports in the Mediterranean region in terms of TEUs handled in the last decade. The ports analyzed are geographically distributed as follows: 11 ports are in Italy, 4 in Egypt, 4 in Spain, 4 in Turkey, 2 in Greece, 2 in Israel, 1 in Croatia, 1 in Cyprus, 1 in France, 1 in Lebanon, 1 in Malta, 1 in Morocco, 1 in Slovenia, 1 in Tunisia, and 1 in Syria. As for the traffic volumes handled, seven ports handled more than 3M TEUs in 2019, 12 from 1M to 3M TEUs, and 16 less than 1M TEUs. In 2019, the 36 ports as a whole handled about 60 million TEUs. Figure 1 shows the map of the 35 ports analyzed.

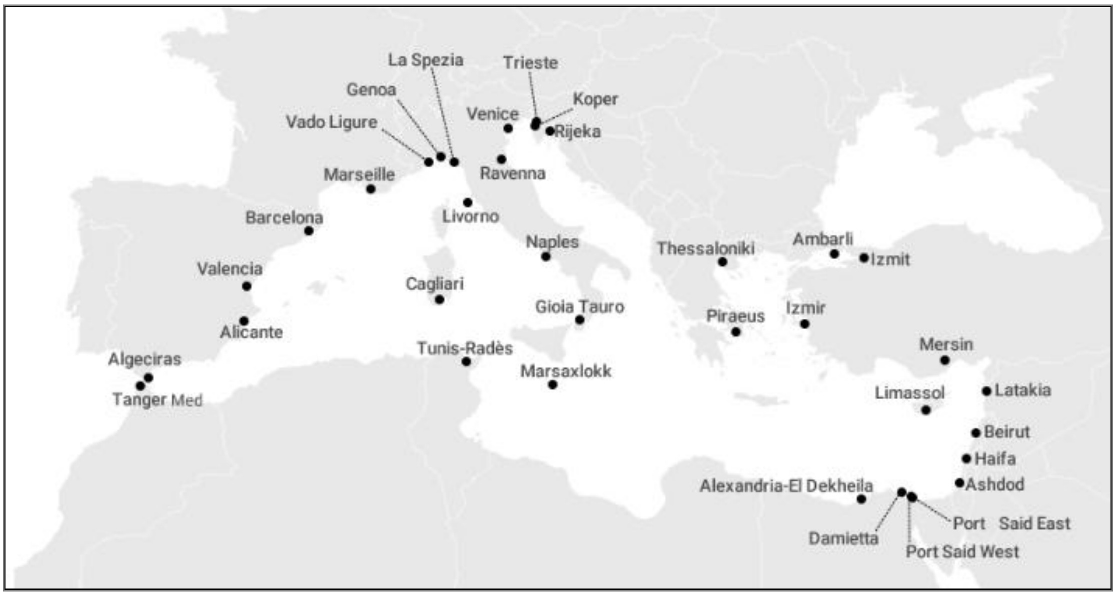

Figure 1: Map of the 36 ports analysed

The proposed analysis offers an overview of Mediterranean container ports, thus providing some useful information on the state of the art. The framework is as follows: section 2 presents an overview of the main Mediterranean container ports, analyzing the growth in the last twenty years while section 3 describes the infrastructural elements that characterize the ports. Section 4 and 5 focus on container shipping alliances and the main global trades that include the Mediterranean region. Section 6 summarizes the shown data.

2. MEDITERRANEAN PORTS THROUGHPUT

Mediterranean ports throughput, as a whole, has grown annually at a rate of 5.4% from 2002 to 2020, with an overall increase of about 160%. During this period, only three times the growth has undergone a trend reversal: in 2009 (-5.8%) due to the global economic crisis, in 2015 (-2.4%) and in 2020 (-0.2%). Figure 2 shows the total TEU throughput of all the container ports that make up the sample.

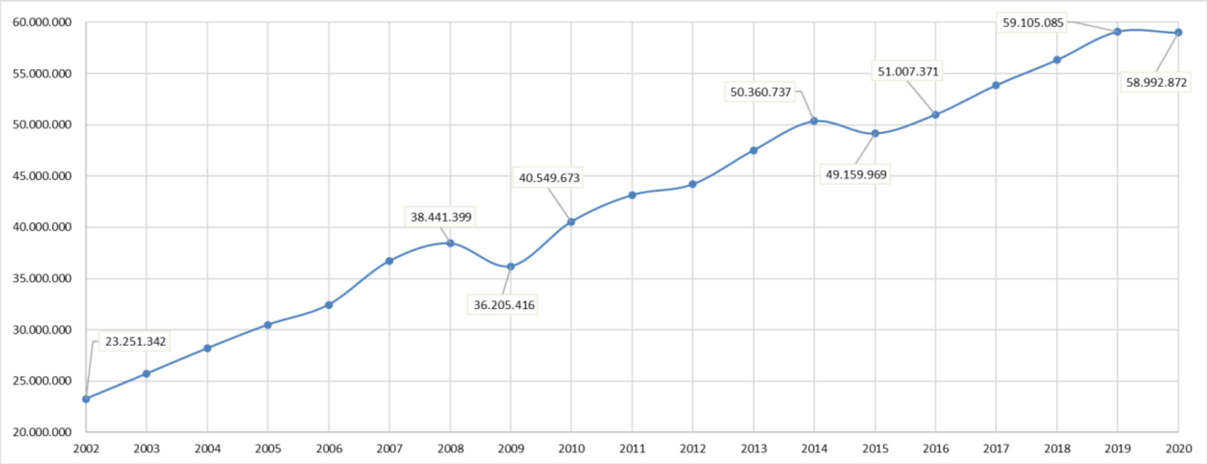

Figure 2: Mediterranean container throughput (TEU)

Container ports can be classified according to their main service: gateway or transshipment. Gateway ports, mainly positioned along the Mediterranean Northern Range and the Eastern Mediterranean Range, have the role of doorways towards local markets. On the other hand, transshipment ports, located along the Suez - Gibraltar route (Port Said, Piraeus, Marsaxlokk, Tanger and Algeciras), mainly transfer containers between ships, allowing them to continue their journey to other continents or, by means of feeder ships, to reach the minor ports of the Mediterranean area (Notteboom et al., 2019). Of the 36 ports considered, 13 are transshipment ports while the remaining 23 gateway ones (see Table 1). Despite this, transshipment ports annually handle, on average, 56% of the total TEU throughput. In Figure 3, the total container throughput trend is split up for gateway and transshipment ports. It is easy to notice that the overall throughput reduction of 5.8% recorded in 2009 (see Figure 2) is entirely to blame to gateway ports that saw a drastic reduction of their total movements in that year (-13%). In 2020, Mediterranean container ports handled approximately 112,000 TEUs less than the previous year (-0.2%).

Table 1. Mediterranean container ports: 2010, 2019 and 2020 throughput (TEU)

Port	*Main service*	*Throughput (TEU)* *2010*	*2019*	*2020*	*Var% 2010-2019*	*Var% 2019-2020*
Alexandria-El Dekheila	transshipment	832,494	1,814,950	1,693,252	118,0%	-6,7%
Algeciras	transshipment	2,810,242	5,119,500	5,107,873	82,4%	-0,3%
Alicante	gateway	147,308	170,739	113,000	15,9%	-33,8%
Ambarli	gateway	2,540,000	3,104,882	2,887,800	22,2%	-7,0%
Ashdod	gateway	1,017,000	1,400,000	1,584,000	37,7%	13,1%
Barcelona	gateway	1,948,422	3,324,651	2,958,040	70,6%	-11,0%
Beirut	gateway	949,155	1,229,081	772.873	29,5%	-37,1%
Cagliari	transshipment	629,127	151,405	68,406	-75,9%	-54,8%
Damietta	transshipment	1,214,910	1,068,002	1,051,869	-12,1%	-1,5%
Genoa	gateway	1,758,858	2,635,000	2,352,769	48,7%	-10,0%
Gioia Tauro	transshipment	2,852,264	2,522,874	3,193,364	-11,5%	26,6%
Haifa	gateway	1,263,000	1,400,000	1,470,000	10,8%	5,0%
Izmir	gateway	727,675	605,727	436,386	-16,8%	-28,0%
Izmit	gateway	416,000	1,715,193	1,800,642	312,3%	5,0%
Koper	gateway	476,731	959,000	945,000	101,2%	-1,5%
La Spezia	gateway	1,285,000	1,490,537	1,173,660	16,0%	-21,3%
Latakia	gateway	586,283	325,097	243,348	-44,5%	-25,1%
Limassol	transshipment	348,358	389,900	360,408	11,9%	-7,6%
Livorno	gateway	628,489	789,833	716,233	25,7%	-9,3%
Marsaxlokk	transshipment	2,370,729	2,720,000	2,441,589	14,9%	-10,3%
Marseille	gateway	953,000	1,454,621	1,717,028	52,6%	18,0%
Mersin	gateway	1,024,171	1,939,000	1,948,700	81,1%	5,1%
Naples	gateway	532,432	681,929	643,540	28,1%	-5,6%
Piraeus	transshipment	878,083	5,650,000	5,437,477	543,2%	-3,7%
Port Said East	transshipment	2,793,416	3,200,000	3,510,140	7,5%	16,9%
Port Said West	transshipment	834,397	660,000	499,532	-21,6%	-23,7%
Ravenna	gateway	183,041	218,138	194,868	19,2%	-10,7%
Rijeka	gateway	137,048	305,049	344,091	122,6%	12,8%
Tanger	transshipment	2,058,430	4,801,713	5,771,200	133,3%	20,2%
Taranto	transshipment	581,936	0	5,512	-100,0%	-
Thessaloniki	gateway	273,282	448,766	460,724	64,2%	2,7%
Trieste	gateway	281,629	789,640	776,022	180,4%	-1,7%
Tunis-Radès	gateway	420,089	285,262	256,078	-32,1%	-10,2%
Vado Ligure	gateway	196,434	54,542	146,081	-72,2%	167,8%
Valencia	transshipment	4,206,327	5,439,800	5,382,303	28,1%	-0,1%
Venice	gateway	393,913	593,070	529,064	50,6%	-10,8%

This reduction is to be ascribed to gateway ports that recorded a -5.2% of their throughput. At the same time, transshipment ports saw their total movements increase by 3.7% compared to 2019. Since 2002, the only trend reversal related to the transshipment ports traffic occurred in 2015, with a reduction of 4.4% compared to 2014.

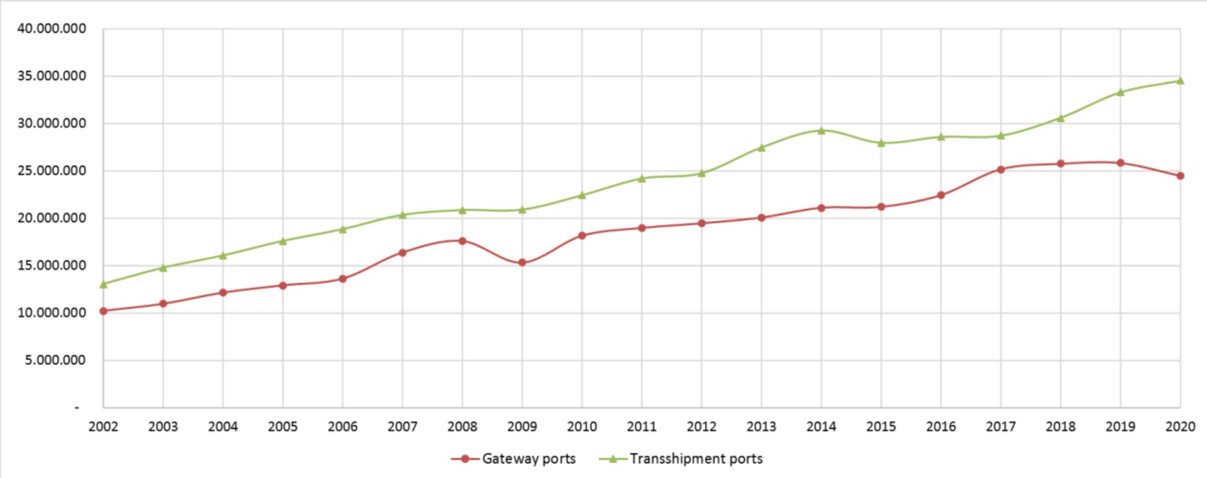

Figure 3: Mediterranean container throughput: gateway and transshipment ports (TEU)

Between 2010 and 2019[c] the overall Mediterranean throughput grew by 15.8%. During this period, not all ports behaved in the same way. Table 1 provides the throughput of each port for the years 2010, 2019 and 2020. The column "*Var% 2010-2019*" shows the variation between 2010 and 2019. Most ports (27 out of 35) are characterized by an increase of their throughput, with the ports of Alexandria-El Dekheila, Izmit, Koper, Piraeus, Rijeka, Tanger and Trieste that have at least doubled it. Among the ports that register a negative variation, the ports of Cagliari and Taranto have been facing, in the last years, a period of great difficulty (Fancello et al., 2021).

Although the effects of the sars-cov-19 pandemic on the global economy are not yet concluded, we can make some initial assessments on the response given by Mediterranean ports with respect to the number of TEUs handled in 2020. The column "*Var% 2019-2020*" of Table 1 presents the variation, for each port, of the 2020 throughput compared to 2019. 24 ports have suffered a reduction in their traffic, with 13 ports that have exceeded by -10%. Among the remaining 12 ports, Vado Ligure stands out because of its recent new terminal opening.

The authors grouped the Mediterranean ports into six groups, represented in Figure 4. Tanger (fourth Mediterranean port in 2018 and first in 2020), Algeciras (fourth in 2020) and Valencia (third in 2020) are included in group 1: its throughput represents 33% of the handled TEUs in the Mediterranean area. Group 2 consists of the Italian ports located in the North Mediterranean Range and the French port of Marseille. Only the port of Genoa is ranked in the top 10 (tenth position in 2020). The ports located in the North Adriatic Range make up group 3, handling less TEUs than the others. Group 4 encloses ports located in the central Mediterranean area. The most important ports are

[c] this period is chosen because of its position after the 2009 global crisis and before the sars-cov-19 one

Marsaxlokk (which went from the sixth position in 2018 to the ninth in 2020) and the Italian port of Gioia Tauro (ranked tenth in 2018 and sixth in 2020). The ports overlooking the Aegean Sea and the Marmara Sea are those that form group 5. More than 75% of the total movements are carried out by the ports of Piraeus and Ambarli. Group 6 is the most numerous one in terms of number of ports but not in terms of total throughput. In this group, only Port Said (both East and West terminals) is ranked in the top 10.

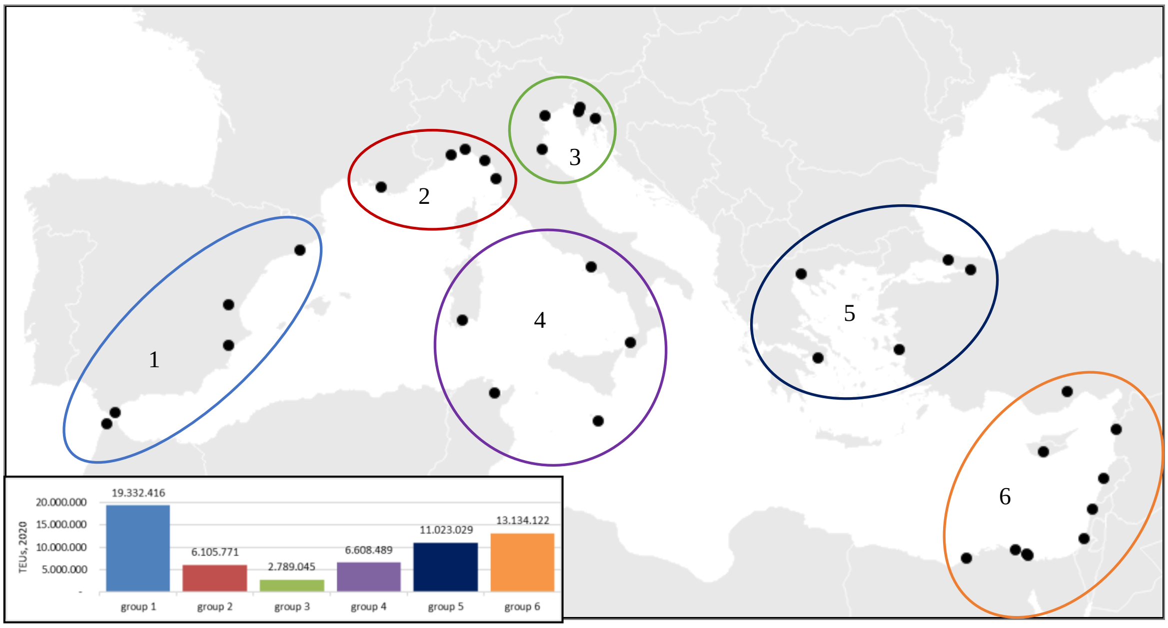

Figure 4: Mediterranean container ports grouped by location

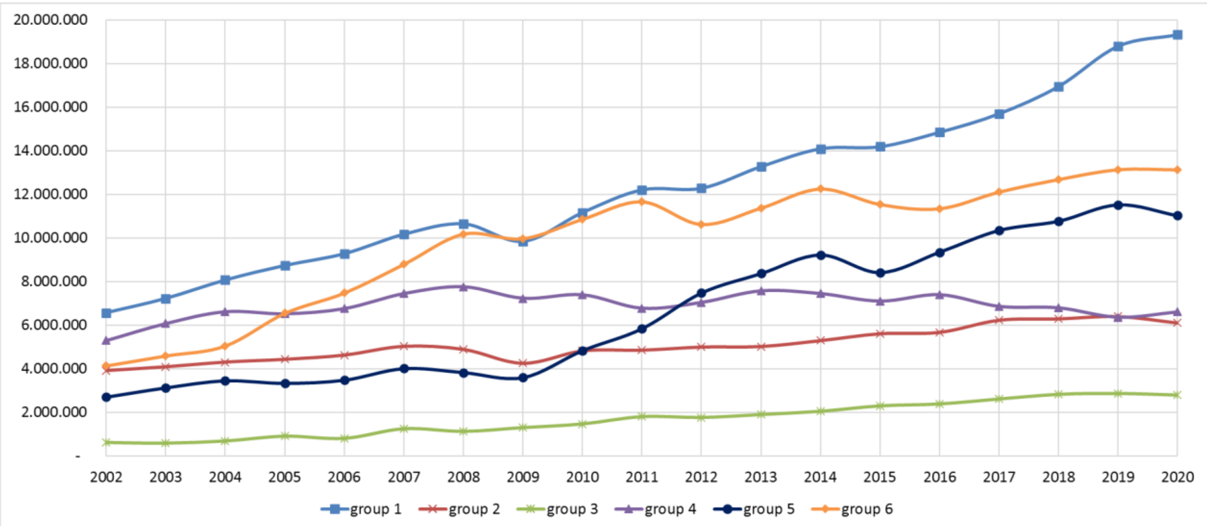

Figure 5: Mediterranean container throughput (TEUs) for the six identified port groups

Figure 5 illustrates the trend from 2002 to 2020 of the six groups. Group 1 is characterized by the exponential growth of the ports of Valencia, Algeciras and Tanger. Until 2009, year in which the privatization of Piraeus container berths took place, group 5 had a constant throughput. As for group 6, the opening in 2004 of the Suez Canal Container Terminal (located in Port Said East) influenced the trend growth.

3. MEDITERRANEAN PORT INFRASTRUCTURES

In the maritime world scenario, various challenges are affecting Mediterranean container ports, which are trying to keep high their efficiency and their competitiveness through infrastructural and managerial improvements (Serra et al., 2016). The plot in Figure 6 provides an overview of the Mediterranean ports, showing two of the main infrastructural characteristics of container terminals, namely the number of QC (quay cranes) and quay length. The x-axis shows the quay length, the y-axis the number of QC while the diameter of the circles the throughput of each port (red circles for those with less than one million TEUs, blue for those between one million and three million, and green for those with more than three million TEUs).

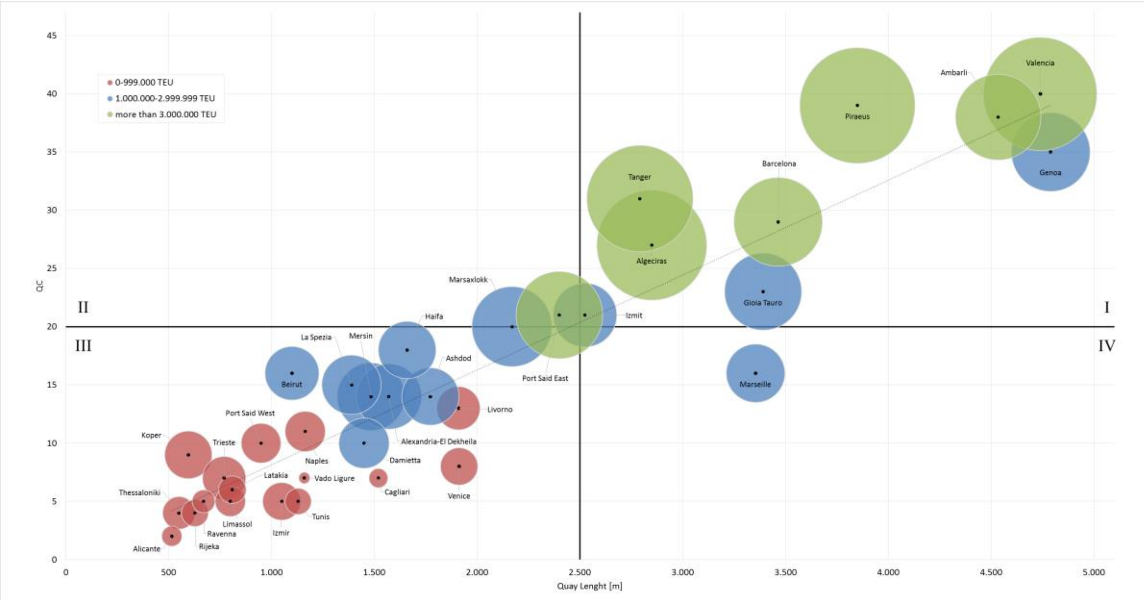

Figure 6: Mediterranean container ports: quay length, QC and TEU throughput

In Figure 6, the cartesian plane has been subdivided into four dials. All ports with less than one million TEU throughput are collocated in the third dial, that is, with less than 20 QC and a total quay length not superior to 2,500 meters. In terms of handled TEUs, the most important ports are located in the first dial except for Port Said East that is the only one located in the second dial. Lastly, intermediate ports require a careful analysis since their distribution follows different rules for each port. Genoa, for instance, has the highest quay length and is the forth port for number of QC, but its throughput is lower than the one of Valencia and Ambarli (the closest ports in the plot). Compared to the ports of their group, Marseille and Gioia Tauro have a surplus of quay length.

4. CONTAINER SHIPPING COMPANIES AND ALLIANCES

Container shipping transportation has become the dominant mode for transporting cargo globally. As a result, the container shipping sailing network continues to expand and become more refined, further increasing the connectivity between most ports worldwide (Chao et al., 2018). In order to consolidate their position in the market, global container shipping companies aim to increase the capacity of their fleet. For this reason, the market is dominated by only a few container shipping companies. Table 2 summarizes the first 12 container shipping operators in terms of fleet capacity while Figure 7 shows the evolution in last three years.

Table 2. Top 12 shipping container operators (Source: Alphaliner TOP 100 / 10 Jan 2022)

Rank	*Operator*	*TEU*	*Ships*	*TEU Share*
1.	MSC (Mediterranean Shg Co.)	4.284.728	645	17,0%
2.	Maersk Line	4.277.274	736	17,0%
3.	CMA CGM Group	3.186.432	568	12,6%
4.	COSCO Group	2.932.779	479	11,6%
5.	Hapag-Lloyd	1.745.032	251	6,9%
6.	ONE (Ocean Network Express)	1.540.540	210	6,1%
7.	Evergreen Line	1.477.644	204	5,9%
8.	HMM Co Ltd	819.790	75	3,2%
9.	Yang Ming Marine Transport Co.	662.047	90	2,6%
10.	Zim	419.064	111	1,7%
11.	Wan Hai Lines	414.542	145	1,6%
12.	PIL (Pacific Int. Line)	266.667	83	1,1%

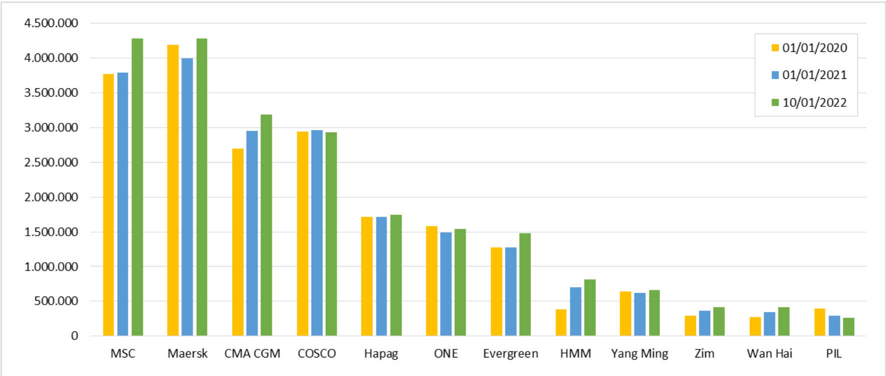

Figure 7: Top 12 shipping container operators: TEU capacity (Source: Alphaliner TOP 100)

These big players have changed their strategic approach towards terminal activities, often creating their own 'terminal operating holding' such as Maersk Line (APM Terminals), COSCO Group (COSCO Shipping Ports), MSC (TiL-Terminal Investment Limited) and CMA-CGM (Terminal Link). In the Mediterranean Sea, carriers mostly invest in pure transshipment hubs along main shipping services, in order to control multiple supply chain phases (van der Putten, 2016).

Main global carriers control Mediterranean container terminals through shareholding with other parties or through a total control on the terminal operations (Kaliszewski, 2020). Maersk Line, for instance, is based in Algeciras, Barcelona, Izmir, Marseille, Port Said East, Tanger, Vado Ligure and Valencia. MSC operates in, Ambarli, Genoa, Gioia Tauro, La Spezia, Livorno, Marseille, Naples, Trieste, Valencia and Venice. COSCO Shipping Ports owns the port of Piraeus and market shares of Ambarli, Marseille, Port Said East, Vado Ligure and Valencia. CMA-CGM operates in Algeciras, Latakia, Marseille as well as Malta Freeport. Furthermore HMM owns shares of Algeciras terminal, Hapag-Lloyd entered in the new Tanger terminal at the beginning of 2021 while Evergreen used to operate in the Italian port of Taranto, now operated by Yilport Holding.

Table 3. The three global alliances in container shipping (Source: Alphaliner TOP 100 / 10 Jan 2022)

Alliance	*Operators*	*TEU*	*Ships*	*TEU Share*
2M Alliance	2M Alliance: MSC, Maersk Line	8.562.002	1.381	34,0%
Ocean Alliance	Ocean Alliance: CMA CGM, COSCO, Evergreen	7.596.855	1.251	30,1%
THE Alliance	THE Alliance: ONE, Yang Ming, HMM, Hapag-Lloyd	4.767.409	626	18,8%

Alliances have become a dominant feature of container shipping. Since global alliances in container shipping emerged around two decades ago, the market shares covered by carriers in global alliances have increased steadily, particularly during the last few years.
Between 2001 and 2011, there were three alliances (CYKH, Grand Alliance and New World Alliance) and their combined market share was around 35%. From 2012 onwards, with the creation of the MSC/CMA CGM alliance (both companies had not participated in any alliance before then), the global market shares of alliances gradually increased year by year. In 2015, MSC and Maersk created the 2M Alliance, with an initial share of about 30%. In the same year, Evergreen joined CYKH.

Currently, all major container carriers are involved in one of the three global alliances: 2M (Maersk, MSC) Ocean Alliance (Cosco-OOCL, CMA CGM, Evergreen), THE Alliance (Hapag-Lloyd, ONE, Yang Ming, HMM). Table 3 shows their capacity share. Together they hold 83% share of the global container fleet capacity (Merk et al., 2018). The establishment of a limited number of multi-trade strategic alliances in container shipping is concentrating the demand on a few players. Global alliances mainly operate on East-West trade lanes, where the combined market share of the three alliances is around 95% (Notteboom et al., 2017).

5. MAIN GLOBAL TRADES

The Mediterranean container ports play an important role in the global maritime scenario due to their key positioning along the main East-West trading routes and their centrality with respect to the

Atlantic and North European markets, on the one hand, and to those of Asia and Africa on the other. Among the East-West trades, the Asia-Europe trade is the major one in terms of container traffic, estimated at 26.3 million TEUs in 2021 (UNCTAD, 2021).

Figure 8 shows the trend from 2009 to today of container traffic along the East-West trades, which involve also Mediterranean ports. The first histogram column is relative to the Asia-Europe trade while the second to the Europe-North America one (Europe as Northern Europe and Mediterranean region). Notice that, in both cases, the Westbound trade traffic (Asia to Europe and Europe to North America) is higher than the Eastbound one. Between 2009 and 2021 the Asia-Europe trade grew by 55% while the Europe-North America by 51%.

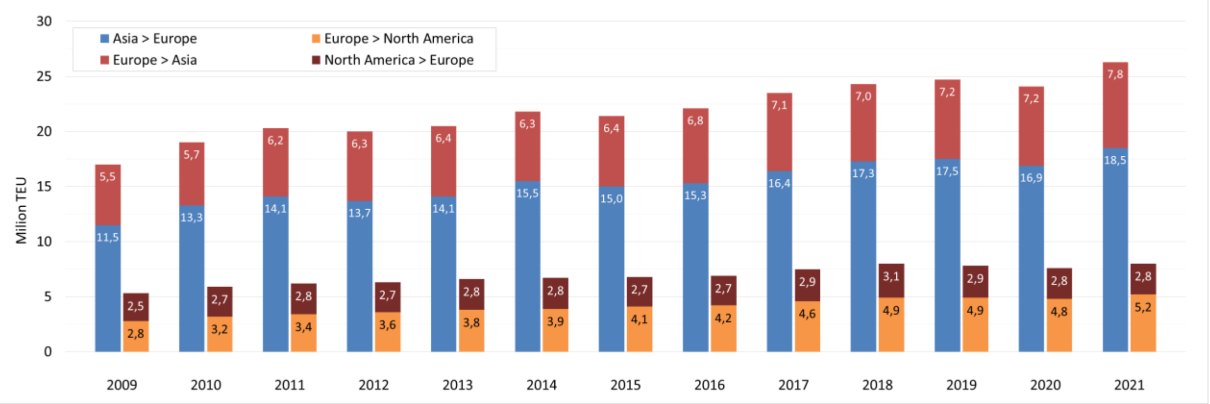

Figure 8: Containerized trade on major East-West trade routes, 2009-2021 (Source: UNCTAD)

6. CONCLUSIONS

This work presents a large data collection related to the main Mediterranean container ports. Through this study, the authors want to emphasize the strategic importance of the Mediterranean basin compared to the other global markets. Its key positioning along the major trading routes has influenced the total throughput growth of the Mediterranean container ports, favoring the main transshipment hubs, such as Piraeus, Tanger, Algeciras and Valencia.

Currently, Mediterranean container ports face a double task: on one hand an increase in competitiveness with the much larger and more structured ports of the Northern range and on the other an internal match against their competitors in the Mediterranean area.

The collected data show how the Mediterranean container port system has experienced a strong growth in the last twenty years, consistently with the main global container ports. The Mediterranean basin remains an important trading area, taking advantage of its central position with respect to European and North African markets.

The proposed analysis offers an overview of Mediterranean container ports, thus providing some useful information on the state of the art. The main objective of this work is to present a report with the last updated traffic data related to Mediterranean container ports (for many ports, 2021 data are not yet made public). The authors have decided to study the principal ports that overlook both sides of the Mediterranean basin, thus going to include in the same system ports that belong to different geographical regions but share the same sea.

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"Blue Economy
Port and Maritime Industry
Resilience "

CONCEPTUAL FRAMEWORK FOR INTEGRATION ON RENEWABLE ENERGY SOURCES FOR MARINE PORT ELECTRIFICATION

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Keywords: green ports, green logistic, intelligent methods, energy management, zero emissions.

1. **ABSTRACT:** In our days electrical energy demand for marine ports in order to cooperate climate change related with zero emissions exhaust gases for the ships has been increased. In order to adapt the situation for the marine port and not use the main grid powered by traditional power stations using fossil fuels, the insertion of renewable energy sources is recommended. The situation created many problems due to variable energy output of renewables and storage system required to be integrated. The authors of this paper propose a decision support framework for the identification and evaluation of the various renewable energy sources and their integration into marine port grid using the Analytic Hierarchy Process and taking into account a number of criteria, as well as, the energy requirements of port activities (i.e.: cold ironing, electrical moving assets, electrical handling devices, etc.). The Kaliningrad sea fishery port (Russia) is used as a case study. The use of hydrogen and hi-pressure as a storage of excessive energy is also to be considered. The proposed framework will advise decision-makers and port stakeholders on choosing the most suitable renewable energy source in the context of a zero-emission port.

2. INTRODUCTION

Marine ports connect a nation as well as the world through the maritime transport networks. Often the prosperity of a marine port is considered a measure for the prosperity of a city or a country. Ports and cities are considered interdependent, where the development of port activity leads to urban development and conversely. Marine ports consume a substantial amount of energy for their everyday operations, particularly for the various ship's activities such as loading, uploading, lighting, cooling, etc. In combination with the nearby industrial activities, ports have an expected negative impact on the environment. Nowadays, most ports use diesel engines that lead to a substantial amount of pollutant gases [1]. Furthermore, marine port operations are often associated with a variety of consequences such as noise and light pollution, water and soil pollution, sea level rise, coastal erosion and coastal flooding, traffic congestion, accidents, vibrations, and land take, resulting from port and ship activities and land transport. All these factors negatively affect the work and living conditions of residents living in cities near the port [1, 2]. In this context, the paper proposes the concept of a zero-emission port, encouraging the use of renewable energy sources.

The study presents a conceptual framework for the evaluation of renewable energy sources based on the Analytic Hierarchy Process (AHP). Choosing the most suitable renewable energy source is often considered a complicated decision-making issue, which AHP can resolve. The AHP firstly developed by Saaty (1980) [3] is considered one of the most notable representatives of Multi-Criteria Decision Analysis (MCDA) techniques and its application is very often in the literature in various fields such as politics, economics, spatial planning, etc. Many studies apply AHP for a variety of purposes, including selecting the most appropriate renewable energy source [1, 4-10]. Even though there is a variety of renewable energy sources (e.g. solar, wind, tidal, wave, geothermal, biomass, and hydro) this does not mean that they are appropriate for a specific site or an industrial sector.

This paper presents a decision support framework for selecting the most suitable energy alternative in the light of the zero-emission port. The paper is set out as follows: the concept of zero-emission port together with a brief description of the case study are presented in section 3. Section 4 presents in detail the proposed methodology. The results and conclusions are discussed in sections 5 and 6 respectively.

3. THE CONCEPT OF ZERO-EMISSION PORT AND THE PORT OF KALININGRAD AS A CASE STUDY

Nowadays, more environmentally friendly solutions are increasingly being considered in marine ports due to the challenges of climate change and the adoption of environmental regulations. In order to reduce air pollution and comply with international environmental regulations, in 2011 the IMO set a 50% reduction in greenhouse gas emissions from ships by 2050, despite increases in freight and passenger transport to date. To achieve these goals, several changes must be made in the shipping sector, both for ships and for ports [11]. In addition to the choice of green fuels, scrubbers, and electric ships that can be powered by renewable sources and the use of storage systems, ports are coming to add another alternative solution: Cold ironing.[1]

During cold ironing, ships shut down their engines while berthed and plug into a land-based power source. During this process, all main operations of the ship can still receive continuous electricity while

[1] It can also be found in the international literature with the terms: shore-side electricity supply, shore-to-ship power.

the vessel is loading or unloading its freight. Although cold ironing is a good alternative, there are some challenges to consider, such as cold ironing infrastructure at marine terminals, lack of standardization, absence of concrete legislation/regulation. Despite the challenges and technical difficulties that may occur, major ports (e.g. Los Angeles, Long Beach, Seattle, Antwerp, Hamburg, Rotterdam, etc.) have already adopted the cold ironing solution, offering important benefits in terms of limited emissions and costs [12].

Although, cold ironing is a way to reduce ships' emissions the fact that is connected with the grid is a drawback for its holistic approach. So, in order to reduce the environmental footprint of cold ironing ships and to avoid the use of the main grid, the use of RES such as wind turbines, mainly offshore due to land limitations in the port, wave devices, solar panels on building roofs and warehouses or floating, etc.as well as storage solutions are increasingly being considered in marine ports. In order to be able to manage all these different aspects (sources, storage solutions, and loads) the development of microgrids in ports is examined in the last decade [11].

The microgrid or smartgrid can be considered as a self-healing system that reduce workload. The control and distribution center has many renewable energy sources depending on the availability of port resources. The center is connected to a fixed electricity network that is used as needed and a digital metering system to record the energy requirements of the marine port and thus to distribute the required available electricity. The surplus energy generated from renewable energy sources is converted to hydrogen and can be used in electric vehicles for marine port activities or stored in high-capacity batteries of new technologies. [2]. Even though, microgrids have been extensively used around the world, in different types and areas (e.g. cities, remote communities, etc.) they are still rare in ports due to the diversity of loads. This condition includes technical challenges, which can now be addressed with Artificial Intelligence (AI) techniques [2, 11].

The proposed methodology in this study is applied to the Kaliningrad sea fishery port, which operates in the port of Kaliningrad, the westernmost port in Russia (Fig.1).

Figure 1. Geographical location and territory plan

Kaliningrad marine port is located in the northern side of the Kaliningrad Sea canal as well as at the estuary of the Pregolya River, offering berths of 17 Km. The length of the canal is 43 Km, the width is 50-80 m and the depth between 9 to 10.5 m. The canal can be used to transport a ship up to 200 meters long [13]. Kaliningrad fishery port provides a range of services including cold ironing and shore power supply [14]. Figure 2 provides detailed data on average power consumption (kW) [2].

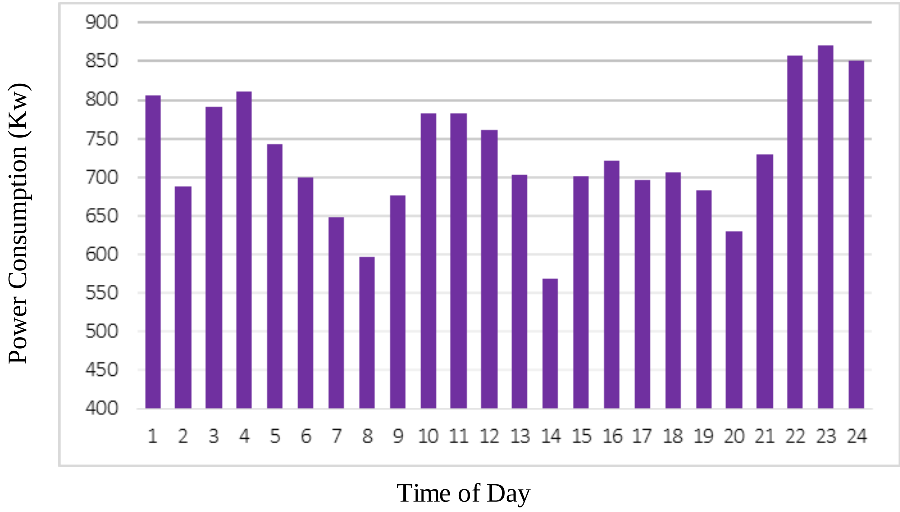

Figure 2. Average power consumption (Kw).

The Kaliningrad sea fishery port has a good resource availability for the development of renewable energy sources. The average wind speed is 7 m/sec (50 m) and 8 m/sec (100 m), and the average solar radiation is 2.8 kWh/m2 [14]. The possibility of developing wave energy is also being explored.

4. METHODOLOGY

4.1 Evaluation criteria for the selection of renewable energy technology

Choosing the most suitable energy alternative can be a challenging issue as many criteria have to be considered, such as technical, economic, social, spatial, and environmental that may be in conflict with each other. Such a selection problem can be resolved using multi-criteria analysis techniques and AHP which is a powerful technique that handles such multiple attribute issues.

Although, there are many types of renewable energy sources, they may not all be suitable for a particular site or industrial sector such as a port. Based on the case study resource availability, and previous studies on the potential for development of renewable energy sources in the port area, the following technologies have been selected for further consideration: wind turbines (onshore and offshore), solar panels (onshore and offshore) and wave devices.

In order to select the most appropriate energy alternative for marine port electrification, this initial stage of methodology accepts that there are graduations in the five (5) renewable energy technologies, which essentially arise from the evaluation of energy options in various parameters. Ten (10) evaluation criteria are used based on the literature review and the opinion of experts through interviews, as follows: (Table 1) [1, 4-10]:

- ***Resource availability***: Availability of renewable sources for energy production.
- ***Technological maturity***: is the degree of diffusion of a technology at regional, national and international level, and shows that a specific technology has reached the theoretical performance limit or that the technology still needs improvements.
- ***Know-how***: Availability of specialized human resources in the region/country for

installation, operation, and maintenance purposes.

- ***Capacity factor***: it is an indicator that essentially shows the amount of energy we can get from a source.
- ***Investment cost***: is the total cost resulting from the installation of an energy unit, including equipment, labor, and infrastructure and commissioning costs.
- ***O&M cost***: is the operating cost of the energy unit, including employees' salaries, the cost of spare parts required for maintenance purposes, etc.
- ***Land requirements***: Each energy unit takes up space. Conflicts can occur if the space is used by other (sea) users. These barriers may hinder the licensing and development of the unit.
- ***Job creation:*** The possibility of creating employment opportunities, especially for local communities.
- ***Social acceptance***: is the public opinion toward a type of power unit.
- ***Impact on ecosystem***: is a measure of the potential impact of the energy plant on the (marine) environment.

Table 1. Evaluation criteria

Evaluation criteria	***Abbreviation***	***Type of criterion***
Resource availability	RA	Technical
Technological maturity	TM	Technical
Know-how	K-H	Technical
Capacity factor	CF	Technical
Investment cost	IC	Economic
O&M cost	O&M	Economic
Land requirements	LR	Spatial
Job creation	JC	Social
Social acceptance	SA	Social
Impact on ecosystem	IOE	Environmental

4.2 The Analytic hierarchy process

In addition, the ten (10) evaluation criteria may not be of equal importance. Therefore, the most important criteria should be weighted more than the others. This can be achieved through the AHP and the pair-wise comparison matrix.

The initial stage of AHP includes developing the hierarchical structure of the selection problem, as shown in Figure 3. The general objective of the selection problem is at the upper level, the ten (10) predefined evaluation criteria at the second level and the five (5) energy options at the lower level.

Next step is the creation of the pair-wise comparison matrix of the ten (10) evaluation criteria listed above according to 9-point scale of Saaty (1980). In this way, the preferences of stakeholders who participate in the procedure are decoded and incorporated in the methodology.

Third step is to calculate the weights of the ten evaluation criteria, including a number of individual steps. The results as obtained from the above steps are presented in Table 2.

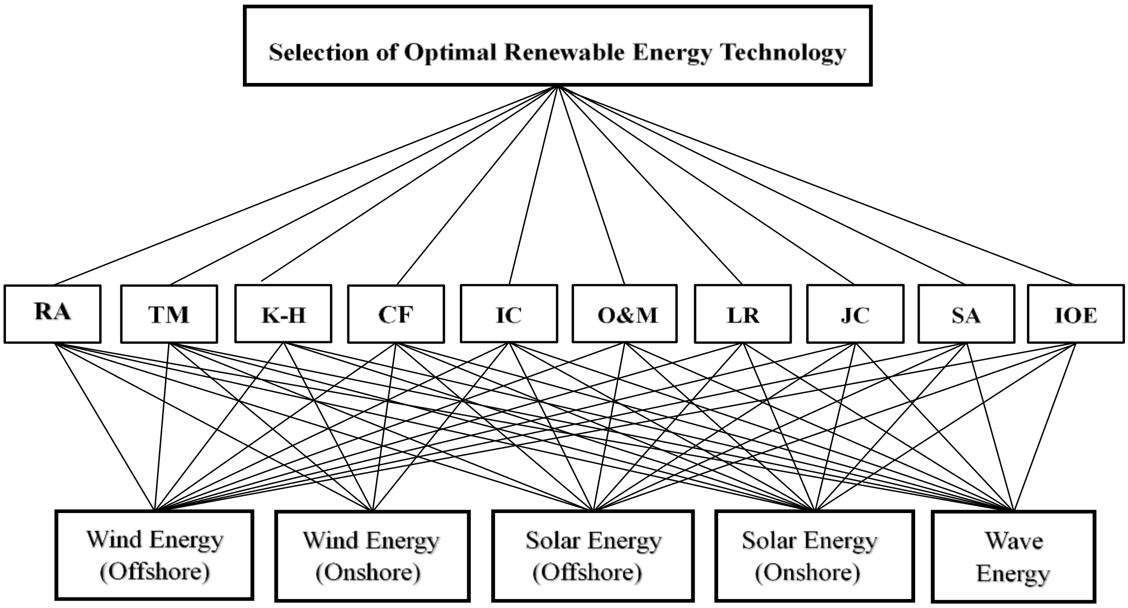

Figure 3. Hierarchical structure for the selection of the most appropriate RES technology

The final stage of AHP is the calculation of Consistency Ratio (CR). CR is a very useful indicator, as it ensures that the opinions taken into consideration were correct.

Firstly, the Consistency Index (CI) is calculated as follows:

(1) $$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{10.37-10}{10-1}$$

Where n= the number of evaluation criteria, and λ_max= maximum eigenvalue

Finally, the Consistency Ratio (CR) is calculated from the following formula:

(2) $$CR = \frac{CI}{RI} = \frac{0.041}{1.49} = 0.027$$

Where RI = Random Consistency Index of a random-like matrix. The CR must not be greater than 0.1.

Table 2. Pair-wise comparison matrix and weights

Criteria	*RA*	*TM*	*IC*	*O&M*	*IOE*	*SA*	*LR*	*JC*	*K-H*	*CF*	*Weights (%)*
RA	0.316	0.383	0.349	0.349	0.297	0.259	0.23	0.206	0.188	0.173	***27.5***
TM	0.158	0.191	0.232	0.232	0.223	0.207	0.191	0.177	0.164	0.154	***19.4***
IC	0.105	0.097	0.116	0.116	0.148	0.155	0.153	0.147	0.141	0.134	***13.2***
O&M	0.105	0.097	0.116	0.116	0.148	0.155	0.153	0.147	0.141	0.134	***13.2***
IOE	0.079	0.063	0.058	0.058	0.074	0.103	0.115	0.118	0.117	0.115	***9***
SA	0.063	0.048	0.038	0.038	0.037	0.051	0.076	0.088	0.094	0.096	***6.3***
LR	0.052	0.038	0.029	0.029	0.024	0.026	0.038	0.059	0.07	0.077	***4.5***
JC	0.045	0.032	0.023	0.023	0.018	0.017	0.019	0.029	0.047	0.057	***3.1***
K-H	0.039	0.027	0.019	0.019	0.014	0.013	0.012	0.014	0.023	0.038	***2.2***
CF	0.035	0.024	0.016	0.016	0.012	0.01	0.009	0.009	0.011	0.019	***1.6***

4.3 Performance score of energy alternatives

Once the ten (10) evaluation criteria of energy alternatives have been identified based on the literature review and expert's judgments, and weighted through the AHP, the next step is to evaluate the performance of the renewable energy alternatives for each evaluation criterion using a scale of 0-10 (Table 3).

Table 3. Performance scores of ten evaluation criteria

Evaluation criteria	***Scores*** ***0***	***10***
RA	Low and unpredictable	High and predictable
TM	Technology is still relatively new	Technology has been used for a long time
IC	Most expensive	Least expensive
O&M	Most expensive	Least expensive
IOE	Significant impact on the environment	Minor/negligible impact on the environment
SA	Negative public attitude toward specific renewable energy source	Positive public attitude toward specific renewable energy source
LR	No land available/Conflicts with other users	Spacious land available/No conflicts
JC	Few/negligible job opportunities	Substantial job opportunities
K-H	Lack of specialized human resources in the region/country	Availability of specialized human resources in the region/country
CF	Low	High

Experts were asked through interviews to evaluate the performance of each energy option in each evaluation criterion for the Kaliningrad sea fishery port, taking into consideration the hypothetical question "*What would be the performance e.g. of first energy option in the first evaluation criterion, if the first energy option is used in the fishery port of Kaliningrad*;" and so on, as described in the study by Budak et al. (2019).

The weights in the above methodology step (§ 4.2) are not geographically dependent. On the contrary, the process of performance score of each energy alternative is site-specific, which means that the involvement of experts, who not only know about renewable energy sources, but also have in-depth knowledge of the techno-economic, spatial, and environmental aspects of a place, is important. The performance score of the above process is presented in Figure 4.

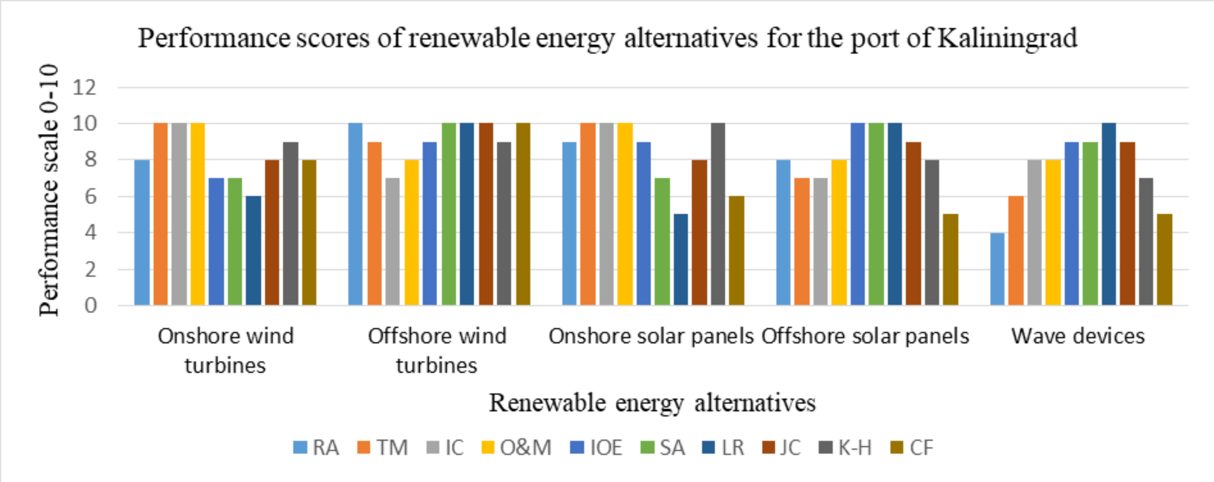

Figure 4. Performance scores of renewable energy alternatives for the port of Kaliningrad

5. RESULTS

In this last stage of methodology, in order to determine the weighted total performance score of the five (5) renewable energy alternatives for the case study, the results in Table 2 and Figure 4 are summed through multiplications (Table 5, Figure 5). At this point, it is important to point out that the five (5) renewable energy sources are not mutually exclusive, but are classified, as one or more technologies can be chosen for a specific place depending on a number of parameters (e.g. restrictions, availability of resources, etc.).

Table 5. Individual overall performance scores of the five renewable energy technologies

Evaluation Criteria	***Weight Factor (%)***	***Energy alternatives***				
		Onshore wind turbines	***Offshore wind turbines***	***Onshore Solar panels***	***Offshore Solar panels***	***Wave devices***
RA	27.5	2.2	2.75	2.475	2.2	1.1
TM	19.4	1.94	1.746	1.94	1.358	1.164
IC	13.2	1.32	0.924	1.32	0.924	1.056
O&M	13.2	1.32	1.056	1.32	1.056	1.056
IOE	9	0.63	0.81	0.81	0.9	0.81
SA	6.3	0.441	0.63	0.441	0.63	0.567
LR	4.5	0.27	0.45	0.225	0.45	0.45

JC	3.1	0.248	0.31	0.248	0.279	0.279
K-H	2.2	0.198	0.198	0.22	0.176	0.154
CF	1.6	0.128	0.16	0.096	0.08	0.08

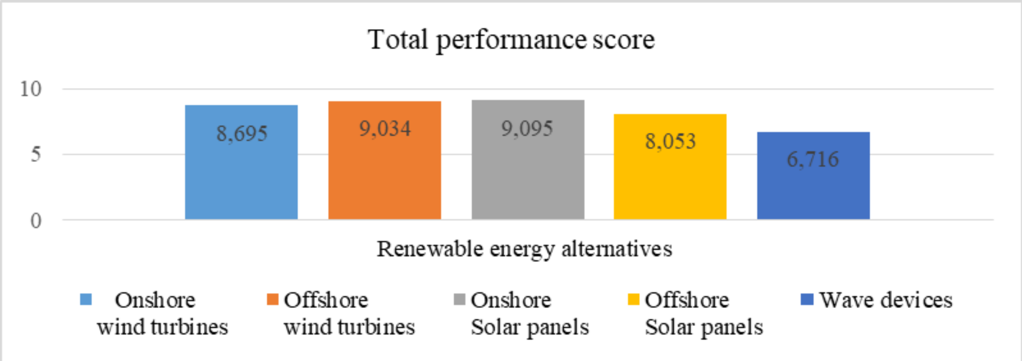

Figure 5. Total performance scores of the five renewable energy technologies

Onshore solar panels are ranked as the top choice for the Kaliningrad sea fishery port among all energy alternatives, as results from the matrixes multiplications, and aggregations, an expected result, as the port has good resource availability, solar panels are considered a highly mature technology, with low investment and O&M costs, while land requirements can be met with their placement on the roofs of buildings and warehouses, without the need for a completely new space, something that it not necessary for the installation of offshore solar panels, as they can be placed further offshore provided that there are no conflicts with other sea users.

Offshore wind turbines are ranked as a second alternative, as the case study has good resource availability, with stronger offshore winds compared to onshore, the technology has been used for a long time, while due to land restrictions in the port can be placed further offshore, and this is one of the main reasons for the lower ranking of onshore wind turbines. In addition, offshore installations (e.g. offshore wind turbines or solar panels) are considered preferable options than onshores, due to the less potential environmental impacts, while there is evidence that the submerged parts of their structures contribute to the restoration of damaged ecosystems by acting as artificial reefs [15, 16].

Finally, wave energy is the last preferable option. The low resource availability in the area and the low technological maturity of this type of technology combined with the lack of specialized human resources in the region/country, among others, make this alternative the least acceptable. The scores and classification of energy alternatives resulting from the methodology are in line with previous research studies on the development of alternative energy solutions in the light of the zero-emission port.

6. CONCLUSIONS

The study presented a decision support framework for the identification and evaluation of the various renewable energy sources and their integration into marine port grid using the Analytic Hierarchy Process and the input of experts, and taking into account a number of criteria as well as the energy requirements of port activities. The output of the decision support model provides scores and well-justified classifications for the various alternative renewable energy sources, which allow decision-makers, port stakeholders, and other interested parties (e.g. neighboring communities) to select the most appropriate energy alternatives for a greener port and in the light of the common interest. Based on the analysis for Kaliningrad sea fishery port, onshore solar panels, offshore wind turbines and onshore wind turbines are the three preferred options, while wave devices are the least acceptable alternative. Different classifications may arise if the proposed methodology is applied to different marine ports, due to different port characteristics (e.g. spatial and environmental constraints, availability of resources, etc.). However, the results are in line with previous research studies on the development of alternative energy solutions in the light of the zero-emission port, and show a clear trend in this direction. Indeed, solar technology is a mature technology, with low investment and O&M costs, and easily adoptable by ports, as solar panels can be installed on the roofs of buildings and warehouses, without the need for a completely new space. Furthermore, offshore wind turbines are an equally good alternative, due to the land restrictions in ports, whose technology has been used for a long time.

Although onshore solar panels are the top choice, the other energy alternatives should not be ignored. Using a mix of renewable energy sources can offer a more comprehensive approach to a long-term energy problem. In this context, the concept of microgrids or smartgrids can encourage marine ports to invest in more environmentally friendly solutions, such as cold ironing, storage solutions, electric vehicles for marine port activities, etc. and to manage the various aspects (sources, storage solutions, and loads) that result from their operation.

In this framework, the paper proposes the concept of a zero-emission port, encouraging the use of renewable energy sources. The proposed methodology can be used for other complicated decision-making issues that include expert's involvement and extensive analysis, as it is characterized as extremely flexible and could incorporate a variety of criteria and alternatives.

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DECARBONISING SHORT SEA SHIPPING OPERATIONS: EXAMINING THE EFFORTS AND OUTCOMES OF A FINNISH SHIPPING LINE'S RELEVANT INITIATIVES

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Keywords: decarbonisation; maritime transport; air pollution; GHG emissions; short sea shipping; Viking Line.

1. ABSTRACT: Decarbonisation of maritime transport operations has become a main priority for shipping companies around the world, especially after the adoption of the Initial International Maritime Organization's (IMO) Strategy on Reduction of Greenhouse Gas (GHG) Emissions from Ships in 2018 that sets the goal of reducing the global shipping emissions by 50% by 2050, as compared to 2008. In a similar direction, the European Union's (EU) Green Deal initiative was adopted in December 2019 and proposed, among others, the inclusion of shipping in the EU Emissions Trading Scheme (EU ETS) as an additional tool for the achievement of climate neutrality in Europe by 2050. The most recent UN Climate Change Conference (COP26) that was held in Glasgow also increased the momentum for global decarbonisation efforts highlighting the important role and contribution of maritime transport in these overall efforts. This paper discusses the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations; initiatives that encompass various technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power). According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model focused on sustainable development. Global and regional regulations/guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

2. INTRODUCTION

Decarbonisation of maritime transport operations has become a main priority for shipping companies around the world during the last decades, as the amount of GHG emissions from shipping has increased over the years and in 2018 it accounted for 2.89% of global GHG emissions following a

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constant increasing trend (Faber et al., 2020; Giziakis and Christodoulou, 2009). It is clear that, besides the vital role of maritime transportation in global trade and its fundamental contribution to societal growth and progress, the negative impact of maritime GHG emissions needs to be tackled (Sirimanne et al., 2019). Although a number of technical and operational measures have already been introduced by the IMO for the abatement of GHG emissions - Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP), and Fuel Oil Consumption Data Collection System (DCS) - the progress has not been the desired one and in 2018 the Initial IMO's Strategy on Reduction of GHG Emissions from Ships was adopted (IMO, 2018; Ölçer et al. 2018). The Initial IMO Strategy sets the goal of reducing the global shipping emissions by 50% by 2050, as compared to their 2008 level, with a vision to phase them out by the end of the century.

In a similar direction, the European Union's (EU) Green Deal initiative was adopted in December 2019 and proposed, among others, the inclusion of shipping in the EU Emissions Trading Scheme (EU ETS) as an additional tool for the achievement of climate neutrality in Europe by 2050 (European Commission, 2019). Additionally, the Monitoring, Reporting and Verification (MRV) regulation also came into force since 2018 requiring all vessels above 5000GT operating within the European Economic Area, starting of finishing their voyage in a EU port to monitor and report their emissions on a yearly basis (EU Regulation 2015/757; Christodoulou et al., 2021). Finally, the most recent UN Climate Change Conference (COP26) that was held in Glasgow also increased the momentum for global decarbonisation efforts, highlighting the important role and contribution of maritime transport in these overall efforts.

In order to comply with the evolving global and regional regulatory framework related to the abatement of GHG emissions from their operations, the vast majority of shipping companies around the world have proceeded with the adoption of a number of measures and initiatives in order to improve the energy efficiency of their fleet and reduce their carbon footprint (Brynolf et al., 2014; Wan et al., 2018). Apart from the implementation of the so-called "mandatory" measures, several proactive shipping companies have proceeded with the introduction of voluntary initiatives in order to reduce further their emissions and promote their sustainable development, but also gain a competitive advantage in the market where they operate (Lai et al., 2011; Lun et al., 2016; Christodoulou and Cullinane, 2021). The differentiation of the service and the sustainability concerns have been found to particularly impact liner shipping that operates in specific routes and trades. Even more intense is the competition and environmental concerns in the RoPax segment operating in Northern Europe, where the environmental regulatory framework is even stricter when compared with other regions of the world, with the environmental output being a crucial factor for the 'choice' of a company by its customers (Christodoulou and Kappelin, 2020).

This paper discusses the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations. These initiatives encompass various technical and operational measures,along with the employment of alternative fuels and/or energy sources (such as wind power). According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model being focused on sustainable development. Global and regional regulations/guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

3. METHODOLOGY

A case study methodology has been applied in this study for the exploration of the various initiatives implemented by the shipping line under consideration – Viking Line – for the reduction of its energy consumption and related GHG emissions. The reason why a case study method was chosen in this research, is primarily the fact that the main objective was to investigate a contemporary phenomenon in depth and within its real-life context, a phenomenon that could not have been examined outside of a specific context (Yin, 2009; Voss et al., 2002). In this case, the regulatory and the contextual framework within the company operates has played a fundamental role for the provision of incentives for the implementation of these exact initiatives. The already existing global and regional regulations for the abatement of GHG emissions played an important role, on the one hand; the fact that Viking Line is a RoPax line operating in Northern Europe was another crucial parameter for the analysis. The various sustainability initiatives adopted by the company - encompassing different technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power) – are analysed in this paper with the objective to provide some evidence of their potential to substantially reduce the carbon footprint of maritime transportation if effectively implemented.

In order to proceed with the data collection for the analysis of the case study, the authors first thoroughly went through Viking Line's sustainability reports and website and also gathered any information available on the news relevant to the company's sustainability initiatives. As expected, real-life and detailed practical data/information could not be obtained from these secondary data sources, so a semi-structured interview with the sustainability manager of the company was also conducted in October 2020. The sustainability manager was chosen as the most appropriate interviewee on the topic under investigation as he had a deep knowledge of the sustainability initiatives undertaken by Viking Line over the years, but he could also provide a comprehensive overview of the company's sustainability strategy. The interview lasted one hour and fifteen minutes; it was audio-recorded and took place via Zoom due to the pandemic of covid-19 travel restrictions. The interview guide was already sent out via email to the interviewee some days before to allow some time to prepare and gather the data relevant to the interview questions.

Both primary and secondary data were analysed in conjunction in order to provide a chain of evidence and strengthen the data validation of this case. As proposed by Denzin (2012), one basic type of triangulation that was used in our analysis was *data triangulation*, including the use of multiple data sources in a single study to overcome subjectivity and establish a chain of evidence. The manuscript was also sent for review to the respondent to avoid misunderstandings and ensure that all the points were clearly and correctly presented. Figure 1 presents the data triangulation method applied in this study.

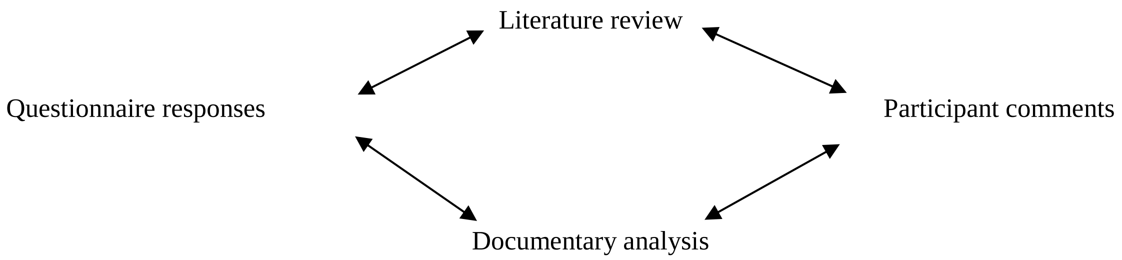

Figure 1. Data triangulation method applied in this study. Source: Authors' own elaboration

4. THE CASE OF VIKING LINE

Viking Line provides passenger and cargo carrier services using the vessels Amorella, Gabriella, Mariella, Rosella, Viking Cinderella, Viking Grace and Viking XPRS between Finland, Sweden and Estonia (Figure 2). The company owns the terminals in Turku and Stockholm and uses the various others in its short sea shipping network. All the company's vessels are certified in compliance with ISO 14001 environmental management standards and sustainability is a very important priority for the company that has already adopted various initiatives for the improvement of its fleet energy efficiency, along with the decarbonization of its operations; initiatives that encompass various technical and operational measures along with the employment of alternative fuels and/or energy sources (such as wind power). The company has also introduced a successful organization model that focuses on sustainable development and crew involvement in decision-making (Viking Line). The efforts already undertaken, as well as the results from the implementation of the various initiatives will be presented and analysed in the coming subsections to shed light on the potential environmental benefits from their adoption, but also underline challenges related to their practical implementation.

Figure 2. Viking Line's route network. Source: Viking Line

4.1 Onshore Power Supply (OPS)

Viking Line has proceeded with the provision of OPS in 4 terminals located in Sweden, Estonia and Finland (Stockholm, Tallin, Helsinki and Mariehamn). By installing and using OPS at berthing time, the vessels do not need to use energy produced from their auxiliary engines, but they can instead use electricity from the port, significantly reducing in this way fuel consumption and emissions generated at the port area (Acciaro et al., 2014; Innes and Monios, 2018; Christodoulou and Woxenius, 2019). This installation has resulted in saving 1200 tonnes of fuel and reducing 3800 tonnes of CO2 emissions by connecting 4 of its vessels to OPS while in quay and verifies the findings from the existing literature that important reductions in vessels' emissions can be achieved from the implementation of this technology (Vaishnav et al., 2016; Winkel et al., 2016).

What is worthwhile to mention is the fact that, in the two Swedish terminals (Stockholm and Mariehamn) and Tallinn, vessels use 100% green electricity while at berth, in contrast to Helsinki, an issue creating significant differences in emissions reductions among the two cases. According to the interviewee, in the case electricity used for the provision of OPS is sustainably produced (green), there's basically no carbon footprint and the environmental benefits are not compared to the electricity coming from coal or other resources. Coming to the reasons why green electricity is not used in all terminals, the respondent highlighted that the company is engaged in talks with the terminal in Helsinki on this issue and the main reason is that in Helsinki Viking Line does not own the terminal and it is basically the port that decides where the electricity comes from.

A crucial parameter for the implementation of OPS is the installation and operational cost for the vessels that is extremely high and requires large investments. According to the respondent, Viking Line's investments in all things that went into making the short side power possible accounted for around 500 to 700,000 euros per vessel, while the ports needed to pay to install the necessary equipment from their side. There was a 30% allocation from the EU through a project in Tallinn port for the installation of OPS that was divided between Viking Line and the ports. As already mentioned by the existing literature (Zis et al., 2014), the interviewee underlined the importance of providing national subsidies to incentivize and promote the installation of OPS given the high initial capital investment required and the potential operational cost from the increased price of electricity that is needed in high loads for the provision of OPS. According to the respondent, these subsidies are essential, but not provided at the moment, because shipping's emissions are not accounted for in the national gas inventories and it consists of an easy step that could bring about a significant change and emissions reduction.

Another major drawback related to the operation of OPS is that it's usually on high loads and, as a result, it is cheaper to use bunker fuel to power the vessel as in vessels' operations there are basically very few times that the loads are so low that it would be cheaper to run on OPS. In other words, the implementation of OPS is just something that shipping companies do as part of their sustainability work, but it implies increased running (operational) cost all the time as the electricity required for OPS is more expensive than using the fuel. Additionally, due to the lack of subsidies, when using OPS the shipping companies carry the entire risk if electricity prices rise unexpectedly while their price risks for bunker fuel is quite often mitigated by signing some kind of fixed price contracts with their suppliers.

Besides the subsidies that could be offered to provide some kind of compensation for the installation of OPS, there are also port environmental discounts that reward cleaner vessels and the use of OPS consists one of the criteria for the vessels' certification with maritime environmental performance indices (e.g. Environmental Ship Index (ESI), Clean Ship Index (CSI)) that form the basis for the provision of these discounts in a number of ports (Christodoulou, 2019). According to the respondent, Viking Line's vessels are certified with the CSI and it is feasible to get environmental discounts from ports if you have to use OPS because this technology does reduce emissions in the port area. However, the certification with the CSI also depends on other parameters (e.g. waste, chemicals) and, although OPS helps in order to receive these discounts, the costs will never be returned unless bunker fuel prices go up a lot or the electricity price comes down or there are subsidies.

4.2 Wind power and LNG conversion

Viking Line equipped in 2018 Viking Grace – a RoPax vessel operating in the Turku-Stockholm route - with a rotor sail that turned her into the world's first hybrid ship of its size to run on both LNG and wind power. The employment of LNG as a marine fuel has been initiated by the Directive 2014/94/EU that requires all core ports in the EU to build LNG refuelling points by the end of 2025 along with the provision of OPS (European Union, 2014). In this sense, this initiative could be easily related to the upcoming European regulations. According to the interviewee, Viking Grace was a RoPax vessel running on LNG fuel from the start, so there were no conversion costs. The rotor sail was installed in 2018 in cooperation with the supplier Norsepower with the installation costs being low, as it was basically an investment from Norsepower to gain experience and build their reputation. Since its installation, the progress of using the rotor sail has been tracked in order to observe if there's any reduction in the total fuel consumption because of its use. The problem is that the data obtained is not really measurable, because there's software on the engine that propels the sail and it provides information on its effectivity, but this data can't really be connected to the data on fuel consumption and the amount of reductions. This is the reason why the company is still in testing for two years although they were initially going to be testing for one year. There were plans to also have the rotor sail on Viking Glory, but because of the test they made and the traffic on the route, the company decided that it's not optimal to proceed with the installation of the rotor sail on this vessel.

Coming to the emissions reductions from the use of LNG fuel from Viking Grace, the vessel already has some 20-25 % less CO2 emissions than conventional fuel. According to the academic literature, what's problematic about the LNG is the methane slip that occurs during the combustion process (Bengtsson et al., 2012). In the case of Viking Grace, the methane slip is estimated close to 1.5%, so it's inevitable that some of the fuel goes on burnt but it's still comparatively less emissions for using LNG than for using regular fossil fuels or bunkers. Additionally, from the use of LNG, SOx emissions are reduced by 85% while NOx emissions are close to zero in accordance with Bengtsson et al. (2012), which is truly beneficial for the population located near the ports (Winnes et al., 2015).

Regarding the question if Viking Line would consider the investment in new technologies/fuels due to the introduction of the NECAs, the installation of humid air motors (HAM) is already in place in one of their vessels – Mariella – and has helped with the reduced production of NOx because the burning temperature is a bit lower, but other technologies available might also be considered to address this issue.

4.3 Construction of new vessels

Another initiative for the improvement of the energy efficiency of the company's fleet is the construction of a new vessel – Viking Glory – that is expected to use up to 10% less fuel than Viking Grace, which was previously awarded the honour of being the world's most environmentally-friendly passenger vessel in its size class. The construction of this ferry consists a huge investment as its construction costs around 200 million euros, it's been built in China and is designed to have around 10% less emissions than Viking Grace. Viking Glory will be replacing the vessel that's currently with Viking Grace on the Turku-Stockholm route – Amorella - so that we will have both these ferries complimenting each other. The Turku-Stockholm route is the most important market for Viking Line and it makes sense for the company to have two comparable vessels operating against each other and offering a product that is the most environmentally friendly way to travel from Finland to Sweden.

4.4 Energy management system

Viking Line has introduced since 2017, in partnership with the company Blueflow, an energy management system on all its vessels in order to ensure compliance with the EU requirements for reporting CO2 emissions (MRV system); and this system has also served as a dual in the achievement of fuel savings on a daily basis. This reporting system enables the company to monitor the vessels' emissions, but has also been used as a trial by error tool to look at potential route planning changes and their effectiveness (of course it's not a proactive tool like other route planning systems that are installed on some of the vessels, basically take in account a few factors, like travel time, trim, weather conditions and then suggest routes planning). According to the interviewee, Viking Line believes strongly in these route planning systems and aims to develop them further. As these systems take into account the weather conditions, then technical conditions, the load, the trim and the wind, their application can result in significant fuel savings; when the vessel operates in the archipelago, there are obviously speed restrictions and it needs to be decided 'where do we push the brakes and where do we push the gas basically to do that optimally'. This process is very time-consuming and there might have to be some kind of artificial intelligence assisting. Stena Line for instance is applying artificial intelligence assisted pilots in one of their vessels that will be rolling out into their fleet and it remains to be seen if there will be significant reductions coming from that.

This energy management system was not costly and it basically included the installation of software into the company's automation systems, then getting screens up and running on the bridge and in the engine room. A crucial factor for the successful implementation of the system was the training of staff and crew. All the staff and crew had training that was not easy because they were working on shifts, so not everyone could be trained at once. Besides the training, the system has been designed to be really easy to understand that it would be intuitive to look at the screens with all the indicators and then to take out the reports. In other words, there's training available but the system is also so simple that a person who knows excel can operate it.

Concerning the certification of the company's vessels with ISO 50001 (energy management certification), the respondent replied that this would be something that he sees happening in the future but not right now, not in a couple of years a least, because doing these management systems and getting them really operational to the crew requires a lot of work that needs to be somehow compensated - there needs to be some kind of payoff, not necessarily purely economic. Moreover, certain aspects of ISO 50001 are more or less covered with ISO 14001 (environmental management) certification, so it would be more administrative workload in a period when administration load for the shipping companies is really heavy.

4.5 Energy efficiency improvement projects

Since 2016, Viking Line has proceeded with the investment of more than four million euros in different projects to improve the energy consumption of its vessels. The interviewee pointed out that by far the most effective investments have been in ventilation; the use of frequency converters resulted in the optimization of the engine's operation. For example, on Viking Gabriela these improvements in ventilation resulted in fuel savings of almost 600 tons per year. Similar improvements in ventilation were applied on Viking Grace, but not at full-scale, and the energy savings were equal to all the energy consumption of all the offices and warehouses of the company in Mariehamn where their headquarters is. It becomes obvious that even tiny energy improvements onboard the vessels – in this case this ventilation tweak on board the vessel - save that much energy compared to investments onshore. Concerning the amount of investments for the improved ventilation system on Viking Gabriela, it comes up to 800,000 euros with an expected return on investment in one and a half years. The most costly energy efficiency project Viking Line invested in is ventilation, but also the most effective. It was a big project that's why it costed so much and it was at the same time the hardest to implement as well.

This successful project and significant energy consumption improvement on Viking Gabriela also shows that even on old vessels there's a lot of ways that energy consumption can be optimized with the retrofitting and there's a lot of work that's been done in vague all the time on the company's old vessels. What the respondent has observed is that – on the one hand- energy consumption climbs basically because the company puts in stuff for the passengers and comfort and – on the other hand - at the same time it keep optimizing the energy consumption so a marked reduction in the total has been achieved but not of the required magnitude to have the desired effect on the climate. According to the interviewee, the company needs to fight on both fronts: of the technical reduction of having the engines and everything operating as well as they can and then it needs to combat the climbing consumption.

4.6 New organisational model

Since 2018, Viking Line has launched a new organisation model, beginning from the vessels and continuing during 2019 with the land-based organisation. The first results from the implementation of this results-driven model are positive, according to the company's sustainability report. The interviewee commented that this new organisation model was basically a way to reorganize the company that allowed the decisions to be made closer to the operations. According to the interviewee, the main motivation behind this organizational restructure was the fact that it would be more effective if the vessels themselves that were every day close with the customers were given more responsibility and more options to decide how to improve the customer experience. He added that at the same time the new organization model allowed them to streamline the organization, but unfortunately due to the covid the company is now back in the same place again as they needed to make big cuts.

Besides the impact of covid-19 pandemic, the new organization model is quite effective, according to the respondent, with positive economic results because there's always a benefit when the people who are operating the vessels are given more responsibility to take decisions on their work. Similar positive results from the environmental auditing for the ISO 14001 certification were also seen for the years when the vessels themselves were given the responsibility of the work and they had some person on board in charge of this. Along with the economic and developmental benefits, the organizational restructure also brought environmental and energy efficiency improvements of the company's fleet.

An overview of Viking Line's sustainability initiatives related to the improved energy efficiency and decarbonization of its fleet is presented in Figure 3.

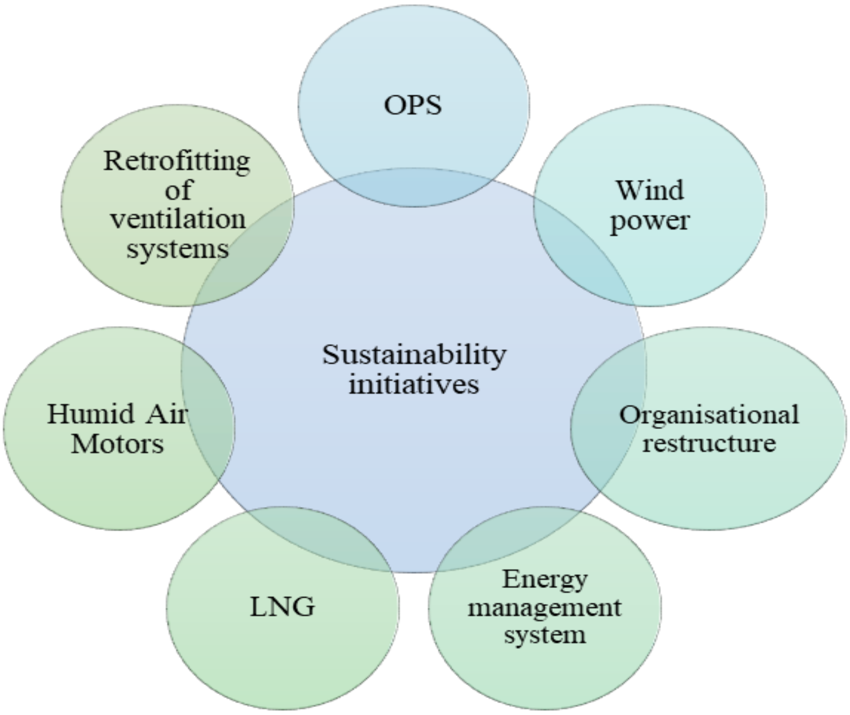

Figure 3. Viking Line's sustainability initiatives

5. DISCUSSION AND CONCLUDING REMARKS

Viking Line has implemented a variety of sustainability initiatives for the improvement of the energy efficiency of its fleet and the reduction of GHG emissions from its operations. Initiatives that range from technical measures, like retrofitting of the ventilation systems of certain vessels and the use of wind power, to the introduction of energy management system for the monitoring of the emissions and the use of LNG as a marine fuel. The company has been closely following the existing and upcoming regulations; the use of OPS, as well as LNG fuel could be considered as an answer to the relevant upcoming EU regulation (European Union, 2014). The same applies in relation to the introduction of the energy management system for the monitoring of the vessels' GHG emissions that is the company's way for complying with the MRV regulation.

Besides the initiatives driven by the relevant regulatory framework, the company has also moved forward with a huge investment that costed around 200 million euros – the construction of a new vessel, Viking Glory, that is expected to use up to 10% less fuel than Viking Grace, which was previously awarded the honour of being the world's most environmentally-friendly passenger vessel in its size class. Viking Glory is designed to have around 10% less emissions than Viking Grace that is the world's first hybrid ship of its size to run on both LNG and wind power with the emissions reductions from the use of LNG fuel being some 50% lower CO_2 emissions compared to the conventional fuel.

The organizational restructure of the company has played an important role for the effective implementation of all these initiatives and brought environmental and energy efficiency improvements of the company's fleet along with the economic benefits. The fact that the staff and crew are now more involved in decision-making has promoted/enhanced the integration of energy management into the company's procedures and processes with beneficial outcomes in many domains.

Another issue that needs to be mentioned here is the importance of efficient collaboration with cargo customers and port authorities that has a direct effect on the energy efficiency of maritime operations. Good collaboration with ports means that no longer times are needed at the port area for accommodating the vessels and, at the same time, the vessels can operate at lower speed, consume less fuel and have less emissions.

In this paper, the efforts and initiatives undertaken by a Finnish shipping line (Viking Line) for the improvement of its fleet energy efficiency, along with the decarbonization of its operations were discussed in order to shed light on the potential of private companies' initiatives for the reduction of their GHG emissions. According to the findings, significant energy consumption reductions can be achieved at the company level from the implementation of a number of energy efficiency initiatives that presuppose a company organization model focused on sustainable development. Global and regional regulations/guidelines definitely initiate the introduction of energy efficiency measures, but their effective implementation depends largely on the organizational structure and priorities of individual shipping companies.

6. ACKNOWLEDGMENTS

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HYDROGRAPHIC SURVEYS AS AN ART OF DELINEATING THE IMPACT OF CLIMATE CHANGE ON THE COASTAL ENVIRONMENT

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Keywords: Hydrographic Survey, Multi-beam system, Side scan sonar, Sub-bottom Profiler, Bathymetry, ROV.

1. ABSTRACT: Marine acoustic techniques are quite efficient in remote seabed classifications and hydrographic investigations by providing highly detailed information about broad areas of the seafloor and the subsurface layers in a short period of time. Climatic change is considered as the forcing factor for the eustatic sea-level-rise along the Mediterranean coast, leading to the large coastal inundation and the subsidence of the ancient maritime installations, these ancient sites can be used as indicators for the relative changes in sea-level through later times. Marine surveys were carried out to delineate the coastal geomorphological changes associated with sea level rises and natural hazards along some areas on the coast of Alexandria during the last two millennia. Hydrographic and seismic surveys were implemented in the study area by using a multi-beam echo-sounder, side scan sonar, and sub-bottom profiler, then the acoustic data were calibrated with dated core samples and ROV camera images. Multi-beam is considered the most commonly used tool in harbor surveys utilizing the returned acoustic signals to measure the depth of the seafloor, while the side scan sonar instrument provides high-resolution images for the elevated structures from the seafloor depending on the backscatter strength of the signal, and the sub-bottom profiler uses chirp waves that deliver high resolution vertical images for the subsurface sediment situation. Results of sonar imaging and bathymetric mapping outlined submerged margins of archaeological remains related to ancient Ptolemaic and Greek ports. Seismic interpretations revealed significant changes in the coastal geomorphology, where the massive burial of the port structure indicated the occurrence of sudden natural hazards originated from seismic waves; therefore, a destructive tsunami wave accompanied by sediment slumping that followed by eustatic sea-level-rise seems to be the dominant factors for this dramatic burial. The research results showed the potentiality of hydrographic surveys in detecting climate change indicators.

2. INTRODUCTION

The sea level rise impact on coastal zones has become a rising issue of interest in the scientific and public fields. Recent studies have indicated that the sea level mean has remained semi-stable since 2–3 millennia, with rate of change not exceeding 0.5 mm/yr (Kemp et al., 2011). During these periods, the majority of the coastal installations were totally submerged under the sea level and the shorelines eroded. These observations indicate that the sea level rise occurs due to climatic and non-climatic factors, or combination of both factors (Bird, 1996).

In the areas affected by fast sea level rising or have sea level rise values close to the global average, the effect of sea level rise cannot be easily detected as they are masked by the effects of currents, waves, cyclones, and anthropogenic forces (Becker et al., 2012). Submerged and uplifted positions of ancient harbors are key indicators for determining the recent sea level changes and the rates of vertical land movements, also the changes in stratigraphy of coastal sediments highlight the effect of human activities on the coastal environment (Mourtzas, 2012). The Mediterranean Sea coasts have been inhabited since the prehistoric times, and preserve evidences for the ancient coastal settlements and the maritime installations. These ancient sites can be used as indicators for the relative changes in sea level through later times (Mastronuzzi et al., 2017).

Recently, waves of violent weather hit the coast of Alexandria on October 2015 and November 2021, accompanied by thunderstorms, lightning and rising sea waves which flooded the whole coast of Alexandria (Figure 1), and led to the sinking of the roads and the cars and homes of Alexandrian civilians. This sudden natural disaster indicated the vulnerability of the recent coast of Alexandria to definite subsidence at any possible time. Therefore, this study is planned to implement hydrographic and geophysical means to study the geomorphological changes of the ancient coast of Alexandria resulted from sea level changes and natural catastrophes in order to develop perceptions for coastal subsidence indicators which in turn benefits the stakeholders and decision-makers.

Figure 1: Photographs showing the impact of rising sea waves on the coast of Alexandria during the violent weather

In past years, the marine geophysical techniques became quite efficient tools in the remote seabed classifications and sunken objects detection due to their ability of covering large seabed regions in a short period of time, and providing highly detailed information on an unexcavated seafloor and subsurface features (Chalari et al., 2009, Hamouda et al., 2021). Considerable developments have been implemented on the hydrographic and marine geophysical investigations to study the lateral and vertical seafloor features using acoustic tools such as multi-beam echo-sounders, side scan sonars and sub-bottom profilers (Fekry, 2021).

The hydrographic surveys were extended in the Eastern Harbor over the Egyptian north coast of Alexandria city (Figure 2). The recent oval structure of the harbor was shaped after being isolated from the sea since the 1st millennium BC., pursued by the establishment of the ancient city of Alexandria and its royal ports during the Ptolemaic rule in the 4th century BC (Jondet, 1916), and over an ENE-WSW trending limestone (kurkar) ridge of the Pleistocene age (Goddio et al., 1998). The basin structure of the harbor has been trapped Holocene sedimentations that provides a full record for the early human history of this region, where this basin was considered as a sediment catchment before being modified by human activities in the late Holocene (Hamouda et al., 2016, 2021).

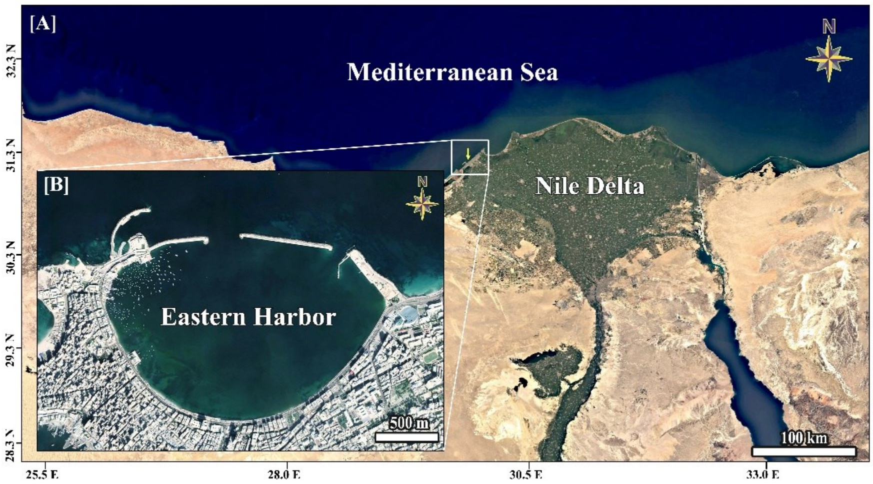


Figure 2: [A] Geographic map of northern Egypt, [B] satellite map of the Eastern Harbor of Alexandria.

Previous geoarchaeological investigations suggested that the area was experienced various subsidences during the last 2000 years. The area of study was affected by post-glacial sea-level rise (~ 2 m) during the late Holocene (Mitrovica and Milne, 2002, Stanley and Landau, 2005), and the sea-level rise caused obvious changes in coastal zones led to the subsidence of ancient settlements and landscapes during the Ptolemaic and Roman times (Lambeck, et al., 2002). Historical sources recorded a tsunami-genic hazardous event which took place on 21 July 365 AD, these tsunami waves were supposed to be generated by an earthquake near Crete at the Hellenic Arch subduction zone, these tsunami waves traveled run-up height of 9.5 m and arrived from the northwestern corner, killing thousands of people and destroying the ancient coast of Alexandria (Hamouda 2010), other studies proposed tsunamis generated from earthquake-triggered slumps as a result of land sliding followed by the retreat of the seawaters (Stiros, 2020). Therefore, the ancient royal ports and structures were collapsed and sunk by the action of the destroying waves and the following tectonic activities (Guidoboni, 1994). During these periods, the port exposed to high silting rate leading to the burial of the port structure under sand alluviations.

The main objective of this work was to implement highly detailed marine surveys to map and investigate the seafloor texture and features, aiming to study the impact of sea level rises and natural hazards on the ancient coast of Alexandria during the last two millennia.

3. MATERIALS AND METHODS

Marine surveys were conducted in the Eastern Harbor of Alexandria onboard Salsabil R/V (Figure 3) by using an integration of multi-beam echo-sounder, side scan sonar, and sub-bottom profiler, then the acoustic data were calibrated with dated core samples and ROV camera images to define the acoustic results. The navigational tracking and sampling locations (Figure 4) were provided by DGPS and specialized navigational software packages. The near shore navigational lines were acquired using a smaller fishing boat (Negm el Bahr) due to shallow water depths. The Bathymetric survey was performed to measure the depth of the seafloor and determine the submerged borders of the ancient port, the side scan sonar survey was carried out in order to obtain clear seafloor images and detect the submerged artifacts by providing high-resolution images for the seafloor depending on the backscatter strength of the signal, also high resolution vertical images for the subsurface have been delivered by acquiring sub-bottom profiling survey to detect the subsurface discontinuities that might have been changed the ancient coastal geomorphology.

The bathymetric survey was executed using Seabeam 1185 multibeam sonar system, which comprised a set of two transducers, motion sensor and heading DGPS. The transducers were side-mounted with stainless-steel pole to the port side of the survey vessel far away from the turbulences of the engine. The transducer arrays were transmitting narrow beams quasi-simultaneously with a high acoustic transmission level, and the Seabeam surface unit collects a swath of bathymetric data with excess of 150 degrees which offers high resolution seafloor coverage (1.5°) with more than 25 pings per second. The system provides very low error rate due to the utilized superior Signal-to-Noise-Ratio technology and 36 dB side lobe suppression during transmission and reception. Before initiating the survey, the linear offsets were measured between the transducers, the motion sensor, the GPS antenna and the sea-level. All measurements were done according to the left-hand rule, where offsets below sea-level, forward and starboard the motion sensor take positive number, and vice versa. A sound velocity profile (SVP) was obtained using Valeport profiler, and input into the multibeam acquisition software to account for refraction of the sound waves through the water column.

Figure 3: [A] Salsabil Research Vessel, [B] Acoustic equipment onboard the Vessel.

Also, multibeam calibration known as patch test was done before starting the survey in order to quantify all possible residual installation misalignments to ensure that subsequent data gathered from the multibeam system is correctly geo-referenced in three dimensions, this can be done by measuring the angular offsets of roll, heave, pitch and latency (Hamouda et al, 2016). The procedure involves collecting data over specific types of terrain or seabed features, in typical survey water depths, and processing using processing software and calibration routines. The physical alignment offsets that must be determined are roll, pitch and yaw/heading (Figure 5). When the data collection system is not synchronized to GPS time, it is also necessary to determine the latency in the positioning system.

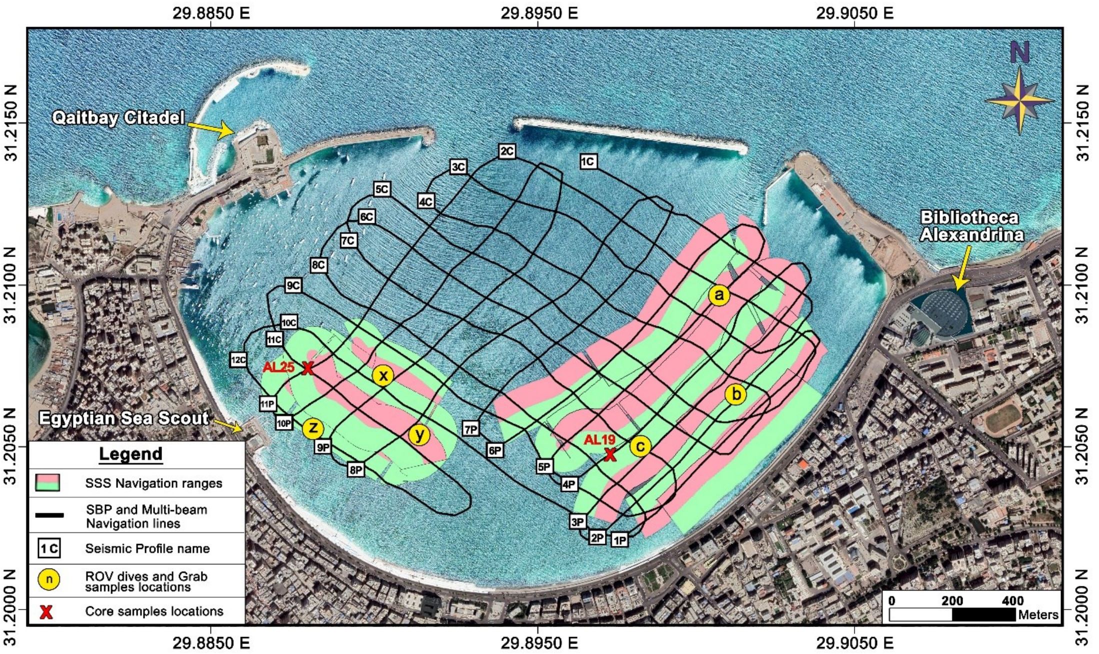


Figure 4: Survey track-lines across the study area.

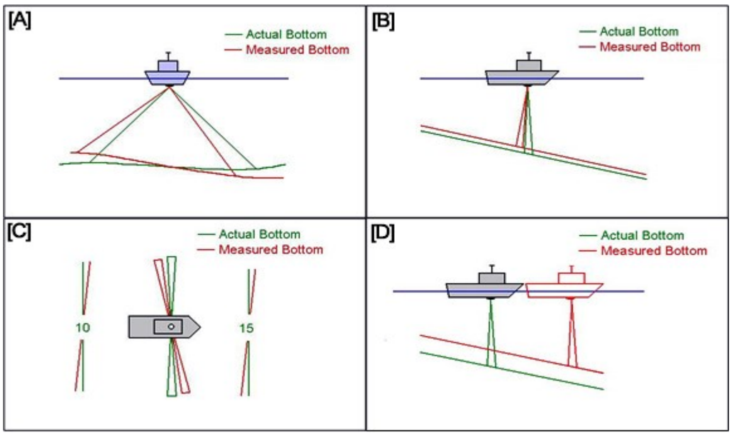


Figure 5: Patch test alignment showing the difference between the actual and measured bottom, [A] Roll, [B] Pitch, [C] Yaw, [D] Latency.

Acoustic imaging survey was carried out using 4200 Edge-Tech side scan sonar (SSS) to identify the seafloor textures and target the submerged artifacts by delivering high resolution sonar images for the seabed up to 18 cm along track and 1 cm across track depending on the backscatter strength

(Hamouda et al., 2016). The system comprised a towed stainless-steel fish which emit fan-shaped pulses towards the bottom and recorded a seafloor swath of 150 m. Ten track-lines were recorded by Discover software in the native JSF format (Figure 4), where six lines were oriented (NE/SW) and four lines were (NW/SE) oriented. Data processing was performed using Hypack® software, where data underwent reformatting then corrected radiometrically and geometrically, also TVG amplifications and slant range correction were applied. A Geotiff mosaic map was then constructed using the high frequency dataset (600 kHz), showing the different seafloor textures according to the degree of backscatter strength. Different materials carry different reflective (backscatter) properties, where a rough, hard and prominent seafloor produces strong backscatter acoustic signals and light tone on the sonograph, whereas a flat, soft, and concave seafloor generates weak echoes (Hamouda et al., 2016).

Seismic survey was executed using 3200 Edge-Tech sub-bottom profiler (SBP) to measure and identify the different subsurface layers which exist below the sediment-water interface, and provide information on the different geomorphology of the near coastal areas and other deeper environments with 8–20 cm vertical resolution (Wilken et al., 2019). The system comprised a towfish containing a projector, receiver and signal pre-amplifier, and a portable floating buoy was attached to the tow-fish to provide a fixed towing altitude along the survey track. Sub-bottom profiler survey was carried out through twenty-three planned lines, where eleven planned lines [P] were oriented (NE/SW) and twelve cross lines [C] were heading in the (NW/SE) direction. Subsurface data were recorded using Discover software in JSF format, and data enhancement was applied using the sub-bottom Hypack® software, where the processing included TVG and band-pass frequency filtering, also profiles were transformed from the recorded time domain into the depth domain using the average sound velocity value acquired by the sound velocity profiler (Valeport). The ages of the top surfaces of each horizon (Figure 6) have been correlated with previously published core samples across the study area (Stanly et al., 2007). Therefore, the lateral geomorphological variations were deduced across the subsurface profiles.

ROV video camera dives were acquired using (Videoray) submersible vehicle to ground-truth the different geomorphologic features on the seafloor, also, surface sediment samples were collected using a stainless-steel Van-veen grab sampler, the station locations (Figure 4) were determined according to the variability of seafloor textures and determined using DGPS. Grain size analyses were performed and the samples were underwent to the combined dry sieving and pipette analysis technique (Folk, 1974).

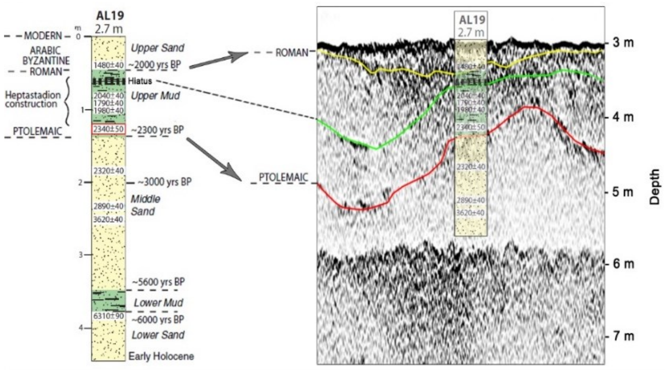


Figure 6: Seismic profile [4P] tie with Core (AL 19) (modified after Stanley et al., 2007).

4. RESULTS AND DISCUSSION

4.1 Bathymetry

The bathymetric map showed the recent topographic situation of the seafloor, where semi-buried relics of submerged ancient ports that once settled above the seafloor were recognized (Figure 7), an eastern Royal Port and other western Greco-Roman port (Goddio et al., 1998). The constructed contours showed depth values ranging from 1m close to the shore down to around 10 m in the northern margins near to the El-Boughaz. The borders of the submerged ancient ports were outlined by the 4 m contour line, then the depth increases towards the central port basin to reach average values from 6 m to 8 m. Two separated closures with shallower depth values (~ 3.5 m) were recognized to the south of the breakwaters, which may reflect the presence of outcropping reef or ridge area. Generally, the contour lines showed irregular patterns around the submerged relics of the buried ports and the outcropping structure, while showed regular gradient across the rest of the harbor.

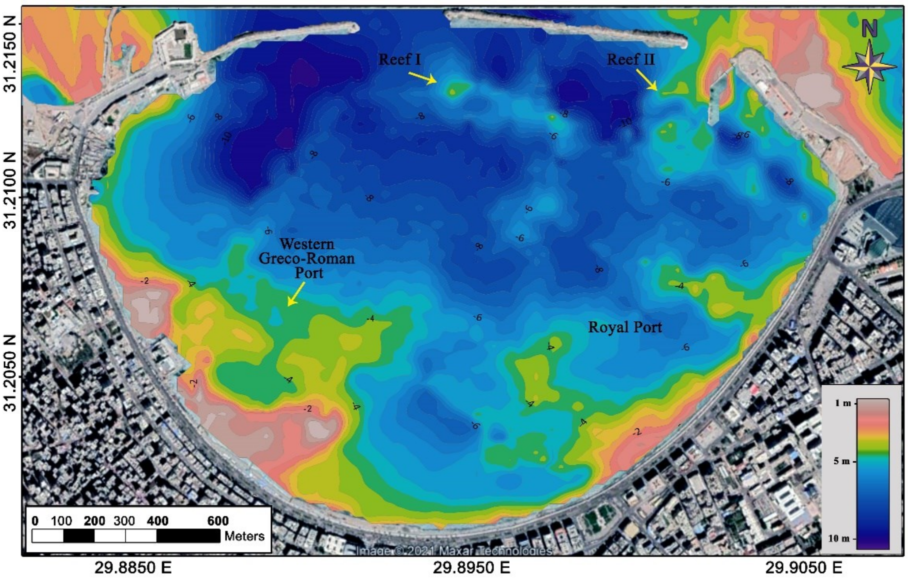


Figure 7: Recent bathymetric map for the Eastern Harbour of Alexandria.

4.2 Seabed imaging

The high-resolution georeferenced map (Figure 8), resulted from the mosaicking of the side scan sonar sonographs of the south-eastern part of the Harbor has defined the recent seafloor acoustic pattern according to difference in the returned backscatter strength. Distinctive backscatter patterns with different color tones were recognized, where distinguished sharp responses were detected along the breakwaters and the exposed ruins of the ancient port, also across the scattered rocks and boulders. The port basin floor and the surrounding seafloor are characterized by patchy tonal backscatter in the form of light tones corresponding to sand ripples intercalated with dark tones corresponding to finer grained sands (Table 1), providing strong and weak backscatter strength respectively.

The mosaic map (Figure 8) showed the exposed ruins of the submerged ancient Royal Port, where two irregular breakwaters were recognized along two opposite sides, separated by entrances (E1 and E2) and marking the borders of the port basin, the position of the ancient Royal Palace in addition to Antirrodus Island, Timonium and Posedium locations were determined across the map (Strabo, the Geography, Vol XVII). Two ancient jetties were detected, one appeared as a chain of boulders (Figure 9) and the other in the form of an elongated reef. Also, different-sized boulders and blocks were found scattered over the seafloor and around the submerged breakwaters (Figure 10).

The recent seafloor morphology of the study areas which has been revealed from the bathymetric maps along with the high-resolution sonar mosaics, showed the effect of climatic and non-climatic factors on the pre-existed settlements. The irregular surfaces and the non-uniform structural form of the submerged breakwaters of the ports emphasized the effect of past sea level rises and natural hazards on the ancient site, while the scattered boulder debris and buried ancient structures, reflected the impact of the storms and currents on the underwater heritage.

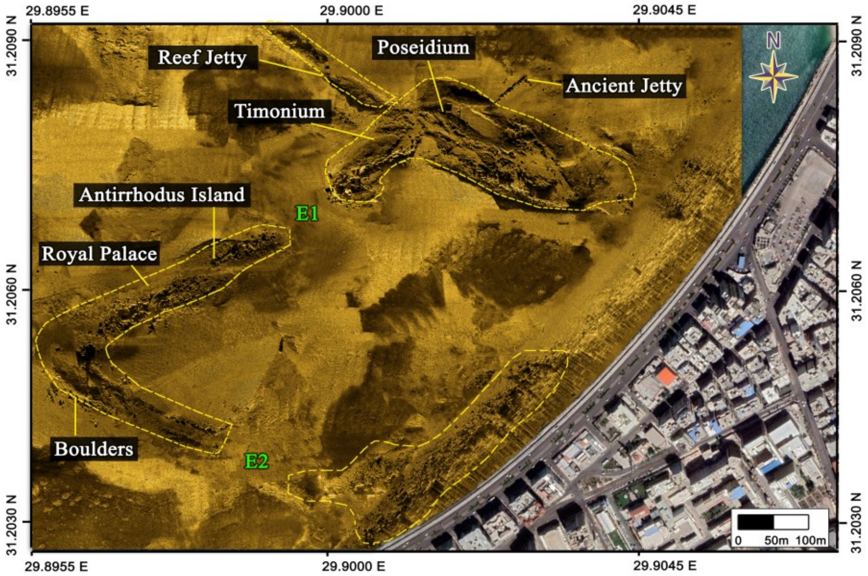
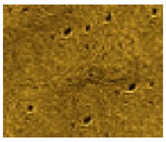
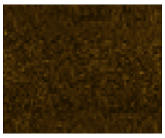
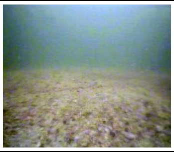
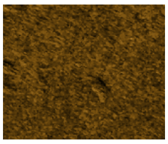
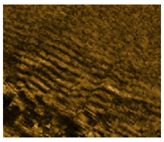
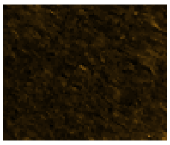
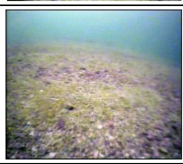


Figure 8: Side scan sonar mosaic of the submerged eastern Royal Port in the Eastern Harbor of Alexandria.

Figure 9: Side scan sonar image showing the jetty boulders which attached to the starboard-side breakwater.

Table 1. Sediment analysis results corresponding to acoustic classes and ROV images in the study area.

Sample no.	*Acoustic response*	*ROV image*	*Sediment type/ Mean size*	*Sediment sorting*
a			Fine sand	Poorly sorted
b			Very Fine sand	Moderately well sorted
c			Medium sand	Moderately sorted
x			Coarse sand	Poorly sorted
y			Medium sand	Poorly sorted
z			Very Fine sand	Moderately well sorted

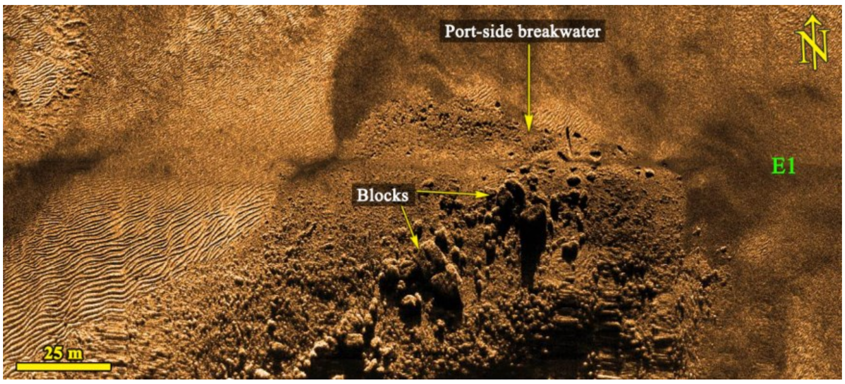


Figure 10: Side scan sonar image showing scattered blocks and boulders around the port-side breakwater.

4.3 Sub-bottom profiling

The seismic profiles explained the top-most stratigraphic succession of the subsurface layers, this depositional succession (Figure 11) was proposed after correlating the acquired seismostratigraphic sections with the previously published core data (Figure 6). Generally, a port foundation (lower) surface representing the Ptolemaic dynasty was detected along the semi-buried margins of the ancient Royal Port, these traces followed by alternative and discontinuous cycles of sedimentation and erosion. Then a port abandonment (upper) surface was detected which marked the upper edges of the ancient port, this surface is recently low-outcropping from specific areas across the sea floor. The uppermost seismic horizon neither showed anomalous sedimentation rates nor remarkable hiatus surfaces during the upper-most Byzantine and Arabic periods, and all the depositional sequence were capped by an undulating surface representing the recent sea floor.

Three-dimensional model was established (Figure 12) after picking the horizon of the initial surface of the Ptolemaic era across the seismic sections of the south eastern part of the study area, this surface showed the ancient topography of the port and delineated the ruins of the submerged Royal port.

In the study area, the coastal geomorphology reveals significant changes since the Mid-Holocene time. Geodynamic processes interacted with natural hazards, global scale climatic changes and human activities are the driving factors for these geomorphological changes. The evaluation of the port site evolution looks crucial in determining the degree of contribution of each factor in the subsidence of the underwater ancient site. The evolution of the port site from the Late Ptolemaic period (Figure 12) to the period after 365 AD where massive burial for the port structure was existed, indicates the occurrence of sudden natural hazards originated from seismic waves; therefore, a destructive tidal (tsunami) wave accompanied by coastal land-sliding (Stiros, 2001) seems to be the dominant factors for this burial or a sediment substrate failure resulted from the inadequate piling under heavy constructions during Roman period (Guidoboni et al., 1994) or might be both factors. Since this time till the Late Roman period, the eustatic sea level rise had caused the inundation of the coastal area, also the inadequate construction piling and excessive sediments load derived from the Heptastadium tombolo had increased the burial and submergence of the port site (Stanley et al., 2007). Uniform sedimentations were recognized over the submerged site from the Late Roman period till the recent time (Figure 7), where the seafloor reflected nearly the same morphology but with shallower depth values. This indicates that the global sea level rise was the dominant factor for the complete submergence of the site over time.

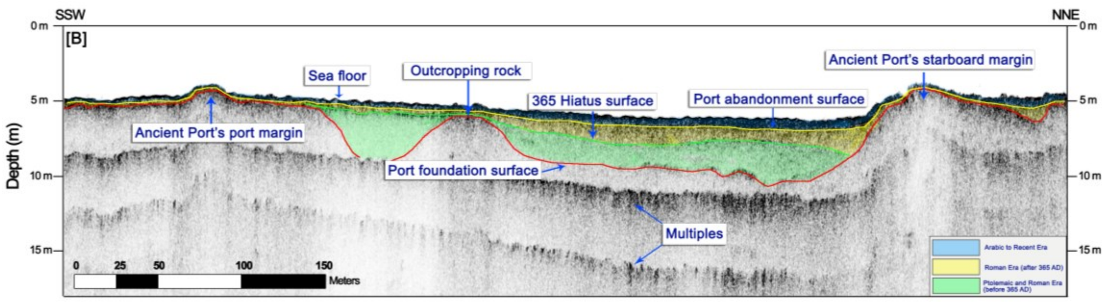


Figure 11: Seismic profile (2P) showing the sediment succession and rock outcropping from the basin of the Royal Port near the shore, [A]: Uninterpreted sub-bottom profile, [B]: Interpreted sub-bottom profile.

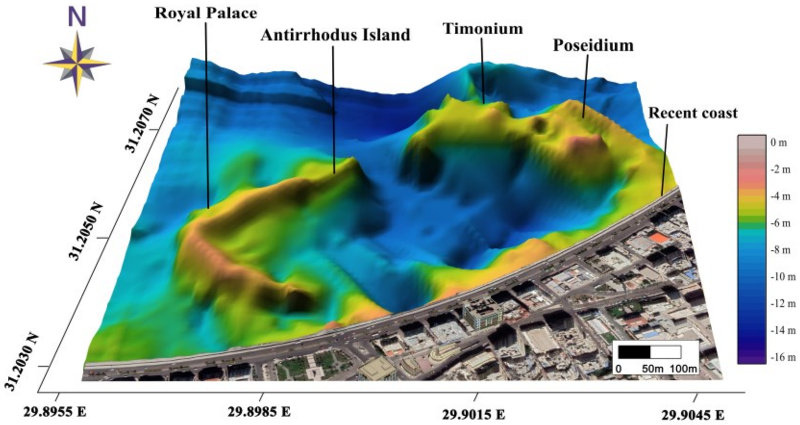


Figure 12: 3D Structural model for the upper surface of the Ptolemaic period (Royal port foundation surface).

5. CONCLUSIONS

Marine geophysical approaches showed significant results in delineating the geomorphological changes associated with sea level rises and natural hazards across the study areas. The developed acoustic methods became largely effective tools in the remote seafloor classifications and the geoarchaeological inspections, by providing highly detailed information about broad areas of the seafloor and subsurface layers in a short period of time. The research results strongly confirm the exposure of the ancient coast of Alexandria city to submergence and subsidence as a result of relative sea level rises and geo-hazards including, earthquakes, tsunami waves, slumping and sediments mass failure. The research results strongly confirm the exposure of the ancient coast of Alexandria city to submergence and subsidence as a result of relative sea level rises and geo-hazards including, earthquakes, tsunami waves, slumping and sediments mass failure.

The bathymetric maps along with the high-resolution sonar mosaics have revealed the recent seafloor morphology at the study areas, where the recognized features emphasized the effect of past sea level rises, natural hazards, storms and currents on the ancient site. The seismic profiles integrated with sediment core samples had suggested a depositional model for the Royal Quarter at the western study area of Alexandria through the following successive stages : (1) The port foundation surface, representing the construction period of the ancient Royal port during the Ptolemaic dynasty, (2) The 365 AD hiatus surface topping the pre-deposited sedimentation related to the Heptastadium tombolo construction during Ptolemaic and Roman eras. (3) The port abandonment surface, representing the Post-365 AD sedimentations from the Heptastadium tombolo during the Roman period. (4) Upper sediment bedding without significant deformation, representing the period from the Byzantine and Arabic times till the recent.

The outputs of the imaging and seismic surveys demonstrate the efficiency of using side scan sonar and sub-bottom profiler in shallow geoarchaeological investigations, especially in semi-closed and harbor areas. It is clear that, the rapid and massive burial of the submerged sites was resulted from global sea level rises accompanied by seismically-originated tidal waves and land sliding, as the subsurface sediment thicknesses typically matched with the previous records of sea-level rise and land subsidence (± 2 m) during the last 2000 years.

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"Empowering

Blue Economy

Insights and opportunities "

INSIGHTS INTO LOGISTICS AND SUPPLY CHAIN STUDIES IN MIDDLE EAST

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Keywords: Supply chain management, Middle East, Higher Education Institutions, Logistics, Sustainability.

1. ABSTRACT: Due to recent supply disruptions, the corona crisis and the limited supply of all kinds of raw materials, components and goods due to global polarisation, the importance of logistics and supply chain management is boosting. This study is therefore a continuation of a study carried out in Slovenia and is investigating higher education study programs in the field of logistics and supply chain in the Middle East. It is oriented towards logistics, supply chains, management, and sustainability topics, which create core competencies for logistics leaders, supply chain managers, and future experts. Keywords were selected to identify key logistics, management and sustainability issues related to higher education sector in the Middle East. It was revealed that some countries are much more focused on company logistics and others more on supply chain challenges. It was revealed that some countries do not give any attention to one of the top priorities of global managers - corporate sustainability. To be able to supply a sufficient amount of logistics experts for managing current and future challenges of resilient supply, onshoring, increasing transparency, and fast response, Middle East countries should develop logistics education even more rapidly.

2. INTRODUCTION

The global logistics industry grew significantly last decade, while logistics has become an essential part of the global business environment. Also, in the Middle East, the logistics industry plays a vital role in transportations development and urbanization. The strategic location of the Middle East (ME) – at the junction of three continents and with of world's most critical natural resources, with over half of the world's proven oil reserves – has historically been a crossroads for trade, peoples and as a transition zone for political and cultural interaction (Balat, 2006; Kort, 2008). The logistics industry is projected to grow by 4.3 % from 2020 to 2025 (Frost & Sullivan, 2017). According to global competitiveness, UEA is ranked among the top 20 countries in 2020 across 13 indexes related to transport (Sale, 2021). The United Arab Emirates is also considered one of the largest logistics hubs in the Middle East. That proves that logistics is among the most rising industry in those regions.

The Middle East has undergone tremendous cultural, political, and economic growth over the past few years. The region is facing a fundamental change in the oil market, where new technologies are increasing the supply of oil on the one hand, and on the other, raising concerns over the environment are forcing them away from oil. In order to reduce their reliance on oil and become a more sustainable society, the oil-exporting countries, including ME countries, are establishing and implementing new reforms to diversify their economies (Mizorev et al., 2020). Similarly, new goals towards a more sustainable environment and green economy are set in the logistics industry (Menon, 2020).

Also, ME higher education is experiencing significant transformation, privatization, internationalization, and industry reforms (Romani, 2009). Many higher education institutes are adjusting to these changes by reforming their study programs or adding new ones to meet the growing market needs. The growth of the young population is estimated to be 65 million by 2030, and education is a crucial element for sustained development in those regions (PWS, 2021). According to Keser (2015), higher education influences the development of production systems, new implementation, and sustainable development and management systems. Logistics education significantly influences the logistics sector's success and potentially sets high demands on the education process. Literature review revealed that there is a lack of studies related to logistic education in ME; existing ones are focusing mainly on corporate social responsibility, sustainability and environmental perspective, a rise of private universities, and global competitiveness (Akkari, 2004; Alzyoud & Bani-Hani, 2015, Miller-Idriss and Hanauer, 2011; Rupp, 2009; Sherif, 2015).

The main aim of this study is to explore the logistics-related study programs in the Middle East. Our focus was to investigate higher education study programs with logistics-related topics (e.g., transport, management, sustainability, environment, eco/green, and others) in chosen ME countries. Analysis of this study programs important serves three purposes: first, it provides a database with the content that no previous authors have made; second, it provides a comprehensive comparison of ME logistic related study programs, using different criteria and thirdly, it can be used as an orientation tool for logistic sector workforce and education providers in these countries.

3. METHODOLOGY

First, we used web-content analysis as a qualitative descriptive approach. Content analysis refers to a systematic coding and categorizing approach used to analyze and explore a large amount of textual information (Gbrich, 2007; Mayring, 2004). The definitions of the ME countries vary; it encompasses these 15 countries that each definition always includes (World population review, 2021): Turkey, Syria, Cyprus, Lebanon, Israel, Jordan, Iraq, Iran, Kuwait, Saudi Arabia, Bahrain, Qatar, United Arab Emirates, Oman, and Yemen. Firstly, we list all private and public higher institutions in chosen ME countries. Egypt was excluded in this case and will be further studied in the future since it is important player in logistics due to the Suez canal. It follows a comprehensive study of publicly available online data, accessible on HEI web pages for each institution to determine logistic-related study programs at all study levels (graduate and postgraduate.)

Nine keywords were set for evaluating logistics-related study programs: logistics, supply chain, transport, management, sustainable, environmental, eco/green, waste/circular, and corporate (social) responsibility. However, only study programes accessible online and English were analyzed and included. Secondly, data were analyzed with the SPSS software program and perform analysis sequences for different variables. To achieve our aim, we compare and analyze the data regarding different criteria.

4. RESULTS

There were 405 logistics, sustainability, and management-related study programs in 15 ME countries found in English. Of which the most significant share is Bachelor programs (59%), followed by Master programs (35%) and Ph.D. programs (6%). Most study programs were found in Israel (which represents 14% of study programs found), and Lebanon (12% of researched programs) presents the highest share of available study programs, including transport, environment, and management study topics in programs. Syria (1% of programs in the ME database) and Bahrain (2%) represent an insignificant share of programs gathered in the ME study program database. Figure 1 exposes how the number of programs correlates with the researched ME countries' population. Cyprus indicates the smallest gap between the programs found and programs per 1 million population.

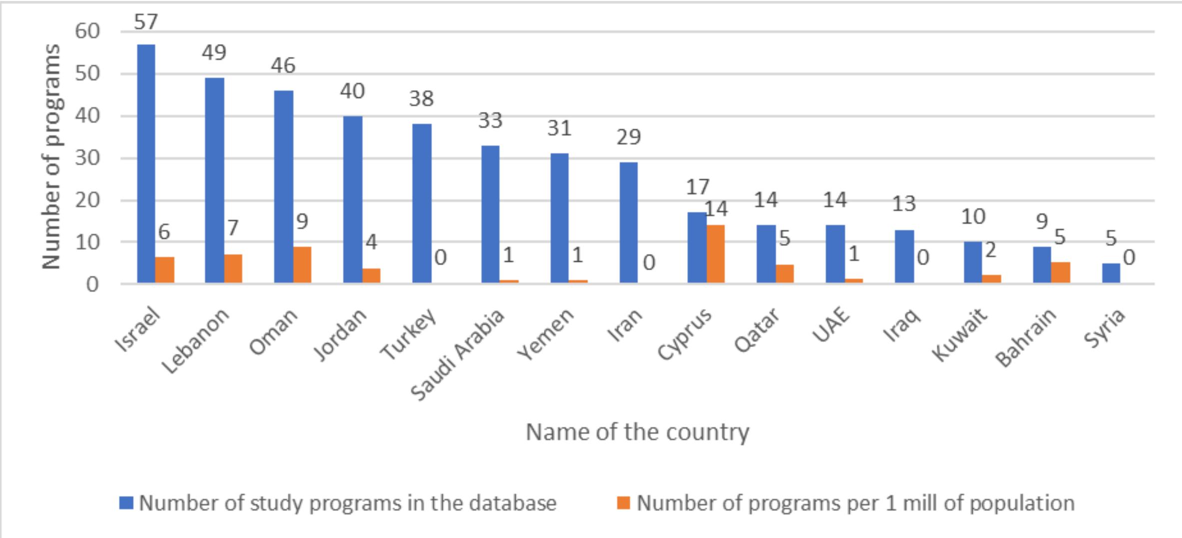

Figure 1: Number of study programs per country in ME database and number of found study programs per 1 million population in ME countries

The found programs were analyzed deeper to determine which of the methodology mentioned study topics (keywords) are integrated into the program curriculum. From all nine researched study topics, the highest share of programs includes management (50.1% of all programs included in ME database), next group is sustainability/transport/logistics (31.6% - 34.8%) and final group Eco/green and CSR (12.6% - 18.0%). The share of each study topic implementation in the created ME database can be visible in Figure 2.

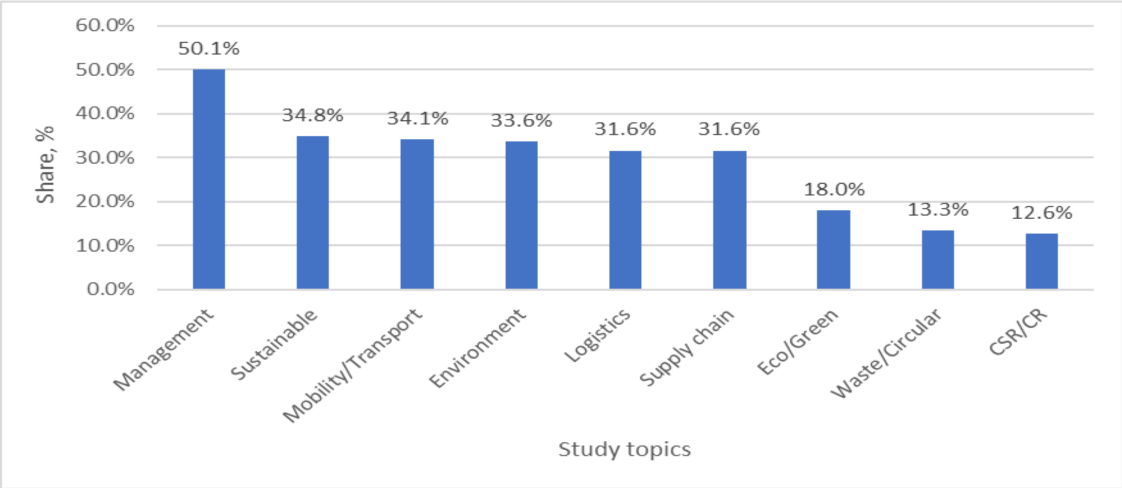

Figure 2: Share of study topics integrated into study programs in ME countries

The ME database data was grouped into study topics per study level to research how each study topic is integrated into each study level. Figure 3 indicates that 53% of all bachelor-level study programs and 49% of all Master's programs include management as a study field in the curricula. According to the ME database, the mobility/transport study field is mainly included in Ph.D. programs. Similarly to mobility/transport, the study topic eco/green has more programs at the Ph.D. level, including this topic in their curricula.

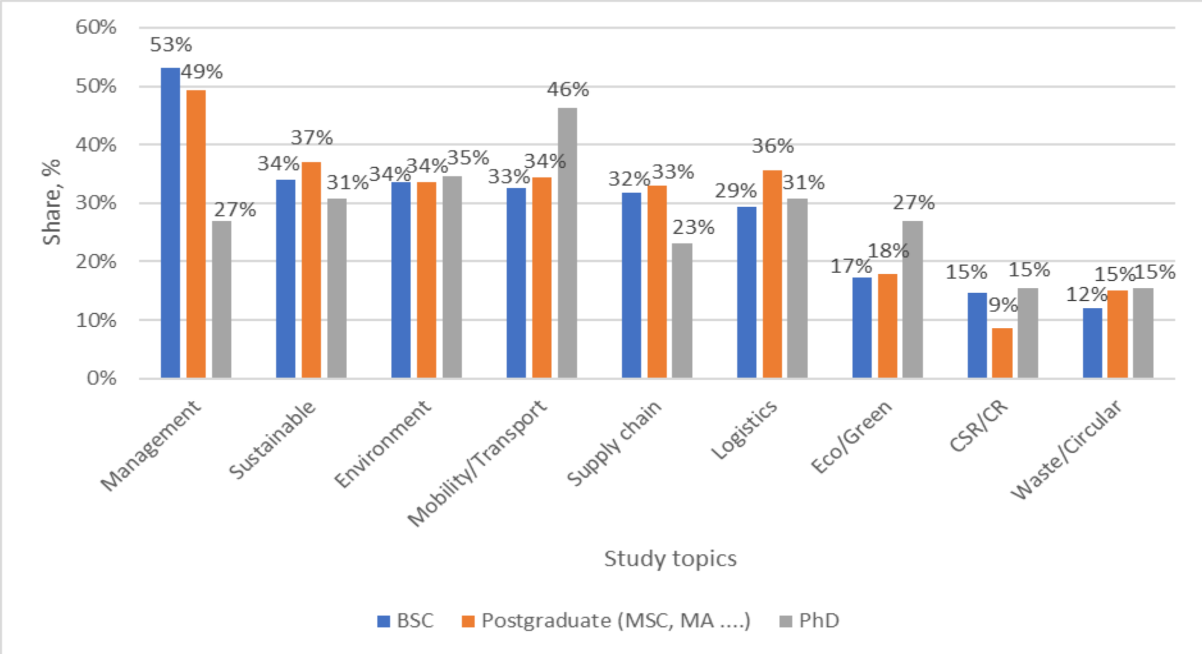

Figure 3: Share of study fields included in ME study programs per study levels

To research why some of the researched ME countries indicate a higher number of programs in specific study topics, the number of found programs per country was compared with GDP per capita in the country (World Bank Group, 2021) and the sustainability score per country (Sustainable Development Report, 2021). It was meant to determine if some countries that score higher in sustainability have more study programs that include this study topic and if higher GDP correlates with more programs. There was no clear correlation found between GDPs per capita and a number of programs, and between sustainability score per country and study topics implemented in the study curricula. The researched data can be seen in Figure 4.

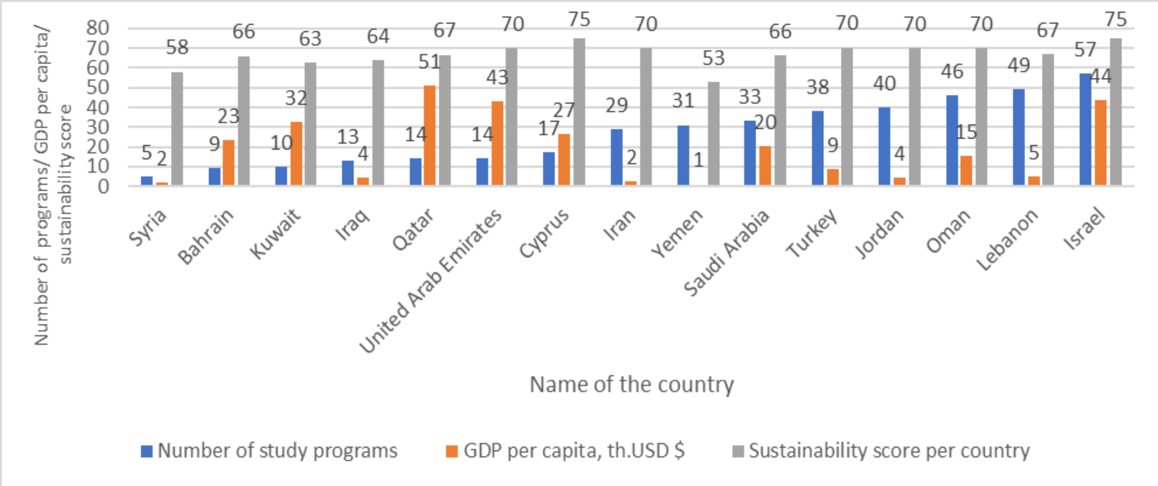

Figure 4: Number of study programs in ME database per country with GDP per capita and sustainability score

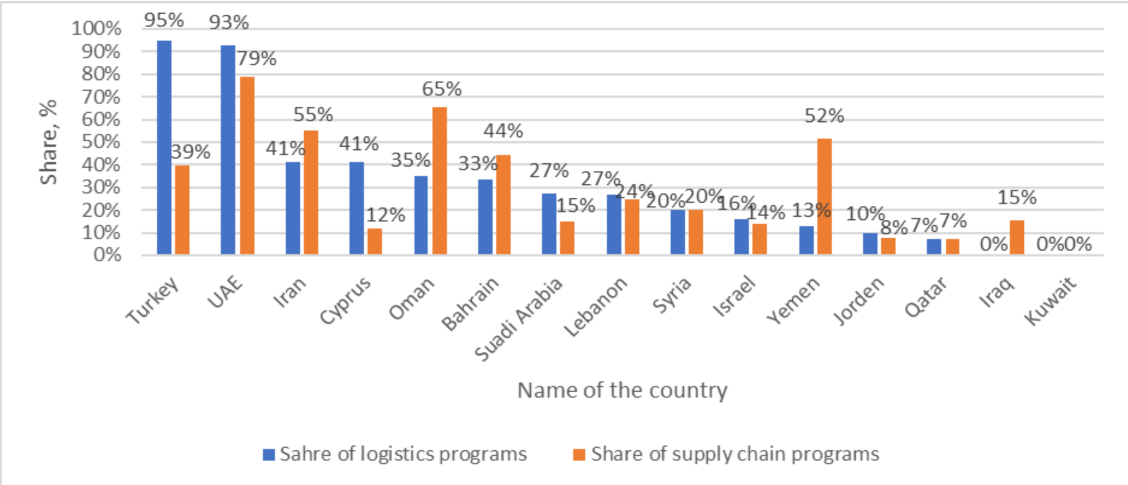

Figure 5: Share of study programs in ME countries which include logistics or supply chain study topics

Some of the programs focused on logistics, some on supply chain study topics, but some of the researched programs in the ME database included both study topics equally. To research how researched ME countries view logistics and supply chain and how it is integrated into the study programs, there were analyzed the number of programs, including logistics study topic and supply chain study topic. Figure 5 indicates that Turkey's HE programs integrate logistics study topics highly, with 93% of Turkey's researched study programs including logistics topics in their curricula. It also represents one of the graph's most significant gaps, indicating a strong focus on logistics rather than supply chain. Opposite results are observed for Yemen and Oman, where more programs were found, focusing on supply chain rather than logistics. On the other hand, Syria and Qatar represent an equal share of supply chain and logistics study topic integration in study program curricula.

5. DISCUSSION AND CONCLUSION

The given results of researched programs indicate that ME countries (Turkey, UAE, Cyprus, Saudi Arabia, Lebanon, Israel, Jorden) emphasize logistics in HE programs. Other ME countries (Iran, Oman, Bahrain, Yemen, Iraq) highlight the supply chain study topic. The economic focus could explain these results in each country or location. For example, Turkey's geographical location bridging Europe with Asia and ME has set an excellent condition for Turkey to become an excellent logistics hub. Sine Turkey is such a critical trading channel, it might explain why many study programs include logistics study topics.

The high integration of management study topic integration in researched programs indicates that HE prepares the young specialists, leaders, and experts to have a necessary skill set in becoming logistic hub managers, sustainability managers, etc. In addition, logistics and supply chain study topics are highly integrated into Master's level of programs, which with additional skillset from management study topic indicates an excellent preparation of well-skilled logistics managers. Although there were very few Ph.D. level programs found, they mainly include study topics mobility/transport, environment, and logistics, which leads to considering that these potentially could be the current focus of the ME academic research areas.

Although most study programs related to logistics, sustainability, and management were found in Israel, comparing it with a number of programs per 1 million of the population in Israel, the found are not that much, considering the number of Israel inhabitants. On the other hand, the number of found study programs in Cyprus is smaller than in Israel, but the population is around eight times smaller. They indicate that Cyprus could be more oriented towards logistics, sustainability, and management than other ME countries.

In conclusion, the ME region is an important part of the global transport, logistics, and supply chain network, and it requires educated, skilled. Well-prepared future specialists and managers and with the general insight of HE current situation in ME countries, it seems that the ME has study programs that cover various study topics and potentially could prepare multi-disciplined logistics and supply chain specialists and managers.

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INVTESTIGATING ELEMSNTS AFFECTING THE PURCHASING DECISIONS OF LOW EMISSION CARS: A STUDY OF EGYPT

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Keywords: Low emission cars, Buying behavior, Green customers and Green marketing

1. ABSTRACT: This article provides a study about the customers' priorities and point of views about alternative fuel vehicles. Presently green technology and specifically green transport have grown to be of great importance for car manufacturers, customers, and energy providers in most of the developed countries. However, in developing countries this idea is considered rather new and is not considered a priority for the manufacturers nor the customers. Worldwide many governments and business field stakeholders are pouring a great deal of endeavor to understand the customer's behavior in order to enhance their green product and make it more appealing for customers. While in Egypt the low percentage of private investment in the energy sector is an obstacle for the technological aspects of energy production, distribution and consumption. The study involves nearly 1086 respondents to define the most significant customer behavior parameters related to buying alternative fuel vehicles. The questionnaire hence involves various variables such as financial considerations at the time of purchase, Long term financial concerns, gasoline and efficiency, fuel consumption, external and internal design characteristics, cargo capacity, and climate change.

2. INTRODUCTION

For most of the last 200 years, the steady growth in energy consumption has been closely tied to rising levels of prosperity and economic opportunity in much of the world However, it's become clear that current patterns of energy use are environmentally unsustainable; humanity currently finds itself attempt higher emissions by fossil fuels resulted in an exceedingly dramatic rise in the level of gases in the atmosphere (Tatsutani, 2009), and it is expected that it will keep rising continually and that petroleum products will continue to be the primary source of energy (Matjaz Knez ⥣, 2014). In the situation of the global warming that the world currently facing and for the purpose of implementing environmental regulations that manage air pollution and fossil fuel consumption, various countries are actively encouraging electric vehicle (Liu et al., 2020); a vital goal of the European Union (EU) is to decrease house emission to be greenhouse by 40% as a minimum by

2030, compared to 1990. Concerning transportation, the EU objective for 2050 is to decrease CO2 emissions by 60%, considering that transport is liable for 30% of total CO2 emissions, and 72% of this caused by road transport (Brătucu et al., 2019).

Transportation is one of the most carbon provider worldwide that could decrease its emissions by electrification (Brückmann, Willibald, & Blanco, 2021). Environment change caused by the emission of greenhouse gases (GHGs) is considered as the most vital environmental problem in society. While there are numerous sources of GHGs, those emitted from vehicles can be decreased by alternative fuel vehicles (AFVs) or green cars. The advanced alternative fuel technologies can split the amount of fuel utilized and decrease carbon dioxide (CO2) emissions and associated environmental influences. These fuel-efficient technologies involve advanced internal combustion engines, hybridization of vehicles, and electric or fuel cell vehicles (Saleem, Eagle, & Low, 2021); subsequently the generation of electricity gradually moves towards renewable energy sources (Brückmann et al., 2021)

Renewable energy sources (RES), that embody hydro energy, wind energy, solar power, biomass, heat, tidal, and wave energy, are seen as a way to short reduction also as a semi-permanent resolution to economic, political, and social vulnerability. Sustainable energy policy suggests that an efficient provision of energy so as to fulfill future wants, needs and requirements without decreasing the flexibility of future generations to fulfill their own needs (Obrecht, 2013). Recently, though, this pattern of continuous renewal has begun to derail. Our planet is being suffering from continuous and dramatic changes that it doesn't recover every year. One modification from that the planet doesn't recover is that the rising level of carbon dioxide (CO2) within the atmosphere, the yearly average concentration of CO2 in the last thousand years remained nearly constant at 280 ppm. Nevertheless, that concentration began to rise in the nineteenth century, then the speed of increase has accelerated dramatically in half of the twentieth century. In 2007 the concentration was about 384 ppm. And eventually if the carbon dioxide concentration continues to extend at the current rate, it'll be double the pre-industrial concentration of 280 ppm by the end of the twenty first century (Komiyama, 2008).

Decreasing CO2 emissions is a global matter that can be partly solved by substituting fossil fuel-powered vehicles with electrically driven ones. in that regard, there is a need to promote sustainable development policies to expedite public awareness of new advances in the automotive industry (Brătucu et al., 2019). From the perspective of the supporters of sustainability, a shift toward low-carbon mobility is required as a current trends of the transportation sector worldwide also requiring investment publically transportation, facilitation of inter-modality, and reduction of private vehicles, as well as encouraging use of economical vehicle technologies (Litman, 2012).

Attaining a sustainable economy is relying on low carbon footprint necessitates entails significant transformation for customer patterns, mainly emphasis on clean acquisition. As claimed by many specialists, this behavioral change can be reached by shifting to electric vehicles. This is a necessity not only for the reason of very high CO2 emissions and air pollution but also the high consumption of fossil fuels (Brătucu et al., 2019).

Two critical factors are expected to drive significant changes in the transportation industry: the advent of alternate fuels and the significant negative consequences of transportation on the climate. At the moment, low oil resources and their accompanying cultural and economic consequences are presently. One of the primary problems confronting for any sustainable system the primary drivers of the demand for alternate fuels and a reduction in reliance on fuel imports and to balance the environmental, economic, and social dimensions within decision-making processes (laurence Turcksin, 2013). In addition, as mentioned above that transportation sector is the second largest contributor to carbon dioxide (CO2) emissions due to fossil fuel combustion. Therefore, it has a great effect on the portion of pollution gases into the atmosphere, which have an effect on people, material, agricultural, environment, and biosphere both intrinsically and extrinsically. Thus, characterizing a sustainable transportation system taking into account all transportation modes and their negative externalities will therefore provide appealing alternative for reducing the environmental footprint of private transportation, reducing hazardous emissions, and increasing the efficiency and effectiveness of limited sources of energy.

To accomplish these goals, bicycles should be used and public transport should be encouraged to reduce the use of personal transportation (Luis Velazquez, 2015) as well as encouraging the purchase of environmentally friendly alternative vehicles instead of gasoline and diesel engines is important, which use alternative fuels such as liquefied natural gas (LNG), compressed natural gas (CNG), bioenergy, and hydrocarbons, as well as drive trains such as electric cars (ECs), plug-in hybrid electric vehicles , and hydrogen fuel cell vehicles (HFCVs) offer an attractive solution for reducing the carbon footprint of the vehicles fleet. (laurence Turcksin, 2013)

Adoption of these AFVs on a global level is a significant hurdle. It depends on large scale infrastructure expenses (refueling and repairing facilities on the stockpile) as well as it has a huge dependence on the acquiescence by the end-users on the consumer side. In this regard, it is critical to understand consumers' views and preferences about AFVs in order to formulate effective policy actions (Matjaz Knez, 2014). However, humanity currently finds itself attempt an infinite energy challenge. This challenge has at least two important dimensions. The irresistible dependence on fossil fuels, threatens to change the Earth's climate and its consequences on the integrity for both natural systems and vital human systems. On the other hand, a large fraction of the world's population still lacks access to at least one or many sorts of basic energy services, as well as electricity, clean cookery fuel associate degreed an adequate means that of transportation. (Tatsutani, 2009)

The forecast of the International Energy Agency (IEA) in its reference scenario estimate is that world energy demand from 2005 to 2030 will rise by approximately 52%, while predictions of World Energy Council estimate that energy demand will double by 2050, which is comparable to IEA's prediction. Fossil fuels will continue to be the primary source of energy, which will cover roughly three quarters of elevated world power needs (Denac, 2011).

Stefan Schaltegger (2012) demonstrated that on a comprehensive level, for more over a decade, the relationship among economic and environmental performance has been a source of contention in the literature. they agreed on that in order to create a sustainability as a business case it will entails management strategy to recognize, establish and strengthen ties between not only non-monetary social and environmental performance but also with business and economic success.

Matjaz Knez (2014) point out that the main questions in terms of developing a value proposition for sustainable business is how corporate sustainability management can help develop and manage business cases for sustainability, as well as how profit may be discovered and gained from increasing social and environmental actions. Consequently, stakeholders must conduct an accurate economic analysis of the economic value provided by new sustainable and friendly enterprises. While a strangely stable global environment needs prerequisite for extraordinary human development over the last ten thousand years, this stability is now under threat from human activity (nation, 2013), (Ministry of Economy, 2002) standardized the process for investing in eco-friendly businesses. It endorses comparing economic assessment, such as net present value in addition to benefits associated with the reduction of dangerous substances in the environment, such as greenhouse gas reduction. Executives are then required to make a judgment call based on both financial and physical value (Minato, 2011).

The initial obstacle appears from unsustainable consumption and production patterns that have established in developed countries followed by developing countries. consequently, developed economies have to address those patterns and their continuously growing environmental impact, while developing countries need to follow the aim of greening their growth (nation, 2013).

(Rodney Duffett, 2018) argue that corporates apply green marketing strategies can lead to competitive advantage which can be perceived by consumers and predictions in the form of lower prices or better value offers. (Fairchild, 2008) utilizes a game-theoretic method determined that the investment charge and consumer awareness of ecological issues have an effect on business motivation to invest in the environment. Kokubu (1999) implies that green parties, such as green customers, as well as acting sustainably is economically achievable as consumers and green investors are willing to accept paying more for investments in sustainable products (Henderson, 2015). Green stakeholders, approve the premium pricing comparable to the economic value on the environmental reduction effects. Thus, the socially responsible benefit established from environmental investments can be leveraged to provide internal organization value (Matjaz Knez, 2014). While HEVs are costly at first, the fuel savings are recovered based on mileage and driving conditions. Examination has demonstrated that the HEV life cycle cost, including the expense of procurement, fuel and maintenance costs, are, -mostly- less than owning a regular vehicle. However, these calculations are emphatically reliant on fuel costs and taxes.

Potoglou and Kanaroglou (2007) analyzed the variables and motivations which probably Canadians' adaptability to greener automobiles is influenced by these factors. As results demonstrated a decrease in the money related liability, buying tax incentives and low carbon rates may urge householders to embrace a greener vehicle; then again, motivations, for example, special parking spot and authorization to drive on high traffic vehicle lanes were not shown to have huge impact on these vehicles' adaptations. (Popp, 2009) determined that fuel costs are very important when purchasing a new vehicle and this relevance is amplified when there is increasing confidence in the vehicle's ability to have a positive impact on the environment. Kishi and Satoh (2005) researched the people’s awareness toward buy of a low carbon vehicle in Tokyo and Sapporo and discovered that Sapporo locals were concerned about the environment; however, concerns about nature don't really urge them to buy low-pollution vehicles. Kahn (2006) inspected the contrasts in utilization patterns among two types: environmental activists and non-environmentalists. The findings indicate that environmentalists are more likely to take public transportation, purchase hybrid cars, and consume less gasoline than non-environmentalists. O'Garra et al. (2007) compared the people’s ability to pay for the decreases in air-pollution related to Berlin, London, Luxembourg, and Perth all have hydrocarbons buses, the findings indicate that there is a positive WTP for hybrid busses, as well as qualities are fundamentally the same among geographical areas. Buyers anticipate that EV makers should concentrate on different aspects, for example, vehicle performance, safety, dependability and cost adequacy (Lee and Lovellette, 2015). Brückmann et al. (2021) Stated that the energy efficiency of (BEVs) is greater than that of other EVs and their battery capacity is better, resulting to possibly larger implications for electricity grids while it recharged at peak hours and peak locations (Achterberg et al. 2010) conducted a study on purchase behavior in the Dutch and discovered that three most significant factors influencing the purchase of new hybrid vehicles are trust in technology, concern of the environment, and a sense of social responsibility for nature. Designing sustainable development strategies requires the integration of complicated processes across the macroeconomic, the energy sector, policies for social, economic and environment and the positioning of technology. Therefore, the world needs a big push based on international development collaboration, and capable to stimulate private sector investment and innovation in order to sustainably transform the energy system (nation, 2013). The ability of developed and developing countries needs to significantly accelerate growth toward higher efficiency, more de-carbonization, greater fuel diversity and lower emission of pollutants to manage the consequences of growing consumption and demand for commercial forms of energy (Tatsutani, 2009).

Many European countries promote laws that support the accelerated replacement of the car fleet with electric vehicles. France, UK intending to ban the sale of gas or diesel cars by 2040. as well as 15 years ago Norway decided to substitute its car fleet through subsidies and tax exemptions consequently the electric vehicles became much accessible and convenient, and momentarily, the percentage of electric vehicles in the total of purchased vehicles has risen a lot, from 5% in 2013 to over 30% in 2018 and 60% in 2019 (Brătucu et al., 2019).

Although there are a great understanding of the danger and threats with automobile dependence globally, nowadays car possession remains still in continuous increase globally, especially in developing countries (IMF, 2008). Egypt ranks 6th in the most polluted countries in the world, and is more polluted than Nigeria. Cairo ranks 2nd in most polluted cities, only less polluted than Delhi (awad, 2018), (Information and decision support center. IDSC, 2007) and (Information and decision support center IDSC, 2008) showed that from the beginning of 2000's, there were an increase in private vehicle licensing at a high rate of 7.4% annually, and 58% of them only in Cairo.

The need for a thoughtful transformation of the world's energy-producing has been extensively recognized. Previous studies on the prospective market for AFVs began in the late 1980s and has been explored using a variety of existing theories. Numerous reports have been written on the subject of sustainable energy, but few have been done from the developing country perception. Specially in nations where they have a large percentage of unawareness and lacks access to basic energy services, many studies reveal that no prior research is made which guides the type of EVs that could be more effective in the developing countries (Rajper & Albrecht, 2020; Tatsutani, 2009).

The purchase of electric cars is affected by environmental matters, economic and technical concerns, and also by personal and demographic circumstances (Biresselioglu, Kaplan, & Yilmaz, 2018). simultaneously, the intention to purchase a new car is affected by the consumers' background and antecedents related to national cultural differences (Barbarossa, Beckmann, De Pelsmacker, Moons, & Gwozdz, 2015); some consumers may have bought electric vehicles based on the future sustainable energy behavior and ecological motivations, while others, may have bought them for financial or technological reasons, having no link to the ecological viewpoints (Brătucu et al., 2019).

3. METHODOLOGY

This paper presents a research study. The research applies a deductive research approach incorporating both quantitative and qualitative research methodologies, followed by explaining the two data collection instruments. Interviews and survey are used to gather all reliable data to allow for method and data triangulation so that to increase the strength of the findings of the study and fill in the gaps missed in the literature. In addition to the primary data, a variety of secondary data should be collected from statistical records, work process documents, handouts and annual reports for the concerned companies. For the primary data collection, a pre-structured questionnaire from (Matjaz Knez 2014) was modified and distributed in Egypt by researchers. Research was done from April to August in 2021.

Starting from the research problem (the identification of the aspects related to the Egyptian customer's behavior regarding the potential green acquisitions, particularly electric vehicle) and based on the analysis of the literature. In order to reach the research objectives, a quantitative marketing research was carried out, based on the survey A sample of 1086 individuals was carried out to ascertain their current perceptions of relevant vehicle performance and financial factors affecting car purchasing decisions.

The questionnaire population consists of households that presently have a car and individuals who do not currently own a vehicle or who do not have daily access to a car when they require one, following by conducting semi-structured interviews to review the results in order to verify and ensure the results that will be found. The Seminars and focus group of our study was adults. Along with many participants in the study, 93% (1010 out of 1086) of study participants already possess daily access to a car, whereas only 7% (77 out of 1086) currently do not own or have daily access to a car. Given Egypt's gender imbalance, 51.5 % of participants were men and 48.5% participants were women.

SPSS is the statistical software tool that has been used in collecting and analyzing data, the acquired Data-Means Cluster Analysis was used to classify the data, which was accomplished by grouping the data to assist analysis of the data. Principle Component Pattern Analysis was used to limit the number of contextual variables, which resulted in the identification of seven broad factors as provided in Table 1.

Secondary data were compiled in this study using a compilation approach from books, online references, periodicals and specialized journals in sustainability, as well as numerous scientific and professional papers, researches, and project reports focusing on the research topic at hand.

Additionally, the study had some limitations, including a restricted time span and the subjectivity of people's opinions, which can be dynamic and change over time. Additionally, the statistical sample may not accurately represent the entire population.

Table1. Important situational elements to consider while making a future automobile purchase choice

Factors	Attributes
Financial considerations at the time of purchase	• Car price • VAT and other buying taxes • Value for money
Future financial considerations	• Insurance set for vehicle • Maintenance/repair charges • Warranty (length and coverage) • Biannual/annual VED • Trade-in value
Fuel and performance gallon/kilometers/liter)	• Fuel consumption (miles per • Engine category/size • Fuel category • Fuel economy • Performance/drive ability
Exterior design features	• Vehicle make • Model of car • Vehicle size • Style/presence/color
Interior design characteristics	• Safety characteristics • Security characteristics • Equipment ranks • Entertainment scheme • Acceleration period
Load space	• Baggage/storage space • Passenger capability • Body shape
Environmental considerations	• Emissions of CO_2 and other greenhouse gases • Emissions of other air pollutants • Vehicle noise

. **Source:** (Borthwick and Carreno, 2012).

4. RESULTS AND DISCUSSION

The results are grouped on the main objectives of the research, and the analysis and statistical tests performed are presented in a logical sequence, which allowed obtaining relevant results.

This section discusses the main results obtained by the researcher through analyzing a sample of 1086 respondents. Results display the important vehicle performance factors, financial considerations and Environmental considerations. Results also show the reasons beyond future decision to buy a lower emission car as well as the gender and age distribution between different segments of consumers. Bar charts are used to show different results. Regarding Figure 1, results indicate that there is no difference between Women and Men in almost everything. However, it could be noted that Luggage/storage space is more important for women, while, Body shape (e.g. hatchback, saloon, estate), Mileage (if you buy a used car), Acceleration time, Fuel type, and Model of vehicle (e.g. Golf, Clio) are more important for men all figures (On a scale of 1 to 7, 1 indicates NOT Vital and 7 indicates VERY Vital).

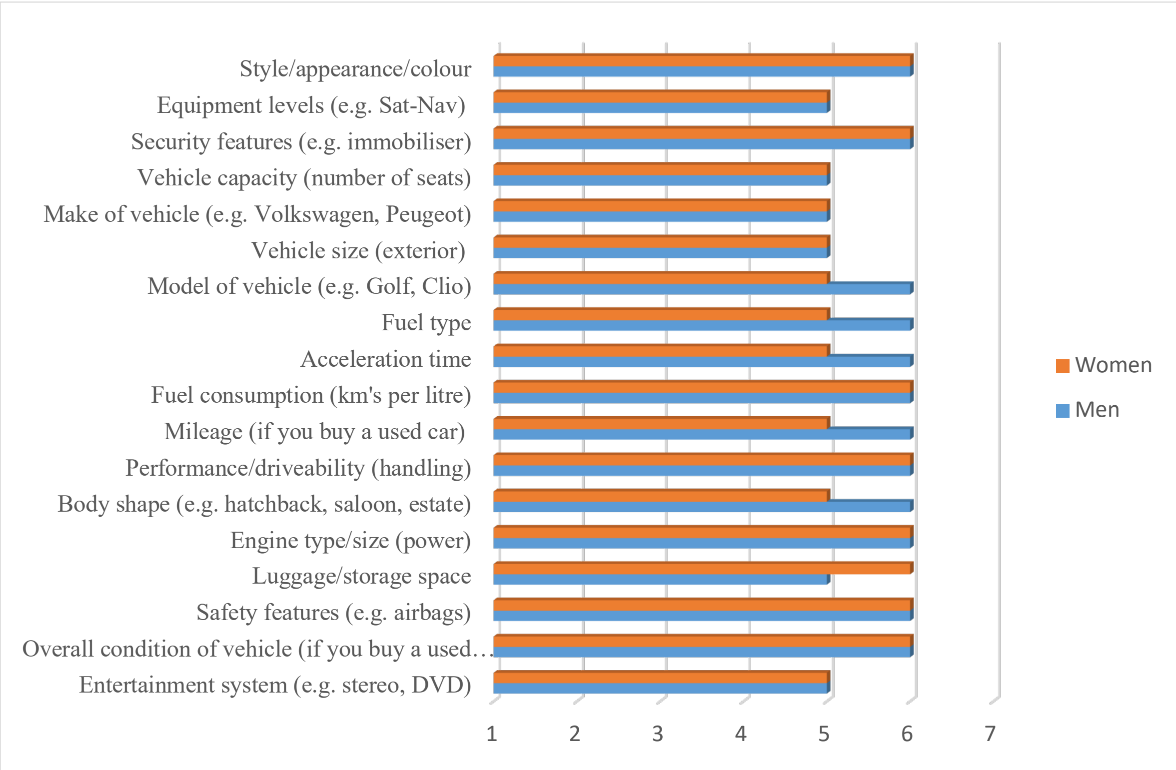

Figure 1: Important Vehicle Performance Factors

Figure 2 displays the results obtained for different financial considerations between gender groups. It could be observed that there is no difference between Women and Men in almost all considerations discussed. However, it could be noted that Maintenance/repair costs, Insurance group for vehicle, and Annual road tax Fuel economy (How much fuel it uses per km) are more important for women.

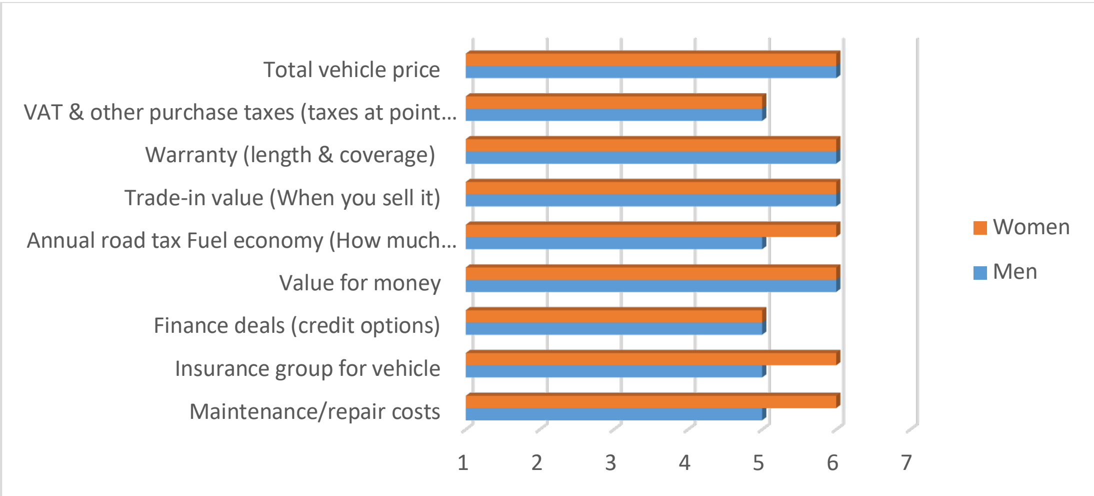

Figure 2: Important Financial Considerations

Figure 3 displays the results obtained for different environmental considerations between gender groups. The results from Figure 3 indicate that there is no difference between Women and Men in Emissions of CO2 and other greenhouse gases. However, it could be noted that Emissions of other air pollutants and Vehicle noise are more important for women.

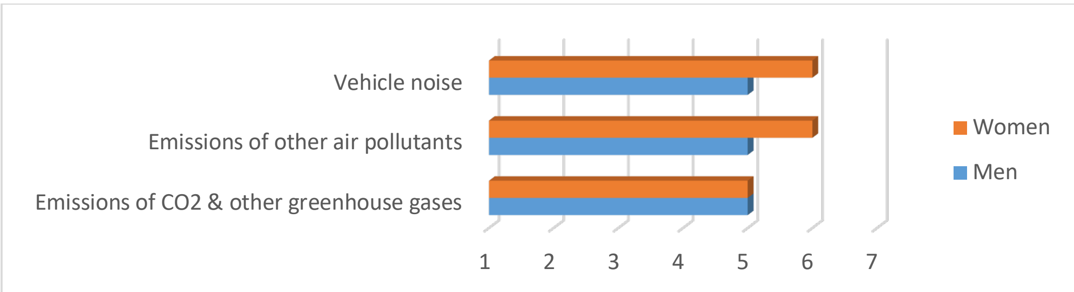

Figure 3: Important Environmental Considerations

Figure 4 displays the results obtained for important reasons of future decision to buy a lower emission car between different gender groups. The results from Figure 4 indicate that the factor "Buying a lower emission car would make me feel good" is more important for women, while, the factor "Because of my own principles & beliefs, I feel no obligation to buy a lower emission car in the future, most other people would approve of me buying a lower-emission car, I am not interested in buying a lower emission car, and I feel no personal responsibility to help reduce the emissions of car related greenhouse gas emissions" are more important for men.

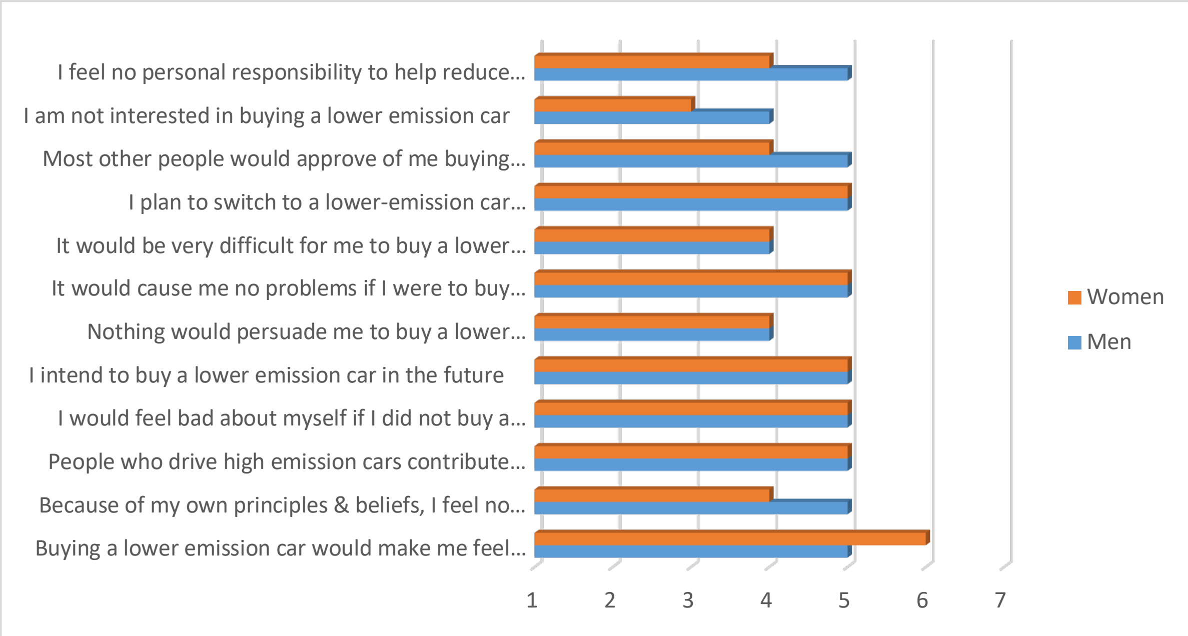

Figure 4: Important Reasons of Future Decision to buy a Lower Emission Car

Figure 5 displays the results obtained for important reasons of future decision to buy a lower emission car between different gender groups. Figure 5 shows that there are certain differences between men and women, as it can be seen that VAT is calculated based on CO2 emissions, therefore buyers of higher emission automobiles pay more VAT. A road user charge model in which drivers of higher-emission cars pay a higher flat fee depending on CO2 emissions, Rebates for vehicles below a CO2 emissions threshold (Drivers of low-emission automobiles, for example, pay less.), The cost of registering a vehicle is determined by the vehicle's CO2 emissions, therefore buyers of higher-emission vehicles devote more. The annual road tax is calculated using a predetermined monetary amount (€) per gram of CO2, which means that drivers of greater emission vehicles devote more, and a 'low-emission vehicle lane,' same as bus lanes, where low-emission vehicles would have their own lane are more important for women, while, the first-year rate of road tax is determined by a fixed monetary total (€) per gram of CO2, implying that drivers of low-emission vehicles devote less, as well as a road user accusing scheme with payment based on CO2 emissions (per km/hour), i.e. drivers of greater emission vehicles devote more are more important for men.

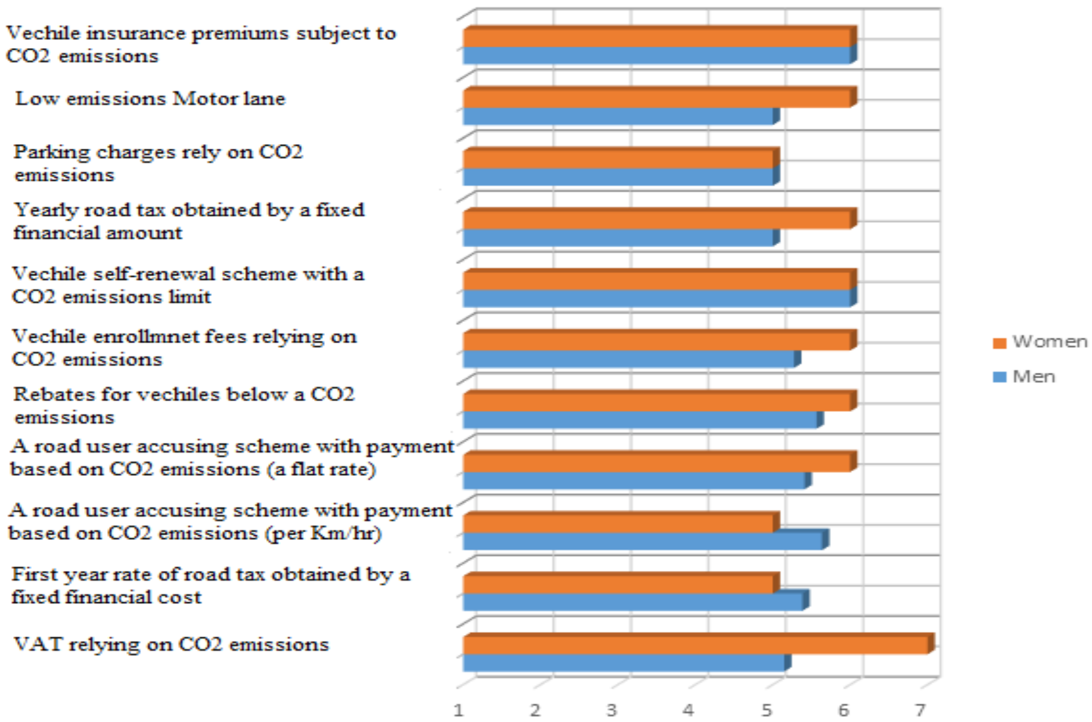

Figure 5: Important of Future Decision to buy a Low Emission Car

Figure 6 displays the results obtained for male-female ratio in various consumer sectors. Figure 6 shows that only 52% of all females are in the "Maybe" group, followed by both "Go-With-The-Flow-Greens" and "Go-Greens" as they got 16%, and finally is "No Green" group as it got 15%. For Male respondents, the highest group is the "Maybe", as it got 47% followed by "Go-With-The-Flow-Greens" group with a percentage of 22%, is the third place is "No Green" group with 18%, finally, "No Green" group with only 13%.

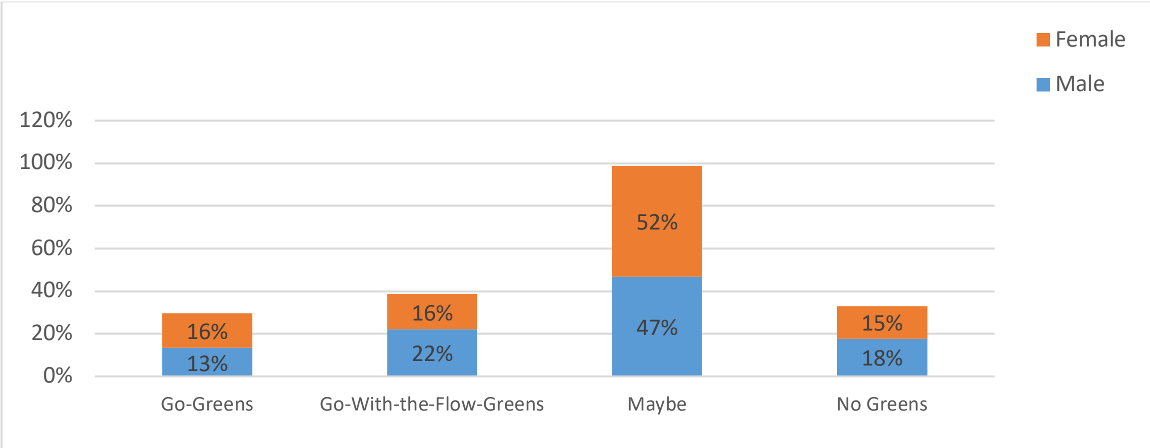

Figure 6: Rate between males and females in various segments of customers

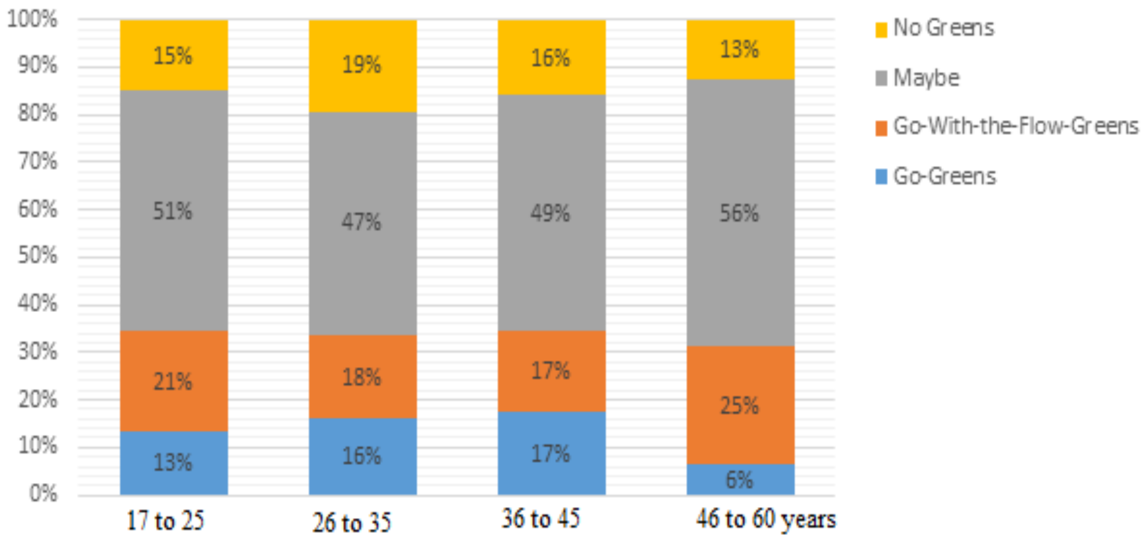

Figure 7: Age distribution between different segments of consumers

Figure 7 displays the results obtained for ratio between different age groups in different segments of consumers. Figure 7 shows that most chosen group is "Maybe" group, in every age group. Also, it could be noted that "Go Green" is decreasing with age.

Table 2. The differences between push and pull factors on car users in Egypt

	Average	No-Green	Go-With-The-Flow-Green	Go-Green	Maybe	Difference between regular maximum and regular minimum
Buyers of higher emission automobiles would pay more VAT if the VAT was based on CO2 emissions.	6.14	5.24	5.74	7.32	6.25	2.08
The first-year rate of road tax is determined by a set of monetary cost (€) per gram of CO2, implying that drivers of low-emission vehicles devote less.	5.32	5.29	5.21	5.54	5.31	0.34
A payment (per km/hour) system based on CO2 emissions, in which drivers of higher-emission vehicles pays extra.	5.49	5.53	5.32	5.71	5.48	0.39
A road user charging scheme with payment (a flat rate) relying on CO2 emissions (in which drivers of higher emission vehicles devote more)	5.57	5.38	5.48	5.82	5.59	0.44
Rebates for vehicles below a CO2 emissions threshold (i.e. drivers of lower emission vehicles pay less)	5.59	5.50	5.63	5.75	5.56	0.24
The cost of registering a vehicle is determined by the vehicle's CO2 emissions, therefore buyers of higher-emission vehicles pay more.	5.45	5.45	5.30	5.57	5.47	0.27
Vehicle scrappage scheme with CO2 emissions limit on alternative vehicle (i.e. If you buy a low-emission new car, the government will pay you to get rid of (scrap) your old one.)	5.56	5.34	5.57	5.78	5.58	0.44
A predetermined monetary sum (€) per gram of CO2 is used annually to calculate road tax. (i.e. car users of higher-emission vehicles pay a higher tax.)	5.52	5.42	5.42	5.81	5.49	0.39
Parking fees could be based in part on CO2 emissions, so low-emission vehicles may pay less to park. Fees for vehicles above a CO2 emissions threshold (i.e. drivers of high emission cars pay more)	5.40	5.36	5.34	5.57	5.38	0.24

'Low emission car separate lane' (same as bus-lanes, where low emission cars would have their own lanes)	5.61	5.55	5.47	5.78	5.63	0.31
CO2 emissions are factored into some auto insurance premiums. (i.e. drivers of higher emission vehicles pay more)	5.71	5.64	5.68	5.78	5.73	0.14

Moreover Table 2 Borthwick and Carreno (2012) illustrate the differences between push and pull factors on car users in Egypt and shows that users who will be rewarded for buying LEV more motivated than people who will not buying LEV in addition table shows that the most influential factor in our survey were (VAT based on CO2 emissions) where it is a pull factor. amongst others contains:

- Premiums for automobile insurance are based in part on CO2 emissions (i.e., drivers of higher-emission vehicles pay more);
- Rebates for vehicles below a CO2 emissions threshold (i.e. car user of lower emission vehicles devote less);
- A road user accusing scheme in which payment (a flat rate) is relying on CO2 emissions. (i.e. drivers of higher emission cars devote more).

4. Conclusion

This study started by highlighting the overview of the research, then presenting the research's problems of the study upon which the research approach and strategies are selected. Using a deductive research approach integrated with mixed research methodologies based on making a theoretical as well as a practical contribution to understanding the elements to control future decisions that influence buying LEV of different groups of people in Egypt. This research used various data collection tools (primary and secondary data gathering). questionnaire is used to gather all reliable data to increase the strength of the findings of the study and fill in the gaps missed in the literature. In addition, this study faces some limitations, despite the well-prepared research process, and these have been explained.

the study has been conducted on both gender males and females with different age. Research showed that there is a slight difference between Women and Men requirements. It could be noted that luggage/storage space, maintenance/repair costs, vehicle insurance, and annual road tax, fuel economy Emissions of other air pollutants and Vehicle noise are more important for women. While body shape, mileage, acceleration time, Fuel type, and model of vehicle are more important for men. Moreover, men have no interest and feel no personal responsibility in buying a lower emission car comparing to females who have more responsibility towards environment and ready to buy LEV. In additions, Women believe that buyers of higher-emission car will have to devote more VAT. However, the first-year road tax rate is determined by a set financial amount (€) per gram of CO2 are more important for men.

The research determined three groups of people with different point of views on LEVs analysis. The most numerous group – the "Maybe" (52% of females and 47% of males)- still not have the full awareness of LEV as it's a new concept in Egypt, however, they have a positive perspective about LEVs, even if they are unsure about purchasing one in the near future. ''Go-With-The-Flow-Greens'' or ''Go-Greens'' The second biggest group (16% of females and 22% of males) they have a very optimistic attitude on purchasing an LEV and aim to do so in the near future. Concerning the third group that known as the "No-Greens," the percentage was (15% females and 13% males)

Study has divided our participants into four groups (no green, go with flow green, maybe, go Green) the most dominated response choose maybe with 49 % this explain that despite the urgent environmental still the great percentages still not ready to buy LEV followed with go with flow green by about 19 % and go green only 10% of the total sample who is ready to buy LEV, Thus the greatest group still considering buying low emission cars in future.

Our study find that LEV demand is strongly (and positively) depends on personal characteristics, such as income, as well as having multiple cars in the household and usage of car sharing are positively related to the demand of LEV

The findings of this study also show that there is no single measure that would significantly raise demand for LEVs. The solution is to integrate various measures or methods, such as top-down and bottom-up, in which both the government and the automobile sector should participate. So Egyptian government should take serious steps firstly towards public awareness for environmental issues, secondly help car manufacturer to produce different motors with less emissions and finally facilitate more governmental motivations for car users to substitute fuel cars to electronic cars.

The car industry should also create awareness of this new concept as most people don't understand what "gram of CO2 per 100 km" means, our suggestion to the car industry that wants to sell LEVs is that they should tell customers the amount of money that they can save by buying one. Moreover, focus groups suggested new factors that can be add in future research which can influence people decisions in Egypt such as electric stations availability for electronic cars, after sales services and car buying cost considering that Egypt still not have variety in electronic cars with different buying cost in addition anonymous cost for electronic charge per kilometers.

To sum up, the contribution of this study investigates the characteristics of various consumer groups willing (and unwilling) to purchase LEVs, and what persuades them to strongly start thinking to buy it. The exploratory study's results establish elements that help future researches in Egypt through theoretical and practical practices

This study extends from previous studies conducted in Slovenia that suggested applying the study in different geographical areas to motivate future studies. The reality of the research topic has also revealed the possibility of expanding this research to other developing countries in order to define potential differences among potential purchasers. The broadening and appeal of this research topic strongly suggest that this could be a very interesting global research area.

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Sea Based Economy: Review of Research Agenda Within The Blue Economy Concept

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ABSTRACT

The Blue Economy concept is a fresh and the new frontier of countries renaissance. It is an economic development and environmental strategy, has gained acceptance and importance worldwide. For national development the Blue Economy is considered as the conventional. Also it can integrate socio-economic development based on sea and land in a sustainable manner. In this way, this paper analyzes the Blue Economy in a global agenda through a systematic review through content analysis of academic literature in order to define a literature gap in this field. Therefore, it adopts a content analysis-based review method to extract the relevant agenda and literature on the Blue Economy in English-language, especially working and white papers. In this vein, literature scan intensively puts emphasis on the published in peer-reviewed in the following three databases only; Taylor and Francis, Springer and Science Direct through the use of the following search string; blue economy, ocean economy, fishing, shipping and ports and marine environment. In order to answer the research question, this study was conducted in three consecutive steps: (1) determining the research question, (2) development of the research protocol in order to explore literature in the defined databases, and (3) conducting an analysis and screen the results. According to study findings, there was a remarkable 41-fold rise in articles over the research period. The study outcomes revealed that descriptive analysis is the primary approach in 48 percent of the analyzed articles. Furthermore, there is a vast number and variety of academic publications in the blue economy sector, making it difficult to correctly identify important research themes and trends.

Key words: Blue Economy, Ocean Economy, Fishing, Shipping and Ports and Marine Environment.

1-INTRODUCTION

The sea and oceans have always been present in economic activities, while maritime transport is the most effective way to link different countries in the globe. Beyond their basic role for transshipment and logistics, the future of sea ports lies in developing their key role in the circular economy and de-carbonization through use of smart and autonomous systems.

European Union Blue Economy Report (UN, 2020), summarized that seas and oceans hold 80%, of all forms of life and 97%, of all water. In comparison with compared to a national economy, the global Blue Economy is the seventh largest economy in the globe. This means seas and oceans as an economic entity should be a member of the G7. Meanwhile, the Europe's blue economy provides more than 4.5 million direct jobs.

Actually, attention to seas and oceans sustainability had grown progressively since the Earth Summit in city of Rio de Janeiro in 1992, and was accelerated with the adoption of SDGs in 2015. So, addressing equity and sustainability demand attention to ocean governance, which is subject to high degrees of difficulty and lacks coordination and consistency.

1-1 Research question

In order to achieve study aim, this paper addresses the following question: what are the disciplines provided by researchers on the global blue economy agenda?

1-2 *Development of the Blue Economy Concept*

The scope for business activities on and around the seas and oceans are enormous. It's including fisheries, aquaculture, mineral extraction, transport, medicine industry and tourism. These are some of the long known business endeavors on and around the sea (Choudhary et al., 2021). As a model, the Blue Economy targets to develop social equity and reduce environmental threats and ecological insufficiencies too.

The terminology of the Blue Economy dates back to late 2009, at the American Senate Committee on Commerce, Science and Transportation Congress. In the context of the Blue Economy concept, Lee et al, (2020), stated that the Blue Economy is popular and gradually concept. It is a strategy for safeguarding the world's oceans and water resources. It aims to encourage better exploitation of seas and oceans or blue resources.

The Blue Economy is an emerging concept, as it is a combination of industry and geographic location. On the other hand, the Commonwealth is considered the Blue Economy as a strategy that goes beyond exclusively viewing oceans economy to an economic growth mechanism. Take sea ports as an example, they are vital to countries economy and or regions.

Similarly, the World Bank (2017), defined the Blue Economy as "*the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem*". The World Bank's definition, in fact, is a comprehensive concept embracing multi-aspects of oceanic sustainability ranging from the sustainable fisheries to ecosystem health and preventing pollution.

In the same way, from a sustainability perspective, Kathijotes (2017), indicated that the Blue Economy refers to the new system of Green Economy that interweaves creative neo-science and associated technologies. However, the sustainable Blue Economy is a marine-based economy that provides; (i) social and economic benefits for current and future generations, (ii) restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems, and (iii) is based on the clean technologies, renewable energy and circular material flows (WWF, 2021).

Most recently, Spinrad (2021), defined the New Blue Economy as *"the commercialization of value- added data, information, and knowledge about the marine environment*". He added, as a concept the traditional Blue Economy is built of a labor relationship legacy as it shaped by centuries of profit- motivated exploitation of workers and aquatic resources, whereas the new blue economy requires an educated workforce and for them to be edictal in new ways.

Wenwen et al., (2016), defined marine economy as an economic form that emphasizes a new operating mechanism, new development concept and management model. While marine economy includes marine construction, resource, shipping, tourism and recreation industries whose establishments are located near ocean shorelines or large lakes (UNCTAD, 2014). The Blue

Economy concept has its origins in the broader green movement and heavy damage wrought on ocean ecosystems through a growing awareness of the human activity such as, over fishing, and pollution and climate change.

1-3 Blue Economy Activities

The global Blue Economy or the Blue Economy at a global scale has various activities, as shown in Figure-1. In this vein, OECD divided activities of Blue Economy to; (i) established industries which include capture fisheries, marine aquaculture, shipbuilding, oil and gas offshore activities, marine business services and dredging, (ii) emerging industries which include marine construction, coastal tourism, maritime transport, safety and marine biotechnology surveillance, marine seabed mining and offshore wind energy or renewable energy and high-technologies marine services,.

1-4 The Benefits of Blue Economy

The Blue Economy is a new governance tool and is considered as an emerging agenda through which sustainable development is being followed within the oceans. However, the nations with large-scale industries have seen progress and a new expansion of their ocean and sea economies through a better stewardship of maritime and marine resources, as such; shipping, ports, tourism and recreation, oil and gas, minerals and mining industries and fishing and renewable energy.

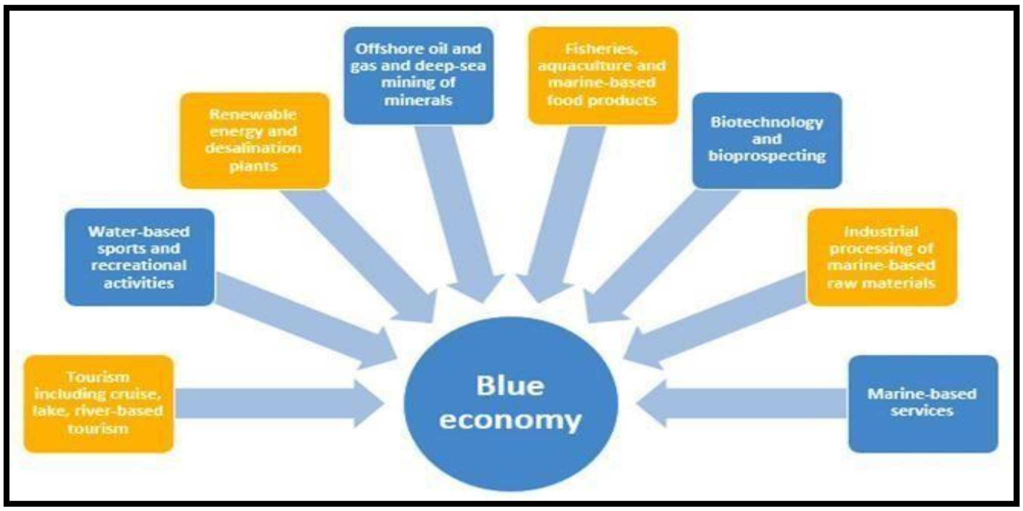

Figure-1 Blue Economy Sectors and activities
(Source: Bolaky, 2020)

Bennett et al., (2019), clarified that the blue economy benefits are including coastal economies renewal, provision of alternative livelihoods and enhance food security and wellbeing. While the new economic opportunities may enable coastal states and small islands to re-assert sovereign control regain access to marine resources. In contrast, the Blue Economy generates unfettered economic growth can produce economic variation and inequity, create limited benefits to locals due to elite capture, generate social damaging, influence culture, expose marginalized groups to pollution and relocate local groups or populations.

The European Commission (EU, 2021), however, claimed the Blue Economy contributes to climate change mitigation through decarbonizing maritime transport and greening ports and by developing offshore renewable energy. Moreover, it will make the economy more circular through renewing design standards of fishing gears, ship recycling and for the decommissioning of offshore platforms improving the green infrastructure within the coastal areas too.

In a different way, Bennett et al., (2019), stated that the Blue Economy contributed to the world economy by US$1.5 trillion in 2010 and the project is set to reach US$3 trillion by 2030. Thus, governments and policy makers are requiring economic indicators for the Blue Economy and prioritizing future investments as a part of strategic planning. Last but not least, Figure-2 clarifies the relationship between the UN's SDGs and the Blue Economy with some priorities; the SDGs 14, 17, 16, 15, 12, 13, 8 and 9.

Figure-2 The relationship between Blue Economy and UN-SDGs 2030
(Source: Schuckmann et al., 2020)

2- Methodology

Fundamentally, the review of literature aims to present and evaluate the body of literature. In this vein, a content analysis-based review method is developed in the second stage of this study, as shown in Figure-3. During the content analysis process, deductive approach was adopted to categorize articles. Moreover, in this approach, the researchers define a priori design protocol for coding the related information and classify the content into the predetermined categories based on the existing theory or knowledge (Krippendorff 2018).

Nonetheless, the research streams have been obtained through highlighting the Blue Economy concept and selected keywords related to it, through a content analysis. In doing so, this study examines journal papers only and excludes book chapters, conference proceedings and dissertations. Logically, journal articles are the principal indicator of academic production and performance. In fact, research strategy starts with determining the journals depending on the main digital libraries.

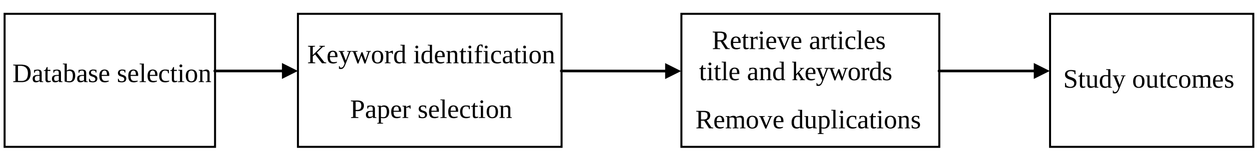

Figure-3 Research process flowchart
(Source; developed by authors)

According to Garcia et al., (2021), that at the UN Conference on Sustainable Development held in Rio de Janeiro in 2012, summarized that the oceans are deemed to be priority areas, with some initial objectives being proposed, such as food security, sustainable consumption and production patterns, sustainable energy for all and disaster risk reduction and resilience As a result, the Blue Economy term is relatively new and thus the reviewed articles performed with time restrictions on its publications from 2013 to 2022.

Actually, all reviewed articles are written in English and connected to the Blue Economy concept. Moreover, the data obtained was from the published in the scientifically indexed journals or scientific databases namely; Taylor and Francis, Springer and Science Direct. In the first stage of this study only three scientific databases were chosen using the most frequent terms related to the Blue Economy concept which includes; ocean economy, fishing, shipping and ports and marine environment. Then duplicates of the reviewed articles were removed in the second stage, while the final stage is devoted to provide study's outcomes.

3- Data Collection and Study Results

Data collection started from late 2013 until January 2022, in the initial selection process of terms the Blue Economy yielded the defined three databases and includes 52213 articles in Science Direct, 96698 articles in Springer and 112576 articles in Taylor and Francis.

After removing duplicate articles in the stage two, the total number of papers on the Blue Economy as a title in the three databases between 2013 and 2021 increased 41 folds for the total articles, as shown in Table-1. In very broad terms, papers with the title of the blue economy increased in Science Direct database from 1 article in 2013 to 2 in 2014 and 2015, and to 6 articles in 2017.

In addition, the number increased in 2018 to 7 and to 12 in 2020 and peaked at 19 articles in 2021. The total number of published papers with a title of blue economy in Science Direct database was 57 articles. Furthermore, papers with the title of Blue Economy increased in Taylor and Francis database from 1 article in 2014 to 4 articles in 2016 and 2017. Moreover, the number increased in 2018 to7, then decreased to 6 in 2020 and 2021.

The total number of published papers with a title of blue economy in Taylor and Francis database was 31 articles. On the other hand, papers with the title of blue economy increased in Springer database from 1 article in 2014, 2015 and 2019 to 6 articles in 2020 and 8 articles in 2021. In addition, the total number of published papers with a title of blue economy in Springer database was 19 articles.

Table-1 Frequency of Term Blue Economy as the Main Topic or Title in Selected Three Databases

Year / **Platform**	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Science Direct	1	2	2	X	6	7	6	12	19	2
Taylor & Francis	x	1	x	4	4	7	3	6	6	X
Springer	x	1	1	X	2	x	1	6	8	X
Total	**1**	**4**	**3**	**4**	**12**	**15**	**10**	**27**	**40**	**2**

(Source: developed by authors)

Moreover, based on these results, Table-2 and Figure-4 present the attributes in research methodologies which includes; descriptive, systematic and or desktop research review, conceptual and or analytical framework, modeling, survey, case study, cluster approach, grey correlation analysis and foresight.

Broadly speaking, the analysis showed that most reviewed studies use the descriptive analysis and document analysis as their main methodology where 48 % of articles employing this methodology followed by conceptual and or analytical framework where 13% of articles employing this methodology. Case study comes third where 10% of the reviewed articles employed this methodology followed by modeling and survey methodologies where 9 and 8.5% of the reviewed articles employing this methodology respectively.

Moreover, descriptive and or document analysis contributes with 4.5% of articles were employing this methodology followed by cluster approach and foresight where equally 3% of the reviewed articles employing this methodology, while grey correlation analysis used only once among three databases during the period of study.

Table-2 The Most Applied Research Methodologies of Study

Term / Database	Descriptive and document analysis	Systematic/ desktop review	conceptual /analytical framework/	modeling	survey	case study	cluster approach	grey correlation analysis	foresight
Science Direct	28	2	7	5	6	3	2	1	3
Taylor & Francis	16	1	3	4	1	5	1	X	x
Springer	6	2	4	1	2	3	X	X	x
Total	50	5	14	10	9	11	3	1	3
Ratio	**48%**	**4.5%**	**13%**	**9%**	**8.5%**	**10%**	**3%**	**1%**	**3%**

(Source; developed by authors)

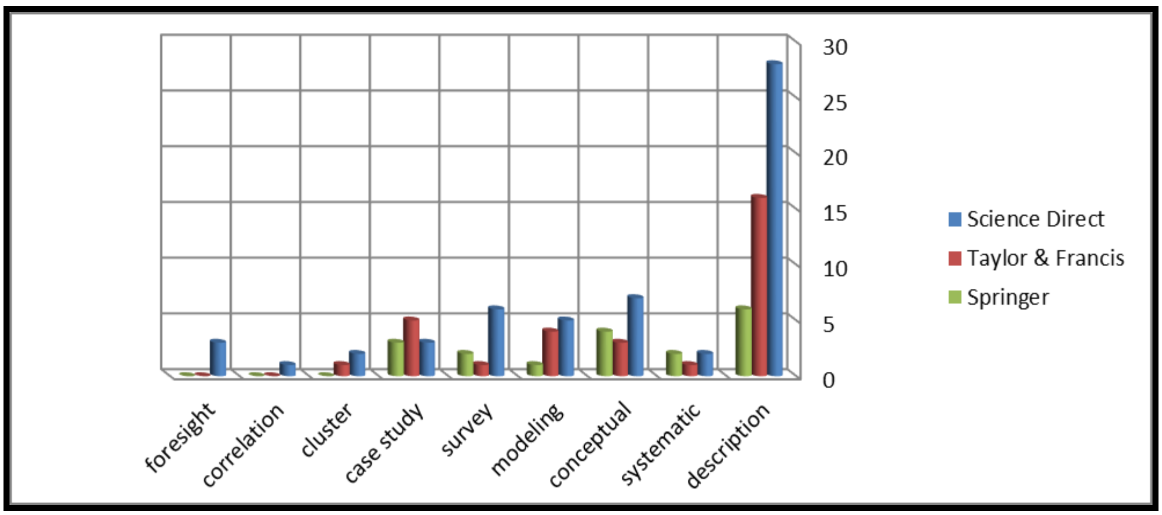

Figure-3 The Most Applied Research Methodologies of Study
(Source; developed by authors)

The second and third stages of study provide content analysis and the study outcomes in order to

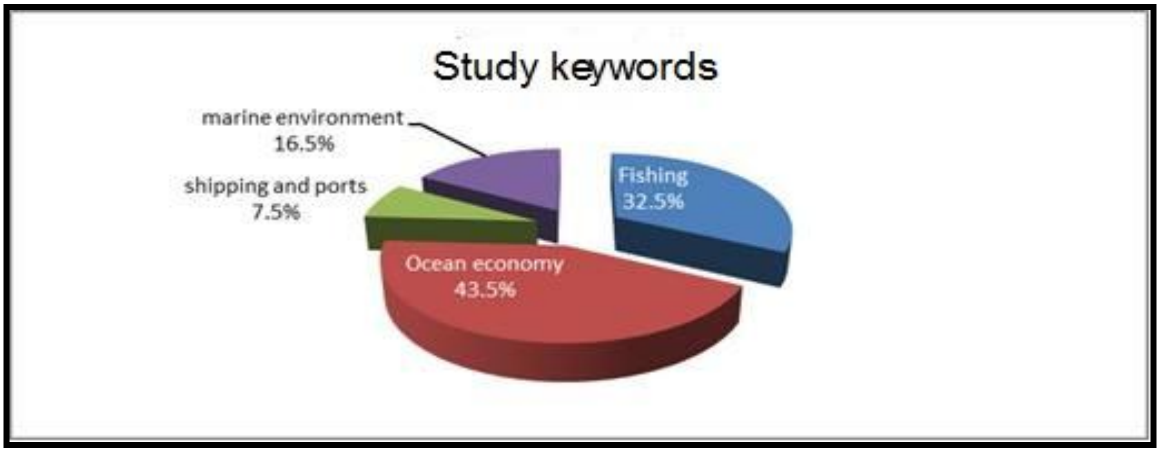

Figure-5 Study Keywords Ratio
(Source: developed by authors)\

answer research question as presented in Table-3 and Figure-5. After removing irrelevant papers and unrelated and or the duplicate articles over the period of study, term of ocean economy encounter the highest number of 125 in Science Direct, 43 in Taylor and Francis and 14 in Springer. The term fishing scored 60 in Science Direct, 44 in Taylor and Francis 32 in Springer

Table-3 Research Matrix

Term / Platform	Fishing	Ocean economy	Shipping and ports	Marine environment
Science Direct	60	125	14	8
Taylor & Francis	44	43	7	12
Springer	32	14	10	49
Total	136	182	31	69
Ratio	**32.5%**	**43.5%**	**7.5%**	**16.5%**

(Source: developed by authors)

4- Conclusion and Recommendations

The traditional approach to sustainable development is the Green Economy, which may be perceived as the outlook of a landlocked country. In contrast, the oceans are increasingly viewed as a lucrative new frontier for the economic development for several countries. Thus, as a new concept, the terminology of the Blue Economy is a field of study that encompasses economic activities that depend on the sea. It is often associated with the other economic sectors such as maritime transport tourism, fishing and energy.

To sum up, this study uses a content analysis-based review method for a literature review of the Blue Economy domain was covering papers in academic journals over 10 years from 2013 till 2022, in order to examine the relationship between the Blue Economy and the selected keywords. The study results indicated that there was a remarkable 41-fold rise in articles over the period of study. The analysis also showed most reviewed studies use the descriptive analysis as the main methodology at 48 %.

Moreover, the increased of papers number was due to an increasing pressure on the research output (Carter et al., 2005). The study outcomes demonstrated that there is a great diversity and large amount of academic articles regarding the blue economy domain make it as a challenging task.

Despite this paper has made an effort to group the studies in the field of Blue Economy by employing a content analysis-based review, it is limited to number of keywords and reviewed journal papers and it excludes book chapters and dissertations. As a research content analysis methodology, it emphasizes the Blue Economy subject. Consequently, the areas for further research in the blue economy domain should include the unused terms of this study such as; renewable energy, aqua culture, coastal tourism and recreation, to name but a few. Also, it should include regions, authors' names and nationalities.

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THE REQUIREMENTS OF AGILE PRICING POLICIES TO BUILD A COMPETITIVE MARITIME SECTOR: REFLECTIONS ON THE EGYPTIAN PORTS

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Keywords: Pricing policies, Seaports, Port competition, Port pricing challenges, Competitiveness, Agility, Resilience.

ABSTRACT

The strong growth of world merchandise trade recorded the highest in 2017. This was the strongest indicator within a period of six years carrying a ratio of 1.5% which is far above 1.0 the ratio following 2018 financial crisis. The period up to 2023 carries positive prospects for short and medium term and will yield to a growth of global GDP by more than 3.0. This paper is coming in the light of the two decrees that had been issued by the Egyptian Government #800 for the year 2016, and #488 for the year 2016 which had set the different pricing for the different services for the port users. The question arising and addressed in the review across the research study sheds the light on the inability of the Egyptian Economy to hunt the opportunities of this GDP growth and the increase of global sea born trade. The weakness that stands as an umbrella hindering Egyptian ports to carry on these positive forecasts is the non-agile policy setup of their pricing systems. On the academic level, the paper tries to study about the competition and how the pricing system in ports to be determined worldwide. The paper in hand, tried conceptually through review to present a typology accounting for the challenges that face the Egyptian ports in setting competitive pricing system and it allows the venue for more empirical studies in this direction focusing on comparative in depth analysis of specific ports that could be studied in the future to extend the research in this field. Moreover, it presents a qualitative primary researched plan that will tackle the leakages for the Egyptian Ports' services in building a competitive edge reflecting the challenges they face in their rigid pricing strategies. Such rigidity in terms of price setting has decreased intra-port competition as well as inter-port competition between different terminals and among firms performing in the port and it reduced the transit- shipment activities at some ports.

1. INTRODUCTION

The ports industry has turned into a competitive industry, as the competitiveness of seaports has had little importance in the past two centuries, and these variables have contributed to the development of maritime ports' functions throughout five generations. The main difference between the three generations was related to the port's infrastructure, activities and services provided while the information systems and the smart port are the hallmark of the fourth and fifth generations (*Zhou,2015*).

The competitive port is the port that is chosen more regularly than other ports for its innovation and operational agility indicators. It achieves growth in its trading rates and market share and is able to provide all the facilities that customers need with the highest possible efficiency and in the lowest possible time and at the prices distinct from other ports and able to attract more customers. The Determinants of Ports' Competitiveness are the location, the updated infrastructure, the quality of facilities and the efficiency of operations in which the prices are considered very important factor (*Younis, Z.,2017*). Operational agility stands as an indicator for the port' success in exploiting both revenue enhancing and cost cutting opportunities to reach a competitive edge and it could be considered as an umbrella for pricing policies settings (*Lewis,2014*). A dynamic for an agile pricing system for the Egyptian ports is crucially needed especially for these huge challenges under the present circumstances of the new normal arising from Post-Covid epidemic.

2. LITERATURE REVIEW

2.1 The changing nature of competition along with Covid19 implications for a new normal wave

Ports play a crucial role in Multi-Modal transportation. Whether sea freight carriers working on a business to business or business to customers, the risks are very high. There are regulations urging developing countries to give priority in the improvement of ports facilities and service delivery as it is the hub of logistics network that coordinates the operations of service providers in a global sense including roles and interactions at work. (*Oanh Nguyen et al, 2015*). In 2017 there was an increase in the volume of world merchandise trade by 4.6% in comparison to 1.5% in 2016. The cross-country variations in trade compensated for the overall decrease in the growth rate of trade at 2018, as emerging Asia and Latin America had the highest trend for the Growth in trade While Africa and the Middle East has the lowest trend, due to the slowdown in their emerging economies and low oil price levels (*UNCTAD,2018*).

The innovation in new technology allow existing services to be upgraded across borders. The globalization of services drives the development and growth of new services sectors, and new ways of delivering services are existed such as the adoption of digital technology, the direct access to online markets and the online Shopping and the Shopping through the social media (*World Trade Report ,2019*). Other tensions that needed recovery by agile actions were the fragile recovery in Europe after the 2008 economic crisis, diverging outlooks for net oil consumers as well as producers, challenging international alliances between giant shipping cargo handlers in the maritime sectors monopolizing the market, and potential slowdown in developing economies especially the emerging ones. According to UNTACD report in 2015, the ten ship owning countries are from Asia, Europe and from America, with Greece on top with an increase of 29% in service companies from 2004 till 2015.

All of these challenges and changes had put pressures along with the competition between ports to update their pricing mechanisms, the paper is to discuss the changing nature of competition in ports, what are the ports' pricing principals, considerations and determinants, and what are the leakages for the Egyptian ports.

Vertical relationships are what describe global seaborne trade in our century, they include both gateway and regional ports; dry and seaports as well as the hub and feeder. The most important notion is that the rail service providers operating horizontally are no longer considered a virtue as cooperating vertically is the name of the game. To reach an increasing level in the development of seaports, governments should base their budgets in an agile operational investment strategy of engaging in both horizontal competitions to gain market share and vertical collaboration to create facility use in supply chain. (*Song, 2003; Hoshino, 2010; Sjostrom, 2010*). Operational agility helps to reduce the well-known "double marginalization" problem, (*Van De Voorde and Vanelslander,2009*). Moreover, it helps in setting clear pricing systems for services rendered in several ports.

The market power that plays a significant role in ports efficiency depends on key strategic factors:

- Geographical characteristics
- Access to channel depth.
- Feeder and Multi modal connectivity.
- Services logistics; reliability; stability and client relationship management and communication. (*Tongzon, 2007; Chang et al, 2008*).

Setting strategic policies for agile pricing can be an important challenge when it comes to Egyptian ports for various reasons:

- First, dynamics of competition set fierce rules on the level of the port's strategic role in relative to others.

- Second, pricing systems should follow the dynamics of market competition and they should be set to face corporate objectives and achieve socio-economic development strategy.

- Third, governments should be involved to monitor and control price setting to decrease monopoly power.

- Fourth, there are conflicting interests in the role that ports play on the level of the country as a matter of national security on one hand and as a matter of public asset to play a role in trade promotion and development. Moreover, ports play a dynamic role as business entity striving for financial profits in rendering maritime services.

- Fifth, Container freight cost volatility as ship bunkers fuel cost have fallen and usually as a result it reduces ship operator expenditure and rates paid by shippers, therefore it requires a legal and regulatory framework to protect it from fluctuations.

- Ports in general are a part of Multi-Modal transport network which has different types of hinterland connections; sea freight cargo and specific rules and regulations to follow.

Therefore, port pricing is complicated by this supply chain where many entities play a crucial role in its determination. (*UNCTAD, 1975*). Moreover, General reduction of seaborne Trade and Ports' economic activity due to health measures restrictions related to Covid19, shown in several cargo pricing threats as the oil trade is facing the steepest fall since the 1970 oil crisis with a seaborne oil-mile trade of 5.0% in 2020 which is a -6.6% from 2019. The dry bulk carrier trade as well is falling with 3.9% and projected to continue till 2021 and the container sector fell to consumer demand in key region under significant pressure with a -10.5% which marks a decrease of -20% in our Egyptian ship building forecast for 2020 (Unctad,2020).

- On the operational level, the disruption of trade market and the lockdown has affected the levels of operations in different ports nationally and internationally regarding the manpower restrictions and several hygiene factors and health precautions. The crew changes and the port acceptance as well the delivery of ships is the major challenging factor regarding operations in Egyptian ports striving to diplomacy to ensure the activation of contract closures. The ship operating costs and freight rate fluctuation; reducing the waiting time in sea ports and the agility trend implemented to adopt different innovative ways to alleviate budget constraints are major challenges as well. Gaps in volumes coming into Egypt's ports created general pricing fluctuations and challenges in Maritime HR management capacities.

This lies in the shock uncertainty that remains in the outlook economically and operationally for supply trends for Egyptian ports. The port industry in Egypt is facing competition and economies of scale; fast IT platforms development that needs implementation; global economic uncertainties and major societal expectations regarding health, safety and security. Some of the specific adverse effects of Covid19 on ports' management policies of its employees can be listed specifically as follows:

- Adoption of precautionary measures and work reduction hours between 2-15%.
- Laid off labor between 10-20%.
- Additional tasks in some departments towards laying off some professions.
- More reviews required in terms of IT infrastructure and capacity.
- Remote management and work operations.
- Delay in ports development projects and maintenance of ports' equipment's spare parts and some are very feasible in Alexandria ports (Ming, 2020).
- Supply chain shortage.

2.2 The Port Pricing Principles

Ports carry many definitions to many scholars as their role changed from just a point of receiving and delivering cargos to a crucial entity in a worldwide logistical system of transportation. (*Goss,1990*)
It is becoming a gateway for trade and an interchange between land and sea transport in the delivery of goods and services. Several operational process definitions look at ports from the perspective of services of transit; loading; mooring and warehousing. These items represent the port product in a chain of consecutive links and the port pricing system facilitates the utilization of ports assets within this loop of interconnections with maximization of profits. (*Suykens and Van de Voorde, 1998*)

The technical progress in operations of goods and services sets all old pricing systems in backwards positions. Therefore, a whole new strategy depending on agility should take place taking into consideration the following factors:

- Relating financial charges to service rendered to ports following international standards.
- Port investments and technical progress given their shorter useful life than was the case in the past.
- Utilization of installations. (*Meersman et al, 2003*)

3. THE DETERMINANTS OF PRICING IN PORTS

Ship operators and cargo owners play a crucial role in setting prices. The ship operator looks at the value of the product as it has a higher value at land and sea connecting point in the market area than the production area. There is also the difference between the value of shipment point and the value at the point of production minus the cost of product transportation from one point to the other and this should be the area to which the cargo owner looks. (*Meersman et al,2014*).

The revenue to the port authority is calculated by the benefit of the cargo owners and ship owners as a flow and charge respectively. Port authority cannot risk dryness of cargo flow by charging the cargo owners more than the benefit costs created by the port. As competition is fierce ports are easily replaced by price bidding from one transaction to another and from one port to another. So, cargo owners will easily change destination routes of their cargos if antagonized by price monopoly of certain ports. (*Haralambides et al, 2001*). As a result, the economic operations of the ports have to act on a cost benefit chart where in order to set a niche in the market fierce full competition: the flow of benefit has to exceed the flow of costs.

The financial terms of identifying the efficiency of pricing systems in ports depend on the quantification of benefits that ports present. Once expressed as a financial flow, the benefit can be re-allocated through the pricing system. (*Meyrick, 1989*).

4. PRICING CONSIDERATIONS

4.1 Reflections on Egyptian ports

The similarity between ports is rare. There are lots of key market players involving: shippers; brokers; agents; forwarders; shipping companies and trade unions. Moreover, there is a great possibility of substituting one port for another which creates high demand elasticity. (*Suykens and Van de Voorde, 1998*).

Various market players need usually an alignment with government regulations when it comes to pricing systems settings. Their strength will be also exposed to change during the course of time and so will be the port authority. (*XIAO et al, 2012*). The Egyptian ports authorities are facing a challenge of achieving a competitive advantage in development of both its infrastructure and superstructure while aligning its pricing policies with the global market trends and players. The Sophistication of the process implies designing and selecting requirements for pricing systems matching worldwide standards and operating in an agile perspective putting the pricing indicators into strategic action combining efforts of the government and private sector in parallel. However, in doing so, Egyptian ports will face the following challenges that are not only global but must addressed specifically within each nation according to its capacity: (*Welch,2019*)

- Forces of demand and supply.
- Growing risks of automation and digitalization.
- Industry monopoly.
- Port services facilitation.

Although Egyptian ports enjoy a considerable number of comparative advantages as the supreme strategic location between three continents, and the presence of Suez Canal linking east to the west, there is a wide lack of competing advantages standards that are enjoyed among its rivals: Pricing system agility and responsiveness to market forces is foreseen to be a maneuvering requirement towards gaining this competitiveness edge. Within this context, the regulation of port pricing structures would entail transferring the Egyptian port from just a gate of cargo delivery to a commercial service center that contribute to the economic welfare of the maritime sector as a whole. Several governmental regulations are needed to achieve a strategic shift towards the formation of pricing systems policies through the acknowledgement of operational benefits of the ports. These requirements have to go in parallel with the following:

- Market indicators for pricing changes and growing demands.
- Transparency needs and agility to face pricing challenges of freights and cargo handling services.
- Customers as stakeholders in the Egyptian ports expecting maritime services providers to help achieve economic growth.
- Climate change adaptation in monitoring energy and transport costs, (*Ali,2019*).

The sustainability of financing maritime services entails innovative ideas and ways to solve the problems of constrained national budget by adopting several operational agility policies as Public private partnerships.

<u>There are several determinants of International maritime transport costs that reflect on Egyptian ports leakages to achieve a competitive pricing system strategy:</u>

- Incapacity of Egyptian ports in running effective and efficient maritime networks enhancing ports' productivity, operations and tariffs.
- Trade flows, imbalances, volume and type of cargo has a direct impact on pricing systems' arrangements. So, when trade imbalances occur, the imports exceed the exports in the country and the lower freight rates become for the exports. Trade flows also depend on market structures and greater imbalance of it reflect on pricing.
- The structure of maritime industry competition and supply regulation play an important role as well in the pricing strategies of the Egyptian ports as any barrier to free competition and any monopoly attempt will impact the pricing structure.
- The ships' operating costs and the freight rate fluctuation impact pricing systems as the carrier can anchor the ship but does not offer the transport service and here comes the deficiency of some Egyptian ports' superstructures.
- The shipped product, volume of shipment, trade facilitation, insurance cost and timely delivery are also crucial factors that are considered challenges to the pricing systems in Egyptian ports.
- The continuing trend towards more connectivity within the global shipping network including automation and technology innovation led the port industry itself to become capital intensive in both cargo handling equipment and port infrastructure.

The multi-pricing structures reflect the fact of the complexity of ports 'services regarding operations; functioning; funding; and competitiveness. These variables increased in recent times in consequence of strong competition between alternatives as supply chain in trade and transport, the movement of cargo transport off the congested roads to sea and rail and the high infrastructure cost of ports, (*Haralambides, 2002*). Moreover, the challenges facing the Egyptian ports would reflect the introduction of globally massive new container vessels that are invading the industry with excess capacity and the efforts of the Egyptian government to face such innovation. The emerging market logistics and the digital freight machinery are also an update of both managerial and technological agility invading the sector, which require a deeper look around the pricing policies used by the Egyptian government in this sector.

The interconnectivity and global openness remain two of the structuring and determining features of the modern world, which have brought considerable benefits to much of the global population and reflected on the Egyptian Economy. Although, growing global economic integration has facilitated productivity gains and their diffusion, global economic growth, the integration of emerging economies in global markets and the lifting out of poverty of hundreds of millions of people, the technological advances and innovation are not in parallel with the development of Egyptian ports as more digital network need to be allocated.

4.2 Conceptual recommendations

For the Egyptian ports to approach the competitive advantages, they have to achieve improvements for several areas which shall include the enhancing of the quality of services for the harbors and an improvement of the quality of the human capital. It is crucial also for the Egyptian government to encourage the participation of the private sector in rendering the maritime services. The improvement of the administrative system is a must in order to curb the implications of the regulations and to motivate the service performance inside the harbor. A revisit of the system of the pricing of the services in the Egyptian ports is crucial; the system of pricing needs to be flexible and competitive specially the maritime services. The instability of pricing policy in Egyptian ports doesn't allow them to attract a market international share of the transit trade, and the typology indicators for this phenomena is mainly due to lack of transparency for exchange information and lack of specialized management. Moreover, the resilience of the Egyptian Economy is under threats and challenges: these include increasing ambitions to tackle existing and emerging vulnerabilities, notably, in supply chains; climate change, and a range of security threats, including those arising from the digital transformation, which is both an emerging source of risk while also offering new solutions to increase adaptability and innovation for resilience. It is also noteworthy that countries are increasingly using economic levers for national security purposes. Building resilient economy requires a systemic approach to a diverse range of known and unknown risks, to hold an agile pricing system to face adversities. There is a need to understand those sources of vulnerability creating challenge, invest in risk management and strengthen international co-operation to build economic resilience against those severe global disruptions.

5. METHODOLOGY:

The methodology used is in this research tried to bridge several gaps of analysis through experiential learning. The focus of the pillars in this study is through content analysis as the researchers try to explore textual data with a view to group together similar types of ideas drawing from the considerable literature on ports in hand and on the content analysis of qualitative research data. Several interviews with Maritime agents and practitioners were open ended questions where the researchers noted phrases and words that summarize the passage of data. These words and phrases accounted for the data selection and grouped together then were reduced to cross cut repetition. These in turn produced list of ideas and headings that accounted for most of the data in this study. A theory is not yet emerged from the categorization of data; however, this conceptual study is an open venue for more fields of research accounting for the current challenges.

6. GAP ANALYSIS:

- The questions that are imposed at this crucial time presented a challenge to the pricing systems regulations worldwide because of the post COVID-19 and they can be research topics for future empirical studies. Such challenges are the type of constraints that will be foreseen in freight markets, the disruption caused to global logistics that might result in fundamental changes to the industry and labor services till the end of 2023 and last but not least the global logistics impacting price increase in the aftermath of COVID-19.
- Very few Literature since 2016 and the rising of the two governmental decrees by the Egyptian authority had tackled the pricing systems especially for the Egyptian ports.
- The competitive edge of this research is bringing upfront the idea of agile policies for pricing systems under the lime light given the limitations in literature related to the Egyptian ports.
- As 2.2% of Egyptian GDP comes from the Blue Economy where sea trade is a crucial part, the question here at the dawn of the Ukraine –Russian crisis is what are the implications of the pricing policies and strategies worldwide?

6. CONCLUSION

No two seaports are physically and economically the same as not two economic crises are the same in challenges and repercussions reflected on the whole maritime sector. Therefore, each economic or pricing analysis should start from the port as a physical entity, taking into account the various activities and the competition with other ports. The Port fees and port services dues for the Egyptian Ports are set by ministerial decrees (decree n# 800 for 2016), regardless of the actual costs and the quality of the provided services.

Although competitive charges have to be set by the Egyptian ports as an essential pre-requisite for competition and efficient management, sometimes there is a clear failure in its achievement which weakens the pricing systems settings and results in extreme rigidity. In this research we do propose a set of questions that given the facts highlighted in the paper concerning the principles and determinants of pricing at ports, does the Port-pricing mechanism maximize the utilization of assets? Does the pricing system of the Egyptian ports account for the interests of the different players in the industry? Do the pricing policies reflect the interests of both the ship-owners and the cargo owners?

While several reports and studies had questioned the logic behind such inefficiency in the of system of pricing for the Egyptian ports, the system had remained in place. Such rigidity in terms of price setting has decreased intra-port competition as well as inter-port competition between different terminals and among firms performing in the port and it reduced the transit-shipment activities at some ports. Rethinking the New Normal economic ways of doing business internationally with a wider scope of Building HR Maritime capacity of handling cargoes, goods and services inside the Egyptian ports while maintaining a stable pricing policy is needed within the scope of research. Reinforcing the capacity of the economic system as well to withstand or absorb a variety of shocks and to adapt or transform itself to bounce forward during the recovery helps in adapting to more agile pricing systems.

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"Industrial and Marine Engineering Innovations to Promote

Blue Economy "

CIRCULARITY OF BULKY WASTE: A CASE STUDY OF KRŠKO IN SLOVENIA

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1. ABSTRACT: Since waste is recognized as an excellent alternative for fresh raw materials substitution, the economy and society are striving for efficiently utilization of different waste fractions. Also bulky waste. To increase and accelerate the utilization of bulky waste the Circular Process Model (CPM) has been designed and applied in case study of Krško, Slovenia. The Material Flow Analysis (MFA) method was used to determine the quality and quantity of bulky waste which can be used at the highest levels of the waste management: 7 % of material was reused for the same or another purpose, 59 % recycled and 34 % energy generated. Besides, the Life Cycle Assessment (LCA) was applied to assess the different processes investigated. The LCA showed recovery has the greatest Global Warming Potential (GWP) impact among almost all of the processes considered. Using both MFA and LCA demonstrated valuing quality over quantity in bulky waste management can drastically reduce the effects of GWP.

2. INTRODUCTION

Since the early 1970s onwards, science has been warning policymakers and the rest of the public in lack of fresh raw materials and the need to use alternatives (Ashby, 2021). Recent academic studies have shown significant conservation of virgin materials if the recycled are used. This is also in close connection with reduction of environmental impacts. Meanwhile policymakers adopted many directives (EC, 2018a) and legislative incentives (EC 2012, 2018b, 2020) to accelerate the use of alternative resources and the transition from linear to circular economic flow which embodies strategy for slow, narrow and close resource loops (Bocken et al., 2016).

The concept of a circular economy is illustrated as a closed butterfly diagram, which includes both a technical and a biological part, and presenting the value circle for endlessly fluxing substances (EMF, 2013). Contemporary studies have presented many different definitions of the circular economy or circularity, respectively (Geissdoerfer et al., 2017, 2018; Korhonen et al, 2017; Kirchherr et al., 2017; Merli et al., 2018; Su et al., 2021; Hull et al., 2021; Upadhyay et al., 2021). If we summarize, circular economy aims to rationalize the use of raw materials and energy resources, limit the formation of waste and to ensure the best appropriate waste recovery, with respect to five-step waste hierarchy and waste quality. Despite the good results in theory, we are today in practice still witnessing a number of economic systems using material and energy flows linearly (raw material → product → waste) and destroying biogeochemical processes in the ecosystem. In this context, we can also include the management of bulky waste.

Bulky waste is a technical term taken from waste management to describe waste types that are too large to be accepted by the regular waste collection. It represents a variety of discarded items, e.g. furniture, sporting and children's goods, sanitary elements, mattresses, waste electric and electronic equipment (WEEE) etc., made from different long–lasting materials, e.g. polymers, ceramics, wood, metals etc., that leave the use process at the consumer after a functional or desirability life. The quantities of bulky waste in Slovenia are rising rapidly and have in the year 2019 reached 55,000 tons. Nevertheless, the collection and sorting of bulky waste usually remains unchanged in Slovenia or in the other countries of the European Union (EU).

Bulky waste is generally being collected from the streets or pavements of the area once or twice annually free of charge and sorted in two groups, e.g. hazardous and non hazardous. Regardless of the fact that EU adopted hierarchy of waste management in 2008 (EC, 2008), in practice bulky waste sorting according to quality is usually still neglected**.** Due to the inconsistent collection and inadequate sorting of bulky waste, large quantities are still being deposited in landfills, illegal dumpings in nature, burned in domestic fireplaces or incinerated without energy production. While the disposal of bulky waste is associated with methane emissions and the occupation of valuable land, the (un)controlled burning of bulky waste, especially wood, may result in pollution of the atmosphere by carcinogenic organic and inorganic aerosols more commonly known as PM10 and PM2,5 (Nava et al., 2015) and increased NOx (Risholm–Sundman & Vestin, 2005; Cichy & Pradzynski, 2007). Furthermore, such inconsistent management leads to carbon loss, which is stored in wood products (Kitek Kuzman & Kuntar). Unfortunately, that does not lead to mitigating climate changes which are mentioned in the EU acts for sustainable or circular development. Due to the fact that the existing methods of bulky waste management do not provide grounds for the circular economy, it is necessary to prepare a suitable model and its environmentally evaluation.

One of the best techniques that has been adopted to assess environmental impacts in circular economy is Life Cycle Assessment (LCA). The LCA is a scientific tool for the methodical and objective evaluation of all the essential influences that a product or a service has on the environment within its life cycle. It is devoted to the comparison of various products with few sequential steps: (1) goal and scope definition, (2) life cycle inventory analysis (LCI), (3) life cycle impact assessment (LCIA), and (4) interpretation, compliant with ISO 14040/44 standards (ISO, 2006a,b).

The observed literature has shown that joining of LCA and circular economy can result in more comprehensive investigation and better understanding of sustainability in waste management, e.g. bulky waste management (Samson–Brek et al., 2019), construction and demolition waste (Zanni et al, 2018; Abouhamad & Abu–Hamd, 2021), tire end–of–life management (Lonca et al., 2018), electric and electronic equipment (André et al., 2019; Jaunich et al., 2020), waste wood cascading (Faraca et al., 2019, Riise et al., 2017). Previusly studies was focused more on the technology of grinding bulky waste using a water jet by the Ecofrag company and assessing environmental impacts applying LCA (Samson-Brek et al., 2019), comparison of global warming potential (GWP) of wood waste management based on quality (Faraca et al., 2019) or establishing holistic framework to systematically estimating life–cycle impacts and costs associated with WEEE management (Jaunich et al., 2020).

Therefore the objective of this contribution is to fill the missing research gaps and present Circular Process Model (CPM) of bulky waste. In this work we will: (1) display waste management processes of bulky waste, (2) investigate material quality, quantity and composition using material flow analysis (MFA), (3) implement environmental assessment employing LCA, (4) perform case study of Krško in Slovenia.

3. METHODS

3.1 Defining the process model and methods for evaluation

The CPM considered: (1) collection orders and appropriateness for reuse, (2) collection and transportation, (3) sorting based on resource quality into different classes, (4) recovery based on resource quality and customer preferences, (5) marketing and sales.

Online bulky waste collection orders 24/7 of waste holders were used. The waste holders provide their personal data, and information about the type of waste, estimated quantity and quality (reusability). Bulky waste was collected using a door–to–door system and transported to recycling centres for all online waste collection orders or else transported by waste holders using their own vehicle.

The goal of sorting all discarded products is to achieve the highest possible quantities taking into account the quality and type of material thus enabling cascading based on the highest possible resource value. In line with the state-of-the art literature, we designed an innovative (cascading) sorting system (Vimpolšek et al., 2022) which follows: (1) primary inspection: classification by quality (excellent, good, average or poor), (2) secondary inspection: classification based on the type of material (furniture, WEEE, sanitary elements, sports and children's goods). Quality and material classification enable work and prolong the lifespan of different discarded products which can store carbon (wood based products), minimize the wastages and improve the sustainability.

Properly sorted material was classified into the appropriate form of recovery: (1) excellent -> preparing for reuse for the same purpose (PRSP), (2) good -> preparing for reuse for another purpose (PRAP), (3) average -> recycling (REC), (4) poor -> energy generation (ENG).

All items collected and repaired were photographed and displayed on company's official website.

Moreover, because there are significant benefits if circular models are also proper evaluated (Mannan & Al–Ghamdi, 2022), the MFA (Brunner & Rechberger, 2004) and the LCA (EC–JRC, 2010) was used. MFA is an analytical method to quantify flows and stocks of materials or substances in a well-defined system. It is an important tool to study the circular economy and to devise material flow management. In this research firstly, bulky waste quantity recording using the MFA method, which represents the material flow through entire waste management, taking into account mass (kg), volume (m^3), proportions (%), resource quality, and main material composition (more than 50% – e.g. wood, polymers, metals, etc.) was employed. Mileage of vehicles was also recorded. Secondly, the LCA using ISO methodology (ISO 2006a,b) for evaluating CPM considered was applied. The selected environmental impact was GWP. Modelling was performed in Microsoft Excel ® using Ashby (2021) database. The basis for proper calculation of environmental impacts was performed by the MFA. The combining LCA and MFA allows for both, planning bulky waste management flow and assessing environmental impacts of CPM.

Sorting time or costs were out of the scope. Besides, collection orders, marketing and sales processes were not environmentally evaluated.

3.2 Case study

Case study was performed in Krško, Slovenia during the European Week for Waste Reduction (EWWR 2021) which took place at the public service provider company Kostak between 22 and 26 November 2021. The company carries out the public service of municipal waste collection in municipalities Krško and Kostanjevica na Krki, at 345 km^2, supplying 11,000 households and collecting about 11,500 tons of waste annually. It also provides sorting and recovery processes for bulky and other waste streams. The company very well cooperate with Knof social company (so.c.) which is responsible for the realisation of the circular economy in the Posavje and Dolenjska regions with its four Reuse Boutiques. Between 10 and 15 tons of materials, mostly furniture, textiles and electronic equipment, are collected, sold or donated to needy families annually by Knof and Kostak. Processes 1–3 were carried out by the Kostak (also process 4, if the material quality was not well preserved), and processes 4–5 in cooperation with the partner Knof so.c. (see Chapter Defining the process model and methods for its evaluation).

4 RESULTS

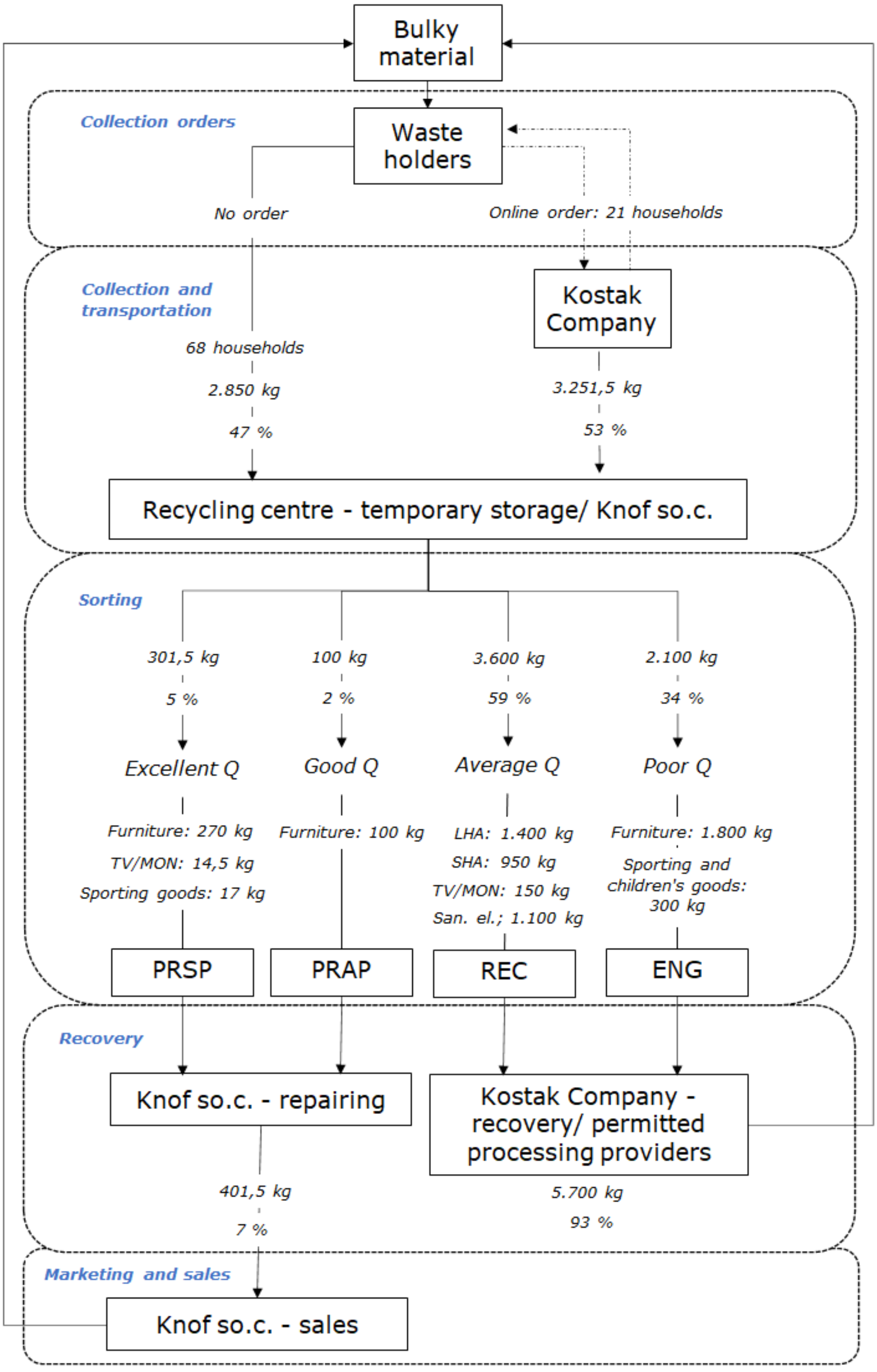
The total amount of collected bulky waste during EWWR 2021 was 71 m^3 or 6,101.5 kg. Of that, 36 m^3 was transported by Kostak (21 households) and 35 m^3 was transported by the waste owners themselves (68 households). Data on weight was gained by weighing and volume by measurement. This was folowed by properly material sorting and classification into the appropriate form of recovery. The material intended for PRSP included mainly excellently preserved types of materials, which were returned to the market after repair and cleaning (301.5 kg of weight and 5.91 m^3 of volume) (Fig 1, Fi. 2). To PRAP, we allocated partially damaged and refurbishment needed material (100 kg of weight and of 1.2 m^3 of volume). The materials directed for PRAP acquired a different function to their original purpose (Fig. 2, Fig. 3). According to material properties and wishes of our customer preferences (e.g. colour and purpose of use), this was very innovative rework. For REC, the recovered material was of average quality (3,600 kg of weight and 41 m^3 of volume) and in ENG material with calorific value, poor quality (2,100 kg, 22.89 m^3 of volume), both mechanically damaged and unsuitable for reuse (Fig. 2). The largest amount of material was furniture, followed by LHA, sanitary elements, sporting and childern's goods and TV/MON (Fig. 4a). The main material composition of bulky waste (>50 %) was metal (41 %), followed by wood (35 %), ceramics (18 %) and polymer based products (6 %) (Fig. 4b). All items collected and repaired were photographed and displayed on Knof's official website. The products were sold or donated to assist families in need. CPM and MFA are presented in Fig 2.

Fig. 1: Furniture repairs, Knof so.c.

(a) Preparation of materials

(b) Renovated kitchen chairs

Fig. 2: Circular Process Model and material flow of bulky waste



Notes:

Information flow= *Material flow=*
Processes boudaries= *TV/MON=televisions and monitors, LHA=large household appliances, SHA=small household appliances*

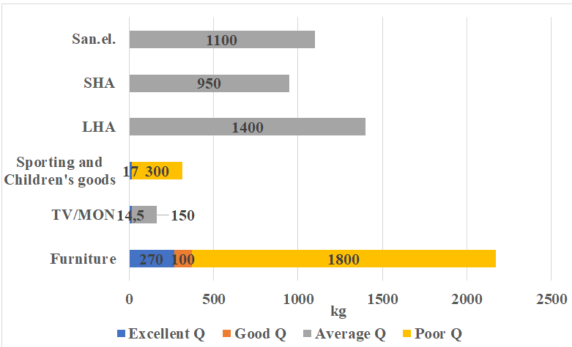
Fig. 3: Materials reused for another purpose at Knof so.c.

(a) The door became a dining table

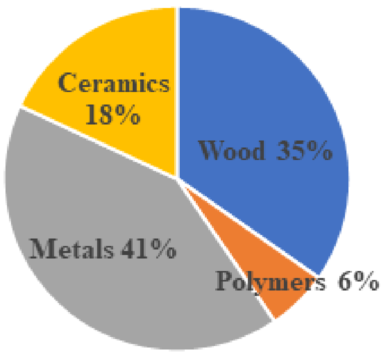
(b) The bedroom wardrobe became a writing nook

Fig 4: Bulky waste management flow

(a) Weight according to quality



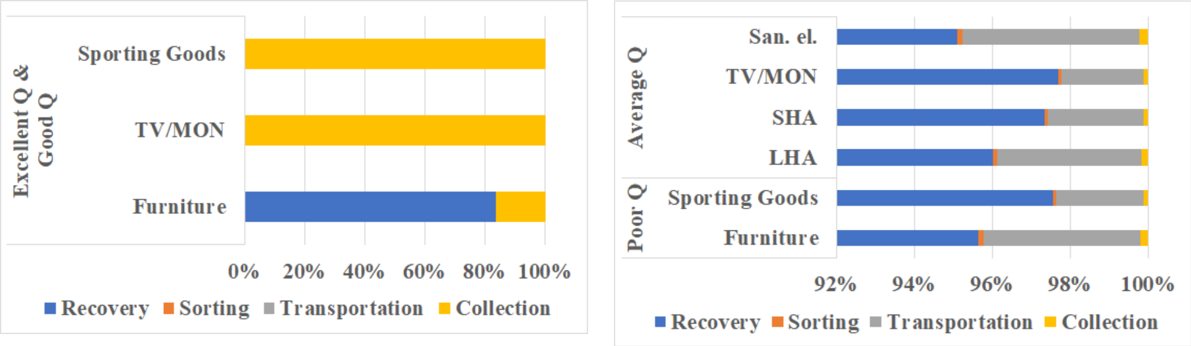
(b) Proportions of main material compositions (>50 %)



All forms of CPM were environmentally assessed (except collection orders and marketing and sales), namely collection, transportation, sorting and recovery. The selected environmental impact was GWP. Excellent and good quality of material was intended to satisfy PRSP and PRAP. While Sporting goods and TV/MON of this waste flow don't need repairing process, furniture was renovated. Consequently, the impacts of the former on environment is only collection, of the letter is also recovery (renovation). GWP is insignificant in both recovery forms (Fig. 5a). Recovery process in average and poorly perserved material had the greatest impact on the GWP effect: from 95 % for recycling of sanitary elements to 97,7 % for recycling of TV/monitors. This was followed by transportation (2-4 %). Collection and sorting have minor GWP effects on environment (Fig. 5b).

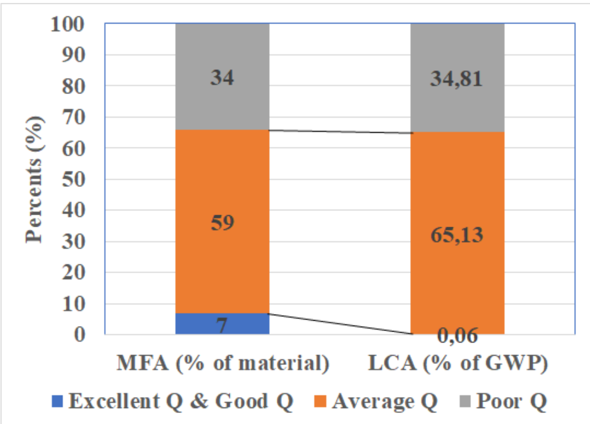
Fig. 5: Environmental impacts of CPM

(a) GWP of excellent and well preserved materials (b) GWP of average and poor preserved material



An insight into the comparison of the recovery process results reveals 7 % of excellent and well preserved bulky waste produce only 0,06 % of total GWP, 34 % of poorly preserved material contribute 34,81 to GWP and 59 % of average preserved bulky waste provide 65,13 % of GWP. Using both MFA and LCA demonstrated excellent and well quality preserved bulky waste intended for reuse can drastically reduce the effect of GWP (Fig. 6).

Fig. 6: Comparison of the results obtained in recovery process based on resource quality



5. CONCLUSION

Due to increasing amounts of waste fractions, waste management is attracting significant attention. Circular economy, which provided for a transition from linear to circular economy flow, is theoretically very well defined, but in practice proper waste management strategies and models are still lacking. Consequently, quality materials are often lost. Public service providers collecting municipal waste do not make sufficient use online collection orders or sorting of the materials based on quality, which accelerates and enables the circularity of materials. Both could also lower the company's operating costs and employ people with disabilities. To this end, CPM that connects and realises the circularity and cascading use of bulky waste materials has been designed. Moreover, the scientific methods MFA, which quantified the material flow in detail, and LCA, which illustrated the effects resulting from processes, have been applied. First, by creating CPM, we have shown that the perception of waste holders is very subjective and that the objective lifespan of material is neglected (physical, functional, technical, etc.). Second, by implementing CPM, MFA and LCA, we wanted to prove that the circularity of material is necessary. A significant amount of material were reused (PRSP & PRAP 7 %) or recycled (REC 59 %) and large amount of primary raw materials were preserved. Bulky waste sorting system also showed valuing quality over quantity can drastically reduce the effects of GWP in recovery process.

Hence, waste hierarchy is completely justified and should be more respected. Finally, we tried to encourage other public service providers and processors to improve their implement of the waste hierarchy and systematic waste management.

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Impact of Oil and Gas Exploration on Marine Environment and Activities in Red Sea

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Keywords: Seismic Survey, Acoustic Energy, Marine Mammals, Mitigation Measures, Vessel's Traffic, Fisheries, Egyptian Law.

1. ABSTRACT: Development in Oil and Gas industry in Egypt went a step forward recently, and in order to have a new oilfield, the exploration operation is a must. The author focused on different types of seismic survey as the latest technology used in the Oil and Gas exploration, which has been specified with evidence for the newly confirmed agreements between the Egyptian government and the international exploration companies targeted the Red Sea as a fresh exploration area. Furthermore, the environmental impact from the sound energy used in the seismic survey has been explained and the types of marine mammals living in the Red Sea affected has been identified among other creatures. Mitigation measures towards protecting our marine mammals has been proposed. Moreover, the seismic survey vessel with her extended gear would affect many marine activities such as vessel's traffic and fishing boats in the area of operation. The author studied the routes might be affected by the seismic operation for the Easterly seismic blocks in the red sea and proposed procedures to avoid any risk with the steaming vessels in this area and proposing also some solutions to avoid any harm could occur to the fishing activities. Finally, the author concluded that the Environmental law in Egypt should have an article to identify specially the impact of the seismic operation on marine environment and to include brief description for the procedures which should be followed to avoid any consequences might arise.

2. INTRODUCTION

The industry for the Oil and Gas offshore is considered as an important factor in the blue economy. It had many processes in place before achieving the final product.

It started with the exploration which leaded to drilling in order to have a reservoir and finally the product should be either exported as a row or enter the refining process before exporting or used locally. Each process stated above had an impact on the marine environment and the different marine activities within the affected operational areas.

In this research paper the author is intended to focus on the Seismic Survey as a mean of exploration and is aiming to find its impact on the marine environment and the different marine activities in the red sea in Egypt.

The importance of this paper is to advise the authorities to have some extra measures to ensure the safety of navigation in the red sea in line with the seismic survey operation in this area in addition to the care about the environment and the fisheries activities in the red sea.

The paper consists of different sections, first it identified the exploration area in the red sea in Egypt, followed by an explanation for the seismic survey, then the author identified the environmental impact with procedures and vessels traffic and fisheries activities followed by the suggested measures to reduce the impacts from the seismic activities.

3. EXPLORING AREAS

Governments should assign the exploring areas in their offshore waters as blocks with agreed dimensions. Blocks should be opened for a tender to the oil and gas companies. The bid should be awarded to the best proposing company and the award should be mainly related to the accepted percentage of share for the expected product from the reservoir in-between the contracted government and the awarded oil and gas company.

In the red sea in Egypt, the government of Egypt for instance identified in 2018 ten new blocks with an area of 30,000 square Kilometers and the government was planning to make a Two-Dimensional (2 D) survey for all of them before releasing them for a tender in order to have as an initial data to help the oil and gas companies to identify the target of their production, Figure 1 identifies the ten blocks in the red sea (Schlumberger, 2019).

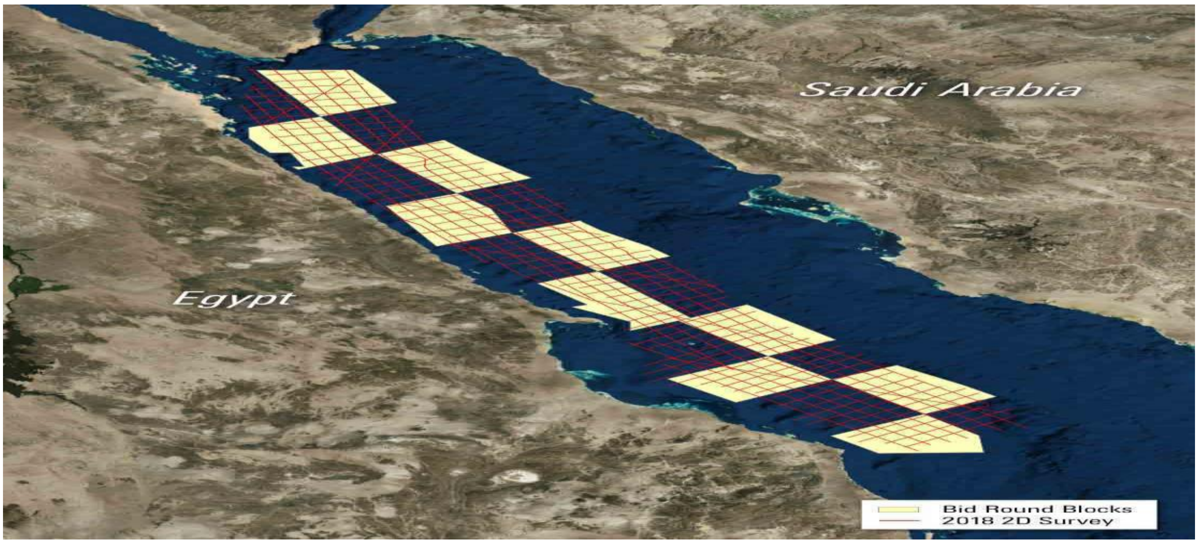

Figure 1 : Blocks in The Red Sea
Source:(Schlumberger, 2019)

4. SEISMIC SURVEY

Marine seismic survey uses the acoustic energy to understand the seabed from its geological point of view. Seismic survey vessels use air guns to produce pulses of high-energy which penetrates the seabed and then the echo should be reflected back to the surface of the water where the hydrophones receive the echoes and by using the reflected data, the geological maps below the seabed should be developed (CAPP, 2016).

4.1 Types of Seismic Survey

There are different types of marine seismic surveys including;

- ***Two Dimensional 2-D Surveys***

Uses one source of the acoustic energy in addition to one receiver.

- ***Three Dimensional (3-D) Surveys***

Air guns are used as transmitters and hydrophones are used as receivers in order to have a more detailed picture for the geological nature of the sea bed.

- ***Four Dimensional (4-D) Surveys***

It is the multiplication of the 3-D survey with a comparison between the geological changes happened in a certain area over a certain period of time and the time in the 4-D is considered as the fourth dimension (CAPP, 2016).

5. ENVIRONMENTAL IMPACT

The speed of the sound under the water surface moves five times faster than its movement in the atmosphere and this movement is accompanied by a great coverage (Sabine ,2019). As a result, sound is used by many marine organisms to communicate, navigate and find food (Compton et al, 2008). Consequently, the presence of the seismic survey activity with the existence of the powerful air guns should definitely had an impact on the marine creatures. (Russell, 2018). And in particular; the marine mammals (Abdulla & Linden, 2018).

Unfortunately, the seismic surveys might extend for months in a certain area (Abdulla & Linden, 2018). Specially, if the survey area consisted of many blocks and they are close to each other's same as the case for the ten blocks in the red sea of Egypt. For Instance, The Company PXGEO should be involved for a 3 D project in the Egyptian Red Sea for a period of four month starting from November 2021 (Energy Egypt, 2019). In Addition, The Company TGS announced on 29th of October 2021 the awarding of a 3D project in the red sea for an area of 6800 square Kilometers (TGS, 2021).

As shown in figure 2 below gives an example for a seismic survey vessel operating with a length of a spread with a 12 km length and with a 700 m breadth.

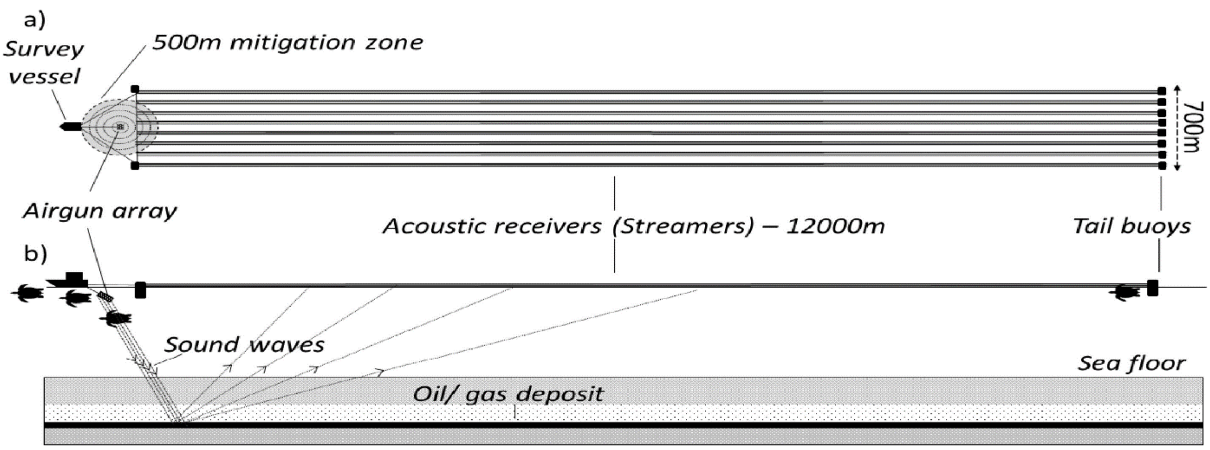

Figure 2: Seismic Survey Spread
Source: (ARS, 2021)

The biggest seismic spread for a seismic vessel was recorded in the world is the spread towed by the seismic survey vessel Ramform Hyperion with 18 streamers towed and each one was with a length of 8025 meters with an achieved a world record for 144.45 km streamers towed behind a vessel (Habibic, 2021).

6. TYPES OF MARINE MAMMALS MIGHT BE AFFECTED BY THE SEISMIC SURVEY IN THE RED SEA

Table 1 identifies the type of species in the red sea that could be affected by the acoustic energy of the seismic survey.

Table 1. Marine Mammals in The Red Sea

Species	In English	Occurrence	Notes
Balaenoptera Edeni	Bryde's Whale	possibly regular	
Megaptera novaeangliae	Hump Back Whale	rare	
Orcinus orca	Killer Whale	rare Records	limited to the southern Red Sea
Pseudorca crassidens	False Killer Whale	regular	
Globicephala macrorhynchus	Short Finned Pilot Whale	rare	
Grampus griseus	Risso's Dolphins	regular	

Tursiops aduncus	India Pacific Bottlenose Dolphins	regular	
Tursiops truncatus	Common Bottlenose Dolphins	regular	
Sousa plumbea	Indian Pacific Humpback Dolphins	regular	
Delphinus capensis tropicalis	Indian Ocean common dolphin	possibly regular	Records Limited to the southern red sea
Stenella attenuata	Pantropical Spotted Dolphin	regular	

Source: (Giuseppe et al, 2014)

As shown in Table 1, the red sea had a number of 13 species who are marine mammals and could be affected by seismic survey noise.

Furthermore, the turtles should be also considered about as a spicy which might be affected by the noise from the seismic survey and should be included in the mitigation measures in order to avoid consequences from the seismic surveys (Nelms et al, 2016).

7. SEISMIC SURVEY CONSTRAINTS

The number of the countries allowed the exploration for the Oil and Gas in their economical water are 50 countries including Egypt (Nelms et al, 2016).

Soft Start means the gradual increase in emitted sound levels from an air gun array by systematically turning on the full complement of an array's air guns over a period of time. In addition, the objective of the soft start is to get the mammals alerted from the seismic operation in order to have an enough period of time for them to evacuate the immediate vicinity before the initiation of the seismic operation. (Rodi & Herbst, 2012). In addition, Marine Mammal Observer (MMO) is required to be presented during some phases such as; pre-start and soft start, or when the source is active (Department of Conservation, 2016).

Furthermore, the marine mammal's observations should take place from the highest platform on board the vessel by a trained mammal observer during the pre-watch and the soft start periods; and preferably during all daylight hours and in case any species has been spotted, it should be reported in a complete and accurate report in an acceptable time frame (GHFS, 2015).

Finally, there are 500 m exclusive zone and no mammal should go inside this exclusive zoon during the operation of the air guns which could be monitored and tracked only via visual observations and the soft start should be initiated using the smallest gun and the seismic crew should then increase the number of the air guns gradually in a period between 20 minutes and not more than 40 minutes and if a marine mammal entered the exclusive zone. Then, the seismic vessel had two options, either to get all the guns to stop immediately. and the vessel needs after that a 30-minute mammals watch which should be done by a qualified marine mammals observer for the seismic area before the soft-start being triggered again or by maintaining a minimum source level and the vessel will not be required in this case to conduct the 30-minute visual clearance for the exclusion zone before ramping back up to full output but to achieve that the seismic vessel are required to do some activities such as;

maintaining the minimum source levels during the turns before the start of the new shooting line (Rodi & Herbst, 2012).

According to the Egyptian Law number 4 for the year 1994 and its amendments for the year 2009. The oil exploration was stated in different locations within the law as in Article 1 item number 36 for the explanation of the meaning of the exploration facilities according to the Egyptian Law. Article number 39 focused on the prevention of pollution by resultant waste or debris from the exploration organizations into the air. Article number 41 focused on getting all the exploration organization to observe all legal requirements according to national and international authorities. Article number 52 preventing any national and foreign company involved in the exploration to discharge any pollutant into the territorial or economical water of Egypt and not to hurt the water environment and to follow the international conventions regarding any discharged waste and nothing was stated regarding the noise pollution and its effect towards the water species withing the Egyptian economical sector. Article 54 focused on accidental leakage from exploration and the immediate measures needed for control. Article 67 stated the exploration vessels focused on controlling the disposal of garbage. Article 96 focused on the ship's master responsibilities and liabilities for any harm and for payment of fines and expense required to correct the effect the pollution occurred.

8. MARINE ACTIVITIES AFFECTED BY THE SEISMIC SURVEY

The marine activities in the red sea which could be affected by the seismic survey operation could be the steaming vessel's traffic within the covered areas and the fisheries activities.

In the following section the author identified the risks associated with vessel's traffic and fisheries in the red sea.

8.1 Vessel's traffic in the Red Sea:

According to publication number 72 (Sailing Direction Enroute Red Sea and Persian Gulf) as shown in figure 3, it represents section 3 (The Red Sea Central passage with the traffic related to that area). In addition, figure 4 shows the red sea ship traffic for instance on 15th of November 2021. This is considered as a prove that the vessel's traffic might interfere with the locations for the Egyptian exploration blocks and specially the Easterly located 5 Blocks as identified in figure 3.

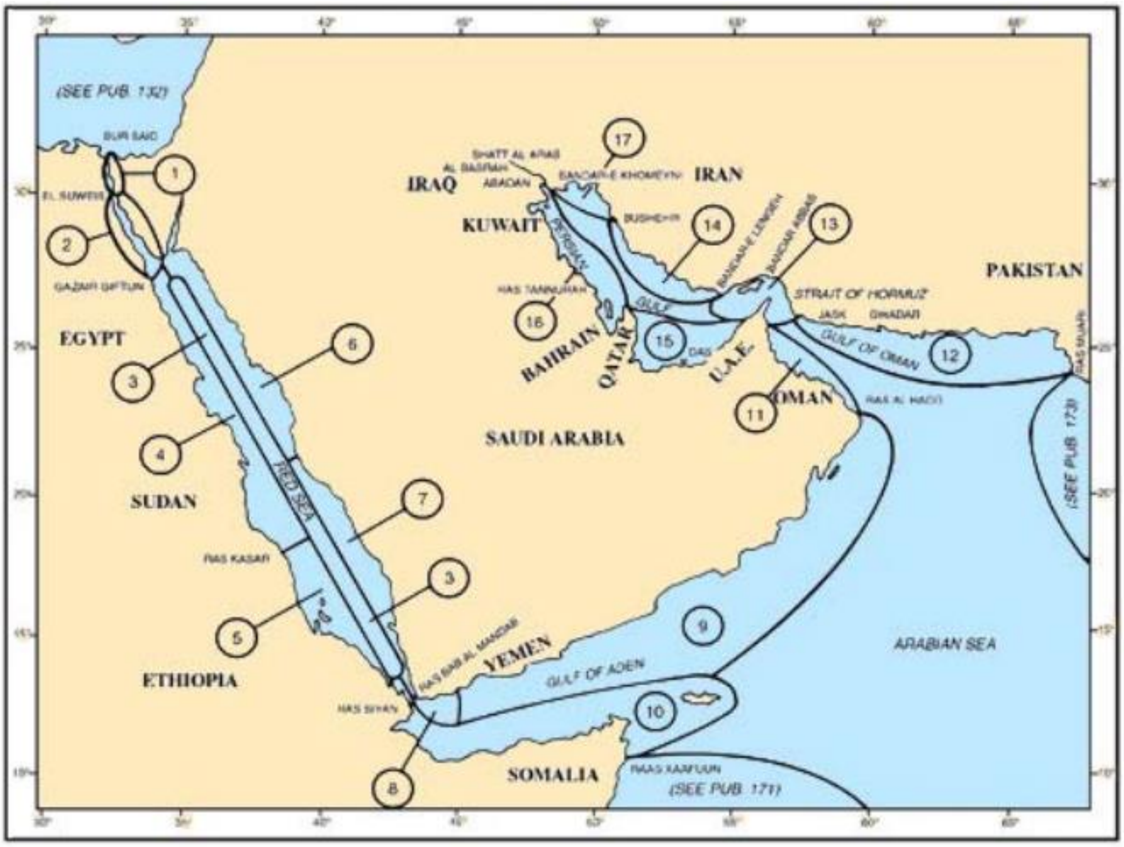

Figure 3: Routes in The Red Sea
Source: (NGIA, 2020)

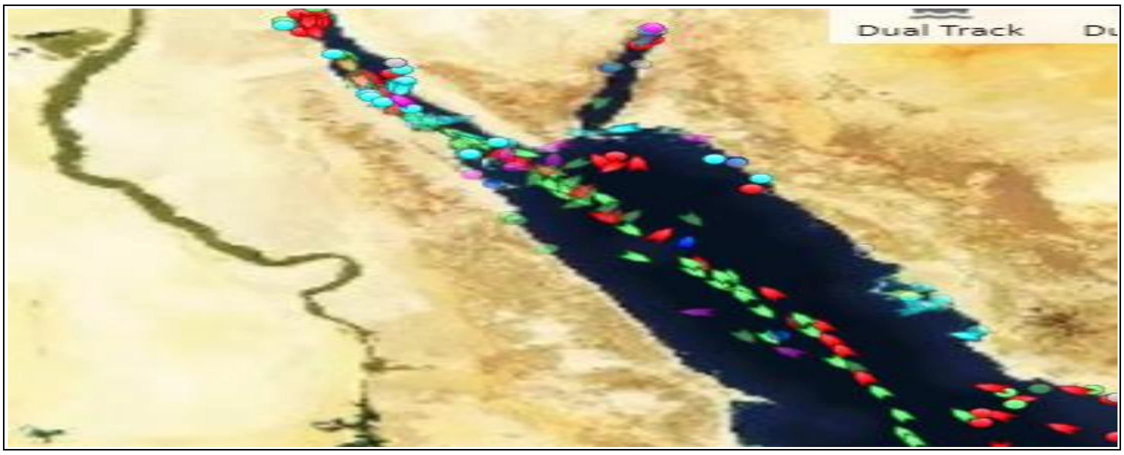

Figure 4: Vessel's Traffic in The Red Sea
Source: (Ship Traffic, 2021)

8.1.2 Seismic Survey Hazards Towards the Vessel's Traffic

The Probability of having some major hazards affecting the steaming vessels passing by the survey area such as the damage to the rudder or the propeller if they have been hit by the seismic gears or if the streamers has been tangled over the propeller. Additionally, we should not ignore the damage which could happen for the seismic gear itself and this gear is considered as high value asset for the seismic survey companies. Furthermore, collision and grounding might also occur because of the long-towed gear from a seismic survey vessel which is considered as a vessel restricted in her ability to maneuver requesting from all the steaming vessels making way through the water to alter their courses or reducing their speeds which is common and significant to marine seismic survey operations (Asuelimen, et al, 2020).

8.1.2.1 Procedures to Avoid Collision with other Vessels

In order to avoid the risk of collision for the seismic survey vessel or the seismic gears with other vessel there are some procedures should be in place (Tetra Tech, 2017).

- "Notice to Mariners" to be issued and to start broadcasting before the start of the seismic activity with enough time including the coordinates of the vessel activity.
- Traffic to be warned using the chase vessels and the support vessels.
- To have appropriate lighting and signaling means on the seismic vessel including the towed gear limits and the chase vessel to prevent the collision hazard with either the fishing vessels or cargo vessels.
- All vessels engaged in the operation should be equipped with all equipment required for the safe operation such as; radar, navigation equipment, and communication equipment to identify obstructions and to provide sufficient warning of approaching surface vessels that might cause a danger to the operations.
- The survey should be stopped in poor visibility or extreme weather conditions.
- Upon completion of the survey demobilization of the gears should be achieved as soon as possible and cancellation of the initial "Notice to Mariners" should be effective.

8.2 Fisheries of the Red Sea

Noise from the acoustic energy fired by the air guns had the possibility to make rapid changes in pressure which might cause a damage to the tissues and the organs in fish which is known as the barotrauma (Carlson, 2012).

Methods of fishing in the Red Sea are using approximately 1250 vessels in-between; (Long line, hand line, trammel nets and gill nets) and we could add to them some unregistered fishing vessels in addition to trawlers but trawlers are active only in the Gulf of Suez and the foul bay with a fleet consists of 71 trawlers and 43 purse seiners engaging in a fishing trip in between 20 and 30 days if they aimed to work abroad. Recently, twenty registered long liners in Hurghada are currently operated as trawlers and purse seiners, they are about 20 m in length and powered by 200 to 220 hp as shown in figure 5.

Figure 5: Purse seiners in Hurghada
Source: (123RF, 2022)

Figure 6, indicates the annual catch in the Red Sea by fisheries from 1995 till 2016 and counted in thousand tons.

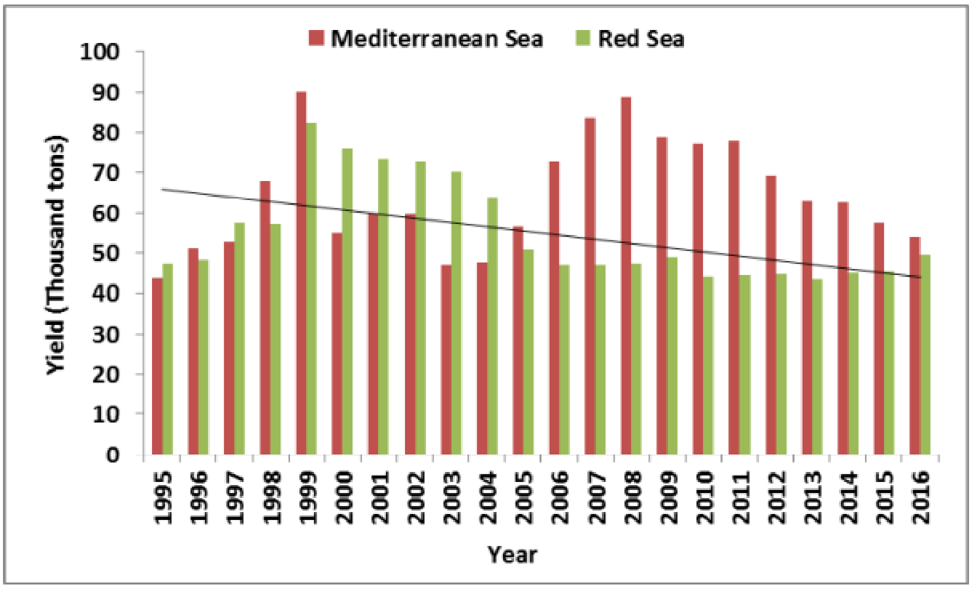

Fig 6: Annual Catch of The Mediterranean and Red Sea Fisheries
Source: (Maiyza et al, 2020)

8.2.1 Procedures for the protection of the fisheries activities in the Red Sea

Many mitigation measures should be in place to avoid the harm that might affect the fisheries activities as below (Tetra Tech, 2017)

(1) At least one month before the survey a "Notice to Mariner" should be issued regarding project activities to all affected parties.

(2) Fliers with introduction about seismic survey equipment and coordinates for the operation area should be distributed in the fishermen groups and associations.

(3) Meeting with the fishermen could be beneficial prior to the operation.

(4) Patrols should be initiated one week before the start of the seismic survey activity, and all obstructions should be removed in the survey area. All the location and information of removed fishing gear.

(5) Fishing vessels operating or passing by should be warned using the chase boats.

(6) Chase vessel with representative from the fishing communities should be employed to ensure navigational safety and appropriate management of fishing interactions.

(7) Upon completion of the survey, all equipment should be removed from the project area,

(8) Organize a complaint, problem, and suggestion receiving point for the entire project duration. Findings from complaints and suggestions shall be reported to fishermen associations.

(9) local fishing vessels should be hired and employed as chase vessel during the survey period to work inside the survey area.

9. CONCLUSION.

Seismic survey is a very important activity for the Oil and Gas industry but it has many consequences due to its effect on the steaming vessels passing by the Egyptian economical waters in the red sea and the fishing activities in the operational areas. In addition, the environmental impact from the use of the acoustic energy in the water on the marine mammals among other creatures.

On the other hand, the Egyptian environmental law including all its articles did not have a special procedure to deal with the seismic survey implications.

Therefore, this paper recommending procedures to be followed during the seismic operation related to the vessel's traffic control and fisheries activities. In addition, a recommendation to make some changes in the articles of the Egyptian Environmental law to cover the mitigation measures against the consequences of the seismic activities towards the marine mammals, fisheries and turtles.

The importance of the this paper is to achieve the exploration of the oil and gas in the Egypt but with the achievement of sustainability from the environmental point of view and economical point of view by saving the environment and issue regulations to protect the Egyptian economy related to shipping and fishing activities by following procedures already has been used in different places around the world to achieve the same target and to have a parallel track to benefice from the mine property of each country but without causing any lose in any related activity could be negatively affected from the oil and gas exploration.

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INVESTIGATING THE EFFECT OF TERMINALS'SERVICE ATTRIBUTES ON ATTRACTING SHIPPING LINES: A STATED CHOICE APPROACH

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1. ABSTRACT

Container terminals in the Mediterranean region have a high competition level between them to achieve a greater share of the regional seaborne trade volume. The national container companies in Egypt face low performance and productivity issues because liners prefer other ports/terminals in the East Mediterranean. One reason for this problem is due to policy makers' belief that spending much money on terminal infra- and super-structure is the best practice for attracting more shippers. However, terminal capital investments and yearly maintenance costs are substantial and may not be useful if other factors control port/terminal choice from a shipping company's point of view.

Recently, the Egyptian Maritime Transport Sector went through a number of new projects through the construction of quay walls, yards, and terminals in various Egyptian ports such as Alexandria, Abu Kir, and El-Sokhna in attempt to improve the available freight capacity (i.e. supply). Nevertheless, and as long as shippers insist on choosing a specific port/terminal, such new improvements may not reap their intended benefits.

This research investigates the important factors that control shipping liners decisions when selecting a container terminal by using a custom-made instrument design. Two data collection methods are used; namely, Revealed Preference (RP) and Stated Preference (SP) or Stated Choice (SC). Then, discrete choice models of terminal switching behavior will be used to help policy makers prescribe efficient strategies to alter shipping lines decisions and ensure that each port/container terminal has a fair market share. However, this paper reports only on the first part, while the latter is still work in progress.

The preliminary data analysis showed that port charges and port infrastructure are the most critical factors shipping lines look for when choosing a container terminal. As such, policy makers need to focus on these factors in attempt to promote their terminals and make them more attractive to shipping lines.

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2. INTRODUCTION

Shipping is the lifeblood of the world economy, without shipping, important intercontinental trade would not be possible. About 80% of world trade volume transported through sea (Fugazza and Hofman, 2017), which makes ports and their hinterlands vital for global trade. Ports are a central and necessary component in facilitating trade. Over the last few decades, container shipping has seen major changes. Liner shipping companies have established globally integrated networks for transporting containers as a result of alliances, mergers, and acquisitions. Trade competitiveness requires governments and key stakeholders to see ports as facilitators of trade and integrators in the logistics supply chain, rather than merely points of cargo loading/unloading.

In addition to enhancing service to shippers, globalization has led to a substantial volume of trade that helped liners to use large vessels and maximize their efficiency. As such, terminal utilization rates are expected to increase over the next few years, putting further pressure on the already congested terminals (Drewry, 2021). Handling volumes will grow by 5% per year between 2020 and 2025, resulting in increasing utilization rates from 67% to over 75%).

In principle, congestion occurs when terminal demand (i.e. cargo volume) exceeds its available capacity (i.e. supply). Other factors contributing to congestion include restricted access to seaports, routine procedures, poor hinterland connectivity, inconsistent government policies, and inability to deal with new technologies (Maneno, 2019).

It has been deeply rooted in planners' minds that spending more on terminal infra and super structure projects is the solution for ending congestion. However, terminal capital investments and yearly maintenance costs are huge and may not bring back their intended benefits. As such, the determination of the extent of integration of container terminals among themselves (horizontal integration), especially if they are owned by the same company, and within the global supply chains (vertical integration) developed as an alternative way to solve congestion (Chen, 2018).

On the one hand, introducing horizontal integration as a business management strategy can aid in keeping up with the dynamic changes of the container market and the service competition (Elsaih and Salem, 2018). Horizontal integration may serve as a solution over resorting to investing unnecessarily in infra- and super-structure, thus; reduces duplication of resources within the integrated terminals as well as lowering costs and increasing economies of scale. Furthermore, it may lead to an increase in market share or even contribute in adding new market segments which consequently increases the terminals' competitiveness (Van de Voorde and Vanelslander, 2010).

On the other hand, vertical integration between terminal operators and shipping lines, for example, increasing port capacity can result in higher market output, consumer surpluses, and fewer delays for the shipping industry. The participation of vertically integrated carriers can increase output at the expense of non-integrating competitors, but research has shown that vertically integrated ports handle a greater volume of cargo and are associated with better infrastructure and equipment utilization. (Álvarez-SanJaime, et al., 2013).

Moreover, and perhaps in the Egyptian context where terminal congestion might not be an issue, given the unprecedented expansion taking place in the supply side (i.e. terminal infra- and super-structure) nationwide, integration will help optimize terminals performance and national market share through transforming the system from a state of "Terminal Equilibrium" in which each terminal performs selfishly (i.e. work against other national terminals to maximize its individual market share on the expense of the others) to a state of "System Optimum" in which terminals deliberately perform in such a way that maximizes their collective market share regardless the fact that individual terminals might experience lower market shares than what they may attain if they perform selfishly. The main drawback in the state of Terminal Equilibrium is that the collective market share of national terminals is not maximized and, hence, the so-called Price of Anarchy is paid. On the other hand, the state of System Optimum is an efficient system-wide approach.

To contribute to this issue, this research investigates the effect of container terminal's service attributes on attracting shipping lines though a tailor-made survey to address customers' preferences and choices. Then, discrete choice models of terminal switching behavior developed to help policy makers prescribe efficient strategies to alter customer decisions and ensure that each port/container terminal has a fair market share based on the integration of existing capacity. However, this paper reports only on the first, while the latter is still work in progress.

The research focus on the national container companies operating under the supervision of the Holding Company for Maritime and Land Transport (HCMLT), following the Egyptian government, in four main ports over the Mediterranean Sea (Alexandria Port, El-Dekheila Port, Damietta Port, and Port Said Port).

The rest of this paper is presented as follows: Section 3 provides a literature review through previous studies that discussed port/terminal choice models and the factors (i.e. service attributes) that controls the choice of a specific port/terminal from the viewpoint of customers (e.g. shipping lines, cargo owners, etc.), to figure out which factors play the major role in the process. Section 4 and Section 5 discuss the methods used in this research, mainly data collection, survey instrument design, and choice modelling. Section 6 reports on survey design, implementation, and preliminary results. Finally, Section 7 concludes the work done in this paper and gives an overview of next steps.

3.LITERATURE REVIEW

A few studies are published on port competition in Latin America and Africa (Lobo, et al., 2021). Selecting a port of call by shippers and carriers, from a set of several options, is not an easy task. For ports, each element in supply chains has to achieve the highest efficiency in order to compete (Cepolina and Ghiara, 2013).

The reoccurring change in requirements and priorities created a major concern of losing customers amongst Port Authorities (PAs) (Mittal and McClung, 2016). Therefore, PAs are required to understand the factors that play have the greatest effect on the port users' selection process, to stay at the forefront (Tiwari et al., 2003). Different stakeholders that are engaged in the supply chain, are also involved in the selection of the port based on multiple factors (Martínez-Pardo et al., 2020).

The factors impacting a shipper's port choice decision were investigated by Tiwari et al. (2003). The investigation results showed that shipper's distance from the port, the number of ship calls at the port for example (the number of scheduled stops by ships, which determines the value of cargo that can be moved within that port), the efficiency of port infrastructure, and the routes counts offered at the port, have the priority over other factors.

Blonigen and Wilson (2006) developed a port choice model. The study estimated the effect of efficiency of ports, internal transport systems and transport rates through ocean the data used in this estimation were retrieved from sample data on trade volumes between United States of America ports and several foreign countries from 1991 to 2003, economical factors have the highest impact over the shippers

choices this presented and supported by strong evidence in the study. The study confirmed the importance of port's efficiency, distance and transport prices.
Through using revealed and stated preference approaches, Tongzon and Sawant (2007), determined liners port choice factors, used on South East Asia selected ports through a survey tool. They found port dues and range of port services to be highest two important factors, port location third most important, and infrastructure came fourth.

Chinonye et al. (2006) determined the characteristics that shippers consider the most while selecting a port. Based on a survey and analytic hierarchy process tool, the study prioritized the characteristics according to their importance. For the analysis, four ports were identified and seven port selection decision criteria. The study found that shippers consider efficiency, frequency of ship stay at port, and infrastructure in their decision-making process before taking into account the quick response time to port users' needs.

While useful, none of the previous studies have looked into the specificities of the Egyptian context. Egypt is located in the North East of Africa (bordered by the Mediterranean Sea to the North and the Red Sea to the East) and has the most important navigation channel in the world (The Suez Canal) that facilitates the transit of global trade. Egypt has 15 commercial ports (six overlook the Mediterranean and nine overlook the Red Sea). Furthermore, the Holding Company for Maritime and Land Transport (HCMLT) has three container and cargo handling companies operating through four container terminals in Alexandria, El-Dekheila, Damietta, and West Port Said ports. The three companies (and the ports they operate at) face numerous challenges that affect their performance. Accordingly, none of the national container terminals is among the Top 50 World Container Ports since 2011 despite the blend that Egyptian ports enjoy. In recent years, other competing ports in the East Mediterranean were among that list (e.g. Port of Piraeus in Greece and Port of Marsaxlokk in Malta).

In attempt to obtain a larger share of sea trade volume, Egyptian Maritime Transport Sector has recently gone through the construction of a number of new projects to increase the offered capacity (i.e. supply); but knowing that many factors other than the availability of capacity may affect the terminal choice behaviour of shipping lines, these projects might not achieve their intended target.

As opposed to previous studies and to ensure the optimum use of these projects, this research is concerned with the Egyptian context. An investigation of the determinants of liners' terminal choice behaviour is undertaken using a twofold approach. First, a survey instrument, mainly a Stated Choice (SC) survey, is designed and used to gather information on container terminals' service attributes (e.g. draft, crane gross moves per hour, handling fees, waiting time, etc.) and customers' (e.g. shipping lines, cargo owners, etc.) terminal choice behaviour by means of in-person interviews. Second, the collected dataset used to develop discrete choice models of terminal switching behaviour that will help:

- Understand customers' choice preferences and the trade-offs that carriers/shippers make while choosing a container terminal of call;
- Prioritize container terminals' service attributes by attaching weights to the various factors affecting terminal choice; and
- Forecast customers' choices in response to service attributes and system changes.

Eventually, the developed models will be used to identify the reasons for the low performance of the three national companies and how they could maintain advanced positions among their competitors in the Mediterranean, and among the Top 50 World Container Ports.

4. STATED CHOICE EXPERIMENT DESIGN

Developing a model for container terminal choice behaviour requires mainly freight transport demand data collection to obtain customers' (e.g. shipping lines) preferences. Generally, to quantify customers' tendencies two data collection methods may be used: (1) Revealed Preference (RP) and (2) Stated Preference (SP) or Stated Choice (SC) (Ben-Akiva et al. 1994). Through the information collected about actual choices made by customers, RP data can be used to estimate statistical demand models. Nevertheless, this approach to data collection and modelling has a limited ability to analyze the impact of new factors in the supply chain or freight transport system (Gunn et al. 1992). If the tested service is new or not well known by targeted shipping lines, RP survey data collection process faces difficulties (Diana 2010). In such situations, using SC experiments leads to more efficient results through using hypothetical choices/scenarios to collect the required data (Louviere et al. 2000; Arasan and Vedagiri 2011).

Research has shown that RP data may have substantial amount of noise for different reasons such as the measurement error. For example, an individual self-report of an actually made decision (e.g. a choice) is likely to be uncertain. The method uncertainty probably increases as the time between the actual choice and the report of that choice increases. On the other hand, SC experiments are usually generated by some systematic and planned design process in which the attributes and their levels are pre-defined without measurement error and varied to create preference or choice options. Nevertheless, SC responses are stated and not actual, and hence are uncertain because individuals may not actually choose the alternatives that they select during the experiment. While, the two methods may have some potential error. Therefore, using RP and SC data may be more effective (Hensher, D.A. and J. King et al. 2001 & 2007).

This research constructed a survey tool that combines RP and SC surveys to collect information about the factors that affect liners' terminal choice decisions. The design of SC experiments, used at economics and marketing but transportation expertise found it useful to be used in transportation studies especially when it showed its efficiency in data analysis and behaviour forecasting. As a general rule, SC experiments are conducted in order to examine the independent influence of design characteristics (factors and variables) such as container terminal service characteristics on an observed outcome (e.g. terminal choice) made by a sample of liner companies undertaking the experiment (Louviere and Woodworth 1983).

In the SC experiment each respondent receives a number of choices (hypothetical scenarios) to select one or more alternatives from a set of limited options. These alternatives are defined by a number of different factors described by pre-specified factor levels that are pulled from some underlying experimental design. As a concept, experimental design can be looked at as a matrix of values showing factors levels, where the matrix columns represent choices and rows represent factors. The design factors distribution method has an impact over the determination of the independent contribution of each attribute to the observed choices. Different factors allocation may also affect the experiment statistical power and its ability to find the potential statistical relationship among the dataset (Rose and Bliemer 2009; Cooper et al. 2011).

Relating to what stated above, attribute levels allocation in the design matrix has major effect on SC experiment design. Orthogonal experimental designs in various researches used to generate the hypothetical choice tasks to collect data from respondents. To reach the non-correlation between the attributes, orthogonal designs will guarantee this purpose with its characterization of correlated structure between the attributes of the design (Louviere et al. 2000; Bliemer et al. 2008).

Additionally, the transport studies that used stated choice experiment, tested respondents' abilities to comprehend and respond to complex designs involving different alternatives, attributes, and choices. Different studies and experiments, showed that the fewer attributes and attribute levels in the design, the more convenient it is for the respondent. In most cases, model specifications determine the number of attribute levels. If a certain attribute is expected to have nonlinear effects, then it is necessary to assess it at more than two levels in order to capture these nonlinearities. However, in case of using dummy attributes, the number of levels is predetermined. Additionally, the number of attribute levels used, impacts the number of choice situations such that the more levels used, the more choices are available. Mixing levels for different attributes is not a good practice as it may also yield a higher number of choice situations in order to maintain attribute level balance, which will lead the respondent to give a non-realistic answers, from a respondent point of view, if the survey took long time to answer respondent will feel exhausted, board and start giving random answers just to finish the experiment (Rose and Bliemer 2009).

Furthermore, experiment design efficiency can be improved through using a wider attribute level range (e.g. port dues= \$2 – \$12) having wide attribute level range is statistically preferable than having a narrow range (e.g. port dues= \$1.5 – \$2) wider range will lead to better parameter estimates (i.e. smaller asymptotic standard error). On the other hand, using extremely wide ranges would affect the choice probabilities obtained from the design because it may create choice tasks with dominated alternatives, if a too narrow attribute level range used this will results in alternatives that are largely indistinguishable from each other. Consequently, this balancing will not be an easy task on one hand, there is the statistical preference for a wide range and on the other hand, the practical limitations for narrow range that may limit the attribute range but maintaining attribute levels in a reasonable limits to the respondents, a trade-off between wide range and narrow range has to be done to reach the required attribute level balance (i.e. all attribute levels appear in the dataset in an equally manner) and to improve design efficiency. Although, achieving a balance between attribute levels may lead to sub-optimal designs, it is still desirable in such an approach. This balance between attribute levels ensures that the parameters are estimated over the whole range, rather than having only a few data points at a few levels, so that a good estimation can be made (Caussade et al. 2005; Scarpa and Rose 2008).

In light of the above, the orthogonal design is adopted in this research to develop the stated choice experiment. The Ngene software is used to generate the design that maintains the utility balance and maximizes the information gained from each hypothetical scenario.

5. MODE CHOICE MODELLING

The planners concerned with transportation field tend to use demand transportation modelling methods mostly over the years, while trying to evolve these methods by time. Unimodal used at the beginning of using models for transportation demand analysis to predict vehicular traffic. A shift happened in the late 1960s, from unimodal to multimodal approaches which take in consideration infrastructure renewal, prices for services and operational polices. Travel demand models have a phenomenal improvement since modellers start to use discrete choice models (Ben-Akiva and Lerman 1985). (Warner 1962) was the pioneer in the field of transportation planning by using discrete mode choice model for the first time to predict the behaviour of users through including binary mode choice between car and transit for a certain trip.
Measuring the levels of the satisfaction for customers dealing with container terminals utilities, a wise study for the factors that affects their choices will be required from the behalf of transportation planners to help them in the behaviour forecasting process. Random Utility Maximization (RUM) Theory state that choice strategies are vital from a customer's point of view while it is random for the planners.
Choosing a terminal decision can be demonstrated through RUM framework as the following: parameters (weight) representation for different factors related to each terminal (utility) the shipping company will face this while a shipping line have a set of available terminals (choices), This can be presented mathematically as follows:

$$V_m = ASC + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n,$$

where:
V_m : Utility associated with terminal (m)
ASC: Alternative Specific Constant
β : Parameter value
X : Explanatory variable

Finally, the shipping line selecting the terminal that achieve the higher benefits for the liner preferences, putting in their consideration the attributes and advantages of other terminals (Ben-Akiva and Bierlaire 1999). Discrete mode choice models are important well known modelling tools that give an economical evaluation for the data through predicting customer's behaviour and forecasting the travel demand for customers (Ben-Akiva and Lerman 1985). Mode choice models have been presented over many researches with different types and various mathematical formulations. Multinomial Logit (MNL) model, which is the simplest shape of RUM framework, considering error terms to be independently and Identically Distributed (IID), follows the double exponential Gumbel Type1 extreme value distribution (Ben-Akiva and Bierlaire 1999). The previous statement leads to a closed form that presenting the probability of terminal selection:

$$P_m = \frac{e^{V_m}}{\sum_{m \in C} e^{V_m}},$$

Where:
P_m : Probability of choosing terminal (m)
V_m: Utility associated with terminal (m) (m= 1, …, M)
C : Choice set of feasible alternative terminals (M)

In this research, the MNL modelling approach is used for developing models considering multiple different factors that influence liners terminal choice. These developed models will provide recommendations to help policy makers in the country.

6. SURVEY DESIGN, IMPLEMENTATION, AND PRELIMINARY RESULTS

The survey instrument designed for this investigation is composed of two parts. A Revealed Preference (RP) and a Stated Choice (SC) components were used to gather information on shipping lines container terminal choice behaviour through utilizing in-person interviews (Idris et al., 2015). In order to ensure reliable parameter estimates, a small-scale pilot survey was conducted among a group of researchers at the Maritime Research and Consultation Center (MRCC) before launching the full-fledged questionnaire to a list of 20 shipping lines that operates in the region. To date, only two major shipping lines responded to the questionnaire, while data collection is still in process. The names of the two companies will not be disclosed for confidentiality of information; however, the two lines will be referred to as the Blue Line and the Red Line throughout this study.

Part number one of the survey identified the revealed preferences of shipping lines based on their actual experiences. In specific, shipping lines were asked to rank a given list of 12 factors that attract them to a port of call (i.e. the most preferred/frequently used port by the shipping line), from the most important to the least important. This would indirectly reveal the key factors which have affecting the port choice of the liner's when they selected their ports of call. Using a similar procedure, the survey also gathered information on 13 factors that attracts shipping lines to a container terminal, as shown in Table 1.

Table 1: Factors that attract a shipping line to (a) a port of call and (b) a container terminal

Factors attracting liners to a port of call	Factors attracting liners to a container terminal
Approach channel	Berth length and draft
Guidance	Quay cranes
Towage	Terminal performance
Port information systems	Service time
Port dues	Terminal Information System (TOS)
Administrative procedures and systems	Service tariff
Waiting time	Administrative procedures and systems
Service time	Customer service
Connectivity to other ports	Terminal traffic volume
Connectivity to hinterland	Safety and security
Customs procedures	Labour/human factor
Safety and security	Connectivity to rail transport
	Marketing policy

Figure 1 depicts preliminary analysis of the factors that attract a shipping line to a port of call for each company individually. As shown, while there is a mutual agreement on the importance of some factors, such as port dues, the importance of other factors, such as safety and security, vary greatly among the two companies.

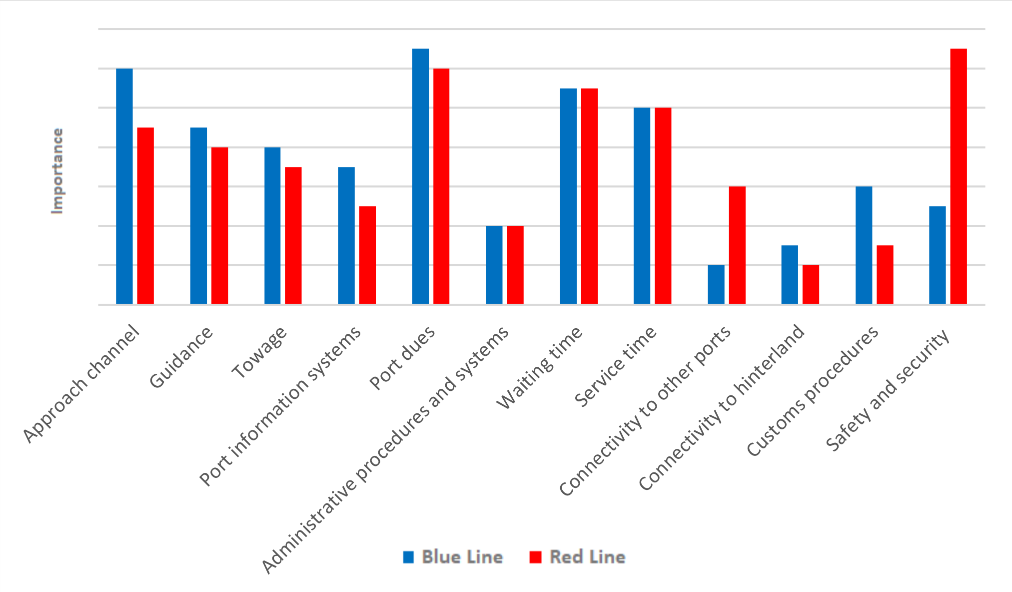

Figure 1: Factors that attract a shipping line to a port of call ranked by importance

By combining the responses of the two companies, as shown in Figure 2, port dues, waiting time, and service time are the top three important factors that attract shipping lines to a port of call. As such, policy makers should focus on improving these factors in attempt to attract shipping lines to Egyptian ports. On the other hand, the analysis showed that connectivity to hinterland is the least important factor from a shipping line's view point, which is an early indication to the way liners view Egyptian ports (being points of cargo loading and unloading rather than integral parts of the total supply chain).

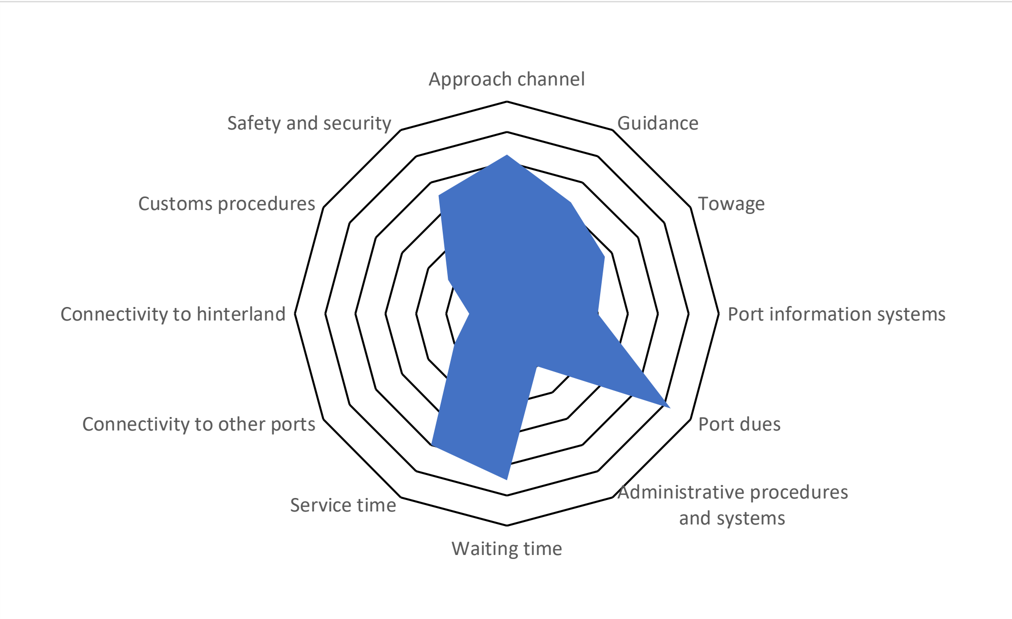

Figure 2: Factors that attract shipping lines to a port of call

Figure 3 depicts preliminary analysis of the factors that attract a shipping line to a container terminal for each company individually. As shown, while there is a mutual agreement on the importance of some factors, such as port dues, the importance of other factors, such as berth length and draft, the importance of other factors, such as connectivity to rail transport, vary among the two companies.

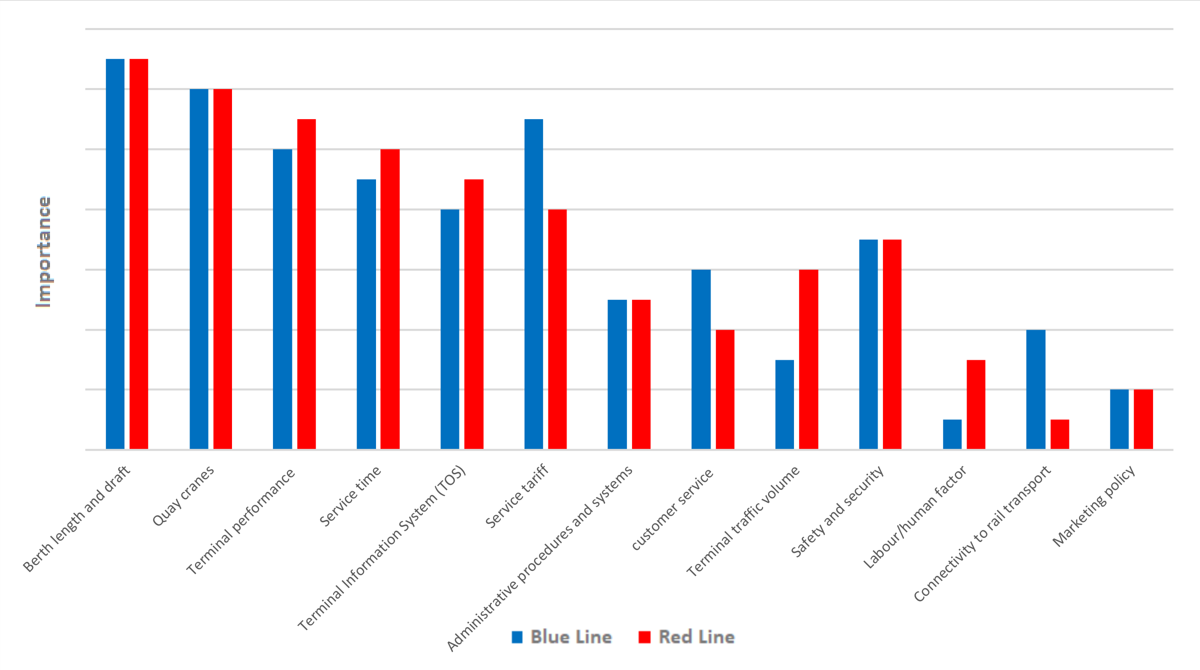

Figure 3: Factors that attract a shipping line to a container terminal ranked by importance

By combining the responses of the two companies, as shown in Figure 4, berth length and draft, quay cranes, and terminal performance are the top three important factors that attract shipping lines to a container terminal. As such, policy makers should focus on improving these factors in attempt to attract shipping lines to national container terminals. On the other hand, the analysis showed that labour/human factor is the least important factor from a shipping line's view point, which might be an early indication to the transition towards automation.

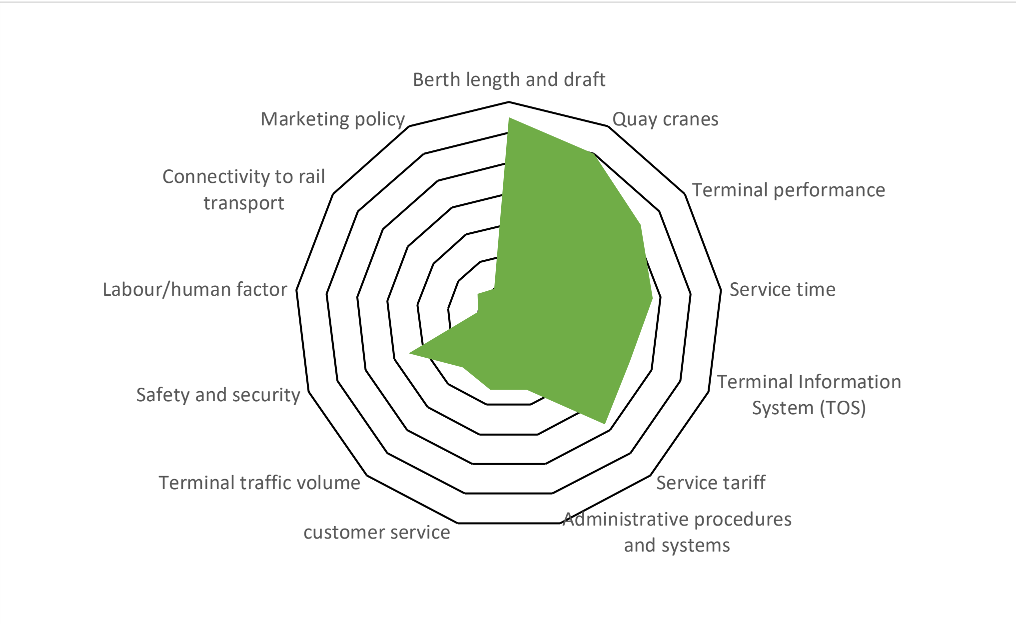

Figure 4: Factors that attract shipping lines to a container terminal

The second part of the survey identified the stated choices of shipping lines based on their response to some hypothetical scenarios characterized by a wide range of terminal operation/service properties (i.e. attributes) considered in the study as determinants of terminal choice. Terminal attribute values (i.e. levels) were changed to make different scenarios and understand which attributes affect terminal choice more. Shipping lines faced a number hypothetical terminal choice tasks (of the same operational attributes and different attribute levels) where they were asked to choose the most suitable option (i.e. container terminal) from their viewpoint.

As discussed in Section 4, research has shown that respondents have limited abilities to comprehend and respond to complex designs involving many alternatives, factors, and choices (treatments). Accordingly, the number of factors (and their levels) that are presented in the SC experiment needed to be kept at minimum to maintain a more convenient design for respondents.

Mittal and McClung (2016) identified the following list of factors that influence shipper's port choice decisions based on reviewing the literature and interviewing local shippers.

Table 2: Initial list of factors with description for each

Factor	Description
Port Infrastructure	Availability of Equipment and port facilities adequacy.
Cost/Port Charges	Delivered price and pilotage, customs, towage and costs.
Port Efficiency	Turnaround time and Facilities for cargo loading, unloading, grouping, and consolidation.
Port Congestion	Time of getting through ports and labour problems.
Cargo Volume	Total TEUs handled at the port and current volume at the port, number of sailings, average size of vessel handled at the port.
Advanced Port Management	The port has a strong health and safety management plan, environmental profile of the port.
Information Conveyance	The action or process of transmitting and communicating information from one place to another, concerning shipments, availability of technology, and communications systems.
Intermodal - Connecting Links	Sailing frequency of deep-sea and feeder shipping services (the service that transports shipping containers from different ports and brings them to a central container terminal where they are loaded to bigger vessels).
Empty Container Management	Distribution and Storage.
Quality and Reputation of Terminal Operators	Their efficiency of cargo handling, and the internal competition (the nature of competition that exists among the different terminal operators within a given port).
Port Services	On-site custom clearance, assistance in claims handling and loss, and damage performance.

While comprehensive, the above list of factors needed to be refined to keep the number of hypothetical choice tasks each survey participant face in the SC experiment between 6 to 8. Otherwise, survey participants may decline to complete the survey due to fatigue. As such, an expert opinion interview was conducted among a group of experts from the Egyptian Maritime Transport Sector (MTS) and national container and cargo handling companies to select a subset of the above list containing the six most important factors that affect liners' terminal choice. Such factors were identified as follows: Port

Infrastructure, Cost/Port Charges, Empty Container Management, Cargo Volume, Port Congestion, and Port Efficiency.

Further, these factors were presented in terms of seven measurable attributes to appear in the SC survey and allow for data processing and modelling. The list of factors that were used in the SC experiment and their equivalent measurable attributes and measurement units are shown in Table 3.

Table 3: Parameters for (SP) experiment

Factor	Measurable Attribute	Unit of Measurement
Port Infrastructure	Water draft	m
Cost/Port Charges	Terminal Handling Charge (THC)	$/Full 20' Container
Cost/Port Charges	Terminal Handling Charge (THC)	$/Full 40' Container
Empty Container Management	Free dwell time on empty containers	days
Cargo Volume	Import/Export cargo balance	Import %/Export %
Port Congestion	Actual/Scheduled Service Time	%
Port Efficiency	Terminal productivity per crane	Gross Moves per Hour (GMPH)

Furthermore, it was found that the factors presented in Table 3 are also in line with the findings of the RP data analysis performed earlier in the study. In particular, Port Infrastructure, Cost/Port Charges, Empty Container Management, Cargo Volume, Port Congestion, and Port Efficiency are the six most important factors that affect shipping lines' terminal choice; having Port Infrastructure and Cost/Port Charges on top of the list, as shown in Figure 5. As such, policy makers need to focus on these factors in attempt to promote their terminals and make them more attractive to shipping lines.

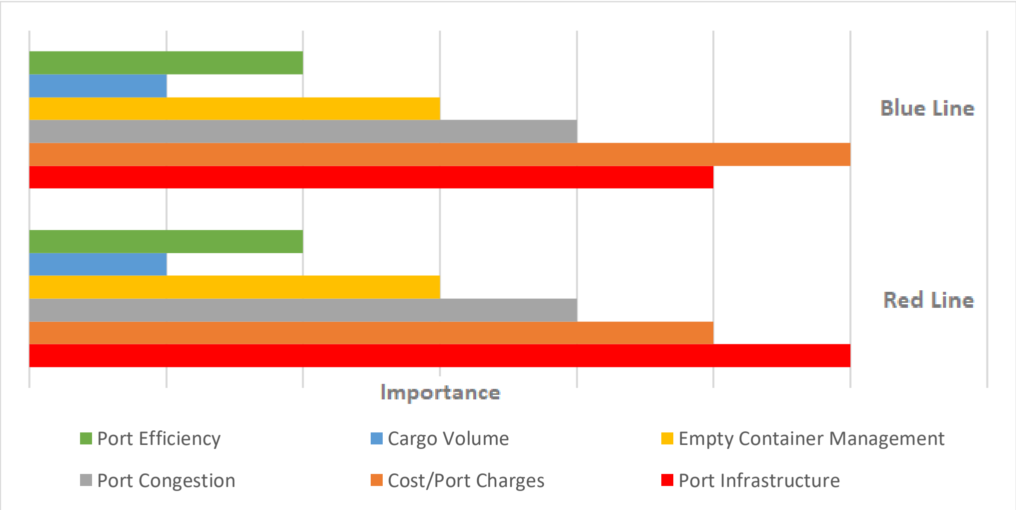

Figure 5: RP survey sample results

Another issue in SC experimental design is the trade-off between the statistical preference for a wide range and the practical limitations that may limit the range to maintain attribute levels within limits that make sense to the respondents. In more specific terms, the experiment should avoid choice tasks with dominated alternatives due to extremely wide ranges and alternatives that are largely indistinguishable due to too narrow ranges.

As such, experts from the Egyptian Maritime Transport Sector (MTS) and national container and cargo handling companies were also consulted about best practices in terminal service design to select reasonable attribute level ranges, as shown in Table 4.

Table 4: Attribute level ranges from the (SC) survey

Factor	Alexandria Container & Cargo Handling Co. **Alexandria Terminal**	Alexandria Container & Cargo Handling Co. **El-Dekheila Terminal**	Damietta Container & Cargo Handling Co. **Damietta Terminal**	Port Said Container & Cargo Handling Co. **West Port Said Terminal**
Water draft	14	14	14	14
(m)	18	18	18	18
Terminal handling charge (THC)	85	85	99	80
($/Full 20' Container)	77	77	89	72
	68	68	79	64
Terminal handling charge (THC)	160	160	198	150
($/Full 40' Container)	144	144	178	135
	128	128	158	120
Free dwell time on empty containers	0	0	0	0
(days)	5	5	5	5
	10	10	10	10
Import/Export cargo balance	30/70	30/70	30/70	30/70
(Import %/Export %)	50/50	50/50	50/50	50/50
	70/30	70/30	70/30	70/30
Actual/Scheduled Service Time	0.5	0.5	0.5	0.5
(%)	1	1	1	1
	1.25	1.25	1.25	1.25
Terminal productivity per crane	35	35	35	35
(Gross Moves per Hour - GMPH)	25	25	25	27
	15	15	15	15

Based on the number of chosen attributes, their levels, and ranges, an orthogonal design for the SC experiment was created. A total of 72 rows were generated to ensure attribute level balance (i.e. all attribute levels appear equally in the dataset; another important property that significantly impacts design efficiency). Giving all 72 choice situations to a single interviewee is too large. As such, the orthogonal design was divided into 12 blocks of 6 choice tasks each (although each block is not orthogonal by itself, the combination of all blocks is orthogonal). This way, each interviewee was faced with a random block of 6 choice tasks instead of 72.

The following is an example for one of the 6 scenarios that the shipping lines answered within the survey.

Please choose the appropriate container terminal from your point of view according to the following service parameters and operating characteristics. Please study the situation carefully before making a decision. Please, choose only one container terminal:

Table 5: Example from the (SC) survey

Factors	Alexandria Terminal	El-Dekheila Terminal	Damietta Terminal	Port Said Terminal	Another Terminal (Please state its name or specify its operation/service properties)
Water draft, (m)	18	14	14	14	
Terminal handling charge (THC), ($/Full 20' Container)	85	85	79	80	
Terminal handling charge (THC), ($/Full 40' Container)	160	128	178	120	
Free dwell time on empty containers, (days)	5	10	5	10	
Import/Export cargo balance, (Import %/Export %)	50/50	50/50	70/30	30/70	
Actual/Scheduled Service Time, (%)	0.56	1	1.25	1	
Terminal productivity per crane, (Gross Moves per Hour - GMPH)	25	35	35	15	
Which terminal would you choose?	□	□	□	□	□

As opposed to common SC surveys, respondents were also asked to express their confidence in their stated choices using a Likert scale that will be used to minimize measurement error of response.

How confident are you in executing your terminal choice in the future?	I will execute immediately	High	Moderate	Low	I doubt

7. CONCLUSIONS

This study is concerned with investigating the effect of container terminal's service attributes on attracting shipping lines, with focus on only survey instrument design and preliminary analysis of RP data.

The study combined RP and SC methods of data collection to make use of their advantages and reduce their individual drawbacks. In particular, RP questions were used to collect factual information on shipping lines' preferences. In addition, SC experiments were used to study the main factors that attract (repel) the most important shipping lines to (from) the Egyptian container and cargo handling companies.

Preliminary data analysis showed that Port Infrastructure and Cost/Port Charges are the most important factors shipping lines look for when choosing a container terminal, while Port Efficiency and Cargo Volume come least in importance. Further data analysis will be represented as soon the targeted sample size complete the survey to show the full image of shipping lines' preferences regarding their terminal choice behaviour.

Further, the complete dataset, when collected, will be used to develop discrete choice models of terminal switching behaviour. Forecasting shipping lines' behaviour will play a major role towards port resilience strategies to adapt to changing conditions, and recover positively from unexpected circumstances like the Covid 19 pandemic. Furthermore, the developed models will help policy makers prescribe efficient strategies to alter customer decisions and ensure that each port/container terminal has a fair market share based on the integration of existing capacity.

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Using Novative UAVs To Support Maritime Emergency Operations

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Abstract— *In the past years, the airship industry became an emerging business with the possibility of developing new transport methods for both tools and people by respecting the environmental constraints given by the United Nations Framework Convention on Climate Change. With this paper, we want to describe a possible scenario of applying this technology. The issue of lost or broken equipment on marine infrastructures is not a rare event. The scenario proposed regarding the delivery of equipment and spare parts to an oil station at sea broke pipe during a storm. We think that the suggested application of this technology may, in the future, help many people. By showing the calculations of the final chapter, we think that using the airships will be a convenient technology in the near future to solve these problems without involving human personnel.*

Keywords - airship, operation spare parts, patrolling.

I. Introduction

Currently, the use of UAVs covers a wide range, from patrolling territories to cargo delivery. In addition, airships are used for various manipulation tasks, logistics operations, inspection or repair of power lines (Luque-Vega L. F. *et al.*, 2014).

Transportation of heavy loads and delivery of various spare parts to port areas, including marine platforms, for example, for oil production, is complicated by the inaccessibility of these areas. Also, when it comes to such delivery to hard-to-reach places, the environmental impact must be taken into account, since using several modes of transport, planes or helicopters, harms nature, including the large amount of greenhouse gases emissions, mainly CO2. The use of large transport ships is convenient in delivering large-sized cargoes but requires a long waiting time.

In this article, we propose the concept of an airship carrying a payload in the form of spare parts, which communicates with a hub using a signal and allows cargo delivery to various hard-to-reach places, such as marine platforms, when equipment has sailed away or broken down.

Our article consists of the following parts. Chapter 2 describes the state of the art and shows the most significant articles in the literature review on the topic. Chapter 3 describes the scenario of using airships for emergency rescue purposes, such as people lost at sea. In Chapter 4, we describe a scenario for delivering spare parts to marine platforms using airships. Finally, in Chapter 5, we present universal formulas for calculating the necessary parameters of a fleet of several airships, including the size and payload capacity that will allow it to "float" and deliver the necessary spare parts on board.

II. Literature Review and the State of Art

The employment of airships for reaching far infrastructures by having a minimal impact on the environment is starting to be a reality. Airships can be employed for many applications, from patrolling (Adorni E. *et al.*, 2021) to delivery of equipment. The application that we are suggesting in our work start from reconnaissance operations. For patrolling operations, we consider airships the safest technology, capable of "floating" over any territory, having the possibility of carrying heavy payloads, communicating through antennas, and sharing the data collected. They can be equipped with state-of-the-art instrumentation with extremely high resolution and are ideal for accessing hard-to-reach areas or operating in hostile environments that would be deadly to human operators. UAVs can reduce the hazards faced by emergency responders, loss adjusters, and risk engineers, increase the effectiveness of rescuers, provide unique viewing angles unavailable to manned aircraft, and are cost-effective.

Unmanned Aerial Vehicles have had many applications during the fifty years. Autonomous UAVs can be used nowadays for collection of data (Hildmann H. and Kovacs E., 2019) and they can play a key role in future cities (Sterbenz J.P., 2016). For civilian purposes, they have been considered especially as mobile measurement/utilization platforms (i.e., platforms for delivering an increasingly wide range of sensors and actuators). The necessity of minimizing the time spent between the travels of an airship is a mandatory aspect during patrol scenarios. The civilian purposes that we thought relevant to analysis for this first project were the scenarios of providing first aid and delivering equipment to marine infrastructures, focusing more on this second event.

Speaking of delivery, it is worth dividing it into several categories. First, since affordability is an attractive factor, many companies are currently trying to occupy the UAV delivery market. A prime example is Amazon (Ackerman E., 2013), which considered delivery by drone and the use of a giant blimp and a swarm of drones to deliver small orders. Another advantage of delivery in such a case is the large area of the airship, allowing it to be used as a platform for advertising, which would be visible from several angles.

UAV delivery can be commercial, such as food, books, clothing, and other goods, but it is also possible to use the fleet for government purposes, such as delivering goods in case of emergencies.

Many researches explained the advantages of the employment of airships as mean of delivery (Gupta *et al.*, 2016, Hayat S. *et al.*, 2016, Chen M. *et al.*, 2015, Erdelj M. and Natalizio E., 2016). A good review of the literature on using different drones for delivery purposes is presented in Hayat S., *et al.*, 2016. The authors presented the network characteristics and requirements for different UAVs for the intended civilian applications in terms of communications and networks. The authors divided the existing applications into four groups with different qualitative and quantitative communication needs. Range, bandwidth, latency tolerance in real-time, etc., were considered.

The main features of the blimp that make it enjoyable to work in this field are:

1. High autonomy and durability in flight: lifting power is not created by aerodynamics, but by buoyancy, which saves fuel;
2. Energy efficiency: in an airship, being an elevator provided with gas, the engines are used only for propulsion. This leads to deficient energy consumption per hour of flight. There is also the possibility of covering the surface of the airship with a large solar panel, which will minimize the use of non-renewable resources;

3. Low environmental impact: (emissions, noise, turbulence): the low energy consumption is immediately reflected in a lower environmental impact. Air and noise pollution is almost negligible relative to traditional aircraft;
4. Ability to operate in areas with no airports: an airship can land and take off vertically, so it does not need long runways. This does not mean it can operate without basic infrastructure, which is necessary.

This study was conducted by Surmin *et al.*, 2018.

Two studies by Capitta *et al.*, 2017 and Capitta *et al.*, 2019 describe the transportation of natural gas using airships. The authors note the main aspects related to the conceptual design of an innovative means of transporting natural gas, such as:

- Advances in meteorology, both the understanding of atmospheric phenomena and the availability of real-time data on the entire planet's climate, allow for increased safety;
- Technological advances: the introduction of GPS overcomes one of the significant difficulties of navigating historic airships, which is determining the vehicle's position in the absence of reference points;
- Improvements in structural materials: new aluminum alloys, titanium, carbon fiber, Kevlar, and composites;
- Improvement of body materials: replacing fabrics and natural membranes with synthetic materials such as nylon, polyester, polyurethane.

This significantly reduces the weight of the component, which makes up a significant portion of the airship's weight, increases service life, reduces permeability to gases, and reduces maintenance requirements.

- Reliability, efficiency, and a high power-to-weight ratio of the hotplug internal combustion engine.
- Process automation;
- Remote control: the ability to reduce cost and weight to perform multiple tasks and missions with otherwise unacceptable levels of risk.

In their analysis, the authors present theoretical calculations and some features of an airship model, a prototype unmanned pilot-scale airship (7.5 m long) capable of transporting natural gas encased in impermeable bags between two predetermined departures and arrival stations following ENAC rules.

III. PEOPLE LOST AT SEA

In case of an emergency scenario, the airship (as part of a fleet) will have the duty to provide first aid. In the case of a machine, it is not possible to respond physically to the rescue, but it would be possible to deliver a "Basic Disaster Supply Kit. The idea comes from the necessity of designing a vehicle that autonomously would deliver the kit and then would go back to its reconnaissance duty. So different are the scenarios in which a person is lost at sea or in the mountains or, perhaps, in the desert, within the scenario in which the airship would be used as a means for reconnaissance and patrolling port areas.

Depending on n the scenario, the content of each emergency kit would be different. For example, the case of a rescue in a mountain area, instead of a device to convert salt water into drinkable water and a life raft, as in a sea scenario, we would need larger supplies of drinkable water, or we would need to implement first aid kits against burns and sun-related diseases in case of first aid to people lost in desert areas.

IV. DELIVERING THE SPARE PARTS

Autonomous airships can be employed for first aid operations and support for marine platforms and ships. If properly designed, airships can deliver tools, spare parts, and other equipment. UAVs can be a profitable and environmentally friendly way to deliver goods thanks to the latest technology, especially in big cities, where it is becoming increasingly difficult to move quickly from point to point, conversely, in places with undeveloped infrastructure, which are very difficult to reach by ordinary transportation. Airships will be able to travel at speeds of up to 100 km/h and less than 5% of the cost of cargo helicopters. UAVs can carry anything, not only spare parts but also oil and gas itself. They can become an essential node in complex logistical chains.

A possible scenario is an oil production station with a busted pipe or a pipe lost at sea during a storm. By sending a signal to the central hub on the coast, it would be possible for an airship to deliver spare parts and other equipment without involving human operations. An airship could land in a hard-to-reach place, or no land at all, but use an elevator. It does not need roads and could carry goods of enormous weight at a relatively low cost.

The delivery container can be placed in a compartment on the bottom of the airship or attached directly to the aircraft itself. The base receives the parcel by picking it up from the compartment of the descending UAV or by detaching it from the rope of the descent mechanism, thanks to which the airship may not land on the ground.

In the case of the scenario proposed where airships would be delivering spare parts for events involving marine infrastructures, such as oil platforms and wrecked ships, we think that different designs and configurations of an airship may be needed depending on the weight and characteristics of the equipment needed. It is preferable to have several different airships because parts can be heavy, bulky, and small, and it is much more convenient to have a whole fleet than just an airship running forward and backward. Different configurations are needed because of the weight of the equipment and the means of holding such equipment to the airship. This would bring to use the formulas presented in the following chapter to determine the proper values of the parameters of the airship.

It is also necessary to highlight the advantages and disadvantages of airships to deliver cargo and spare parts.

First of all, the environmental issues. Planes and helicopters are not very environmentally friendly. In 2010 the International Air Transport Association called for an end to heavy cargo planes due to CO2 emitted. The Boeing 747 uses 7,840 kg of aviation fuel to take off and fly 250 km. And 10 kg for each subsequent kilometer under ideal conditions. A short journey of 700 km produces about 45 tons of CO2. The same atmospheric emissions would produce 350-400 vehicles on such a journey. Airships emit 80-90% less harmful gases into the atmosphere. Furthermore, they do not leave inversion trails that contribute to the greenhouse effect due to the low flight altitude.

The next challenge, or even a severe problem, is weather conditions. UAVs have only recently begun to use heated batteries, allowing the vehicle to operate at sub-zero temperatures and not for a long time. There is also strong wind and precipitation, which cannot be ignored and are a significant obstacle to the widespread use of airships for cargo transportation. It is desirable not to have an empty or light-loaded envelope, as in places where it is challenging to arrive is usually very windy, and unloaded envelopes will go off course more often. However, modern, longer-lasting materials, including carbon fiber, will make airships less fragile and safer, and computer weather forecasting systems will avoid storms and help optimize the use of air streams.

V. CALCULATING THE PAYLOAD OF THE UAV

This work is the continuation of previous studies (Adorni E. *et al.*, 2021, Adorni E. *et al.*, 2022), which should bring us to determine the perfect approach to define the fittest parameters for our airship. Of course, we have to keep in mind the civilian intent of such technology, carrying out operations like reconnaissance and patrolling. The process we decided to approach is that to define the volume of necessary lifting gas, we first need to calculate the payload that the airship will have to carry. We think that this type of analysis will help give an idea of the model to use to have the most efficient design in terms of costs.

Archimedes' principle is the ruling law behind the physics of an airship. Being Lighter-Than-Air, the airship's envelope is filled with a lifting gas providing the body with the necessary lifting force. We found how the most relevant gasses that can be used are helium and hydrogen from our research. The following calculations are needed to determine the optimal capacity of the airship. This is because it is proportional to the internal volume of the envelope, plus considering the mass of the structure.

We start from the physical assumption that an LTA vehicle behaves as if it was underwater. In particular, it would be submerged in the air, the fluid that will provide the airship with lift.

From this assumption, we will assume that the volume available for the lifting gas will be the same as the displaced air volume.

For buoyancy:

$$B = \rho_a \cdot V_a \cdot g$$

Where a indicates our fluid, the air. A collateral assumption will be that V_a is the same volume as the airship V_{LTA}.

The effects of buoyancy will be that it will push up in the airship, but at the same time, it will pull down as if something is hanging from the airship. This hanging thing is only the mass of the airship that we have to find. In addition, the mass of the lifting gas has to be considered (m_{lg}). Given these considerations, the equation for the buoyancy can be written as:

$$\rho_a \cdot V_a \cdot g - m_{lg} \cdot g - m_p \cdot g - m_{LTA} \cdot g = 0$$

A factor that we are considering as a constant will be air density. As we well know, this value is not fixed. It depends on parameters such as altitude and pressure. Because we do not intend to have our airship flying over certain altitudes, we can consider this a fixed value of $0{,}9\ kg/m^3$. Another density that has to be known is the density of the chosen lifting gas. Due to safety reasons, we decided that the best solution is to employ helium ($\rho_g = \rho_{He} = 0{,}1785\ kg/m^3$, even if this would result in additional costs. For structural reasons, we assume that our airship will have the shape of a prolate spheroid. This solid is the most accurate representation of an airship, given a circular section in the middle and an ellipsoid section on the horizontal plane.

The variables of the following equation will be V_a and m_{LTA}. In particular, m_{LTA} can be written as in relationship to the volume of the airship (Pant R.S *et al.*, 2008). Considering the available resources on the market and making the proper assumptions to have a realistic problem, we can consider the material of the envelope of Mylar, a polyester, which studied optimal thickness can be of 1,5 mm (h_{env}). The density of this material has been found to be 1390 kg/m^3.

Given our assumptions, we can write that:

$$m_{LTA} = V_{LTA} \cdot \rho_{env}$$

And the final equation will be:

$$\rho_a \cdot V_a - \rho_g \cdot V_a - m_{pay} - V_{LTA} \cdot \rho_{env} = 0$$

Which can be written again as

$$V_a = \frac{m_{pay} -\cdot A_{env} \cdot h_{env} \cdot \rho_{env}}{\rho_a - \rho_{lg}}$$

The following equation describes the surface of a prolate spheroid:

$$A_{env} = 2\pi a^2 + 2\pi \frac{ac}{e} \arcsin{(e)}$$

Where a the minor semi-axis, c the major semi-axis and e the eccentricity (given by $e = \sqrt{1 - \frac{a^2}{c^2}}$ in the case a<c), the following function can describe the value of Va:

$$V_a(a,c) = \frac{m_{pay}}{0{,}7215} - 3{,}355 \cdot \left(2\pi a^2 + 2\pi \frac{ac}{e} \arcsin(e)\right)$$

From the unknown variables V_a and m_{LTA}, once the payload's mass is known, only a and c will be left as variables.

The function describing V_a results to be strictly dependent on the value of the thickness of the envelope. If, instead of a material such as Mylar, we would use another material such as polyurethane, we would be able to diminish the thickness of the envelope and obtain more efficient results.

VI. Conclusion

Airships are an innovative technology. They give us the possibility of delivering equipment to marine infrastructures and rescue victims at sea with minimal human personnel employment and a low impact on the environment.

With this article, we wanted to present the applicability of this technology. The relevant studies we described showed that this problem is urgent and will soon become an integral part of smart cities.

The scenarios we described refer to Support Maritime Emergency Operations, and the presented calculations of the aircraft's dimensions showed how the critical variable is the mass of the payload, which must be calculated prior. Once this is known, it is possible to understand the needed characteristics of the airship.

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"Smart Innovations for
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MULTICRITERIA ANALYSIS OF THE SUSTAINABILITY PERFORMANCE OF THE MARITIME ACTIVITY OF EGYPT AND ROMANIA

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Keywords: sustainability, performance, maritime activity, seaports, sustainable development indicators, multicriteria decision analysis.

1. ABSTRACT: The objective of the paper is the examination of the sustainability performance of the maritime activity of Egypt and Romania. Three more countries of interest (China, the Netherlands, and Morocco) were added to the analysis, as being representative of the world's sea trade. The analysis was performed using the multicriteria decisions method (MCDA), with criteria of equal importance. The selected countries were analyzed, based on six relevant available sustainability indicators. According to the results obtained, the most sustainable country for maritime activities proved to be China, followed by Morocco, the Netherlands, Egypt, and Romania. This analysis provides important information and insight about the sustainability performance of the maritime activity in the selected countries from Asia, Europe, and Africa and offers a valid tool for scientifically assessing their sustainability efforts.

2. INTRODUCTION

The first official definition of sustainable development can be found in the 1987 Brundtland Report of the World Commission on Environment and Development, entitled "Our Common Future", and synthesized the concept as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Report of the World Commission on Environment and Development – Our Common Future, 1987).

The principle behind sustainable development is the continuing concern for the systematic integration of the three essential pillars on which it is based: the environmental, social and economic one (Deselnicu *et al*., 2017). It is essential that in all aspects of decision-making over the generations, people, organizations and nations take into account their systemic correlation and inter-dependence (Ukaga *et al.,* 2010):

- Environmental sustainability: the ecological component that must be found in every initiative aimed at protecting biodiversity; sustainable organizations aim to reduce their environmental footprint as much as possible;
- Economic sustainability: ensuring the longevity of the company is a responsibility, regardless of market developments; financial profitability is one component of the business, not the only or the most important one.

- Social sustainability: companies act for their own interests, but at the same time, they serve the interests of their employees and of society as a whole. It involves the concern for the welfare of employees and the investment of a part of the company's profit for charitable causes in the community in which it operates.

In 2015, at the meeting of the United Nations General Assembly in New York, a historic document was adopted: The 2030 Agenda for Sustainable Development. Through its 17 objectives, this document aimed to achieve a better future not only for the present generation but also for the next ones (Transforming our world: the 2030 Agenda for Sustainable Development, 2015). Built on the three pillars of sustainable development - economic, social and environmental -, the 2030 Agenda is the one that guides the most important decisions regarding sustainability at the strategic level. Hence, it was quickly adopted by most countries and the European Union.

For a more effective pursuit of directives, on 1 January 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, came into force. The 17 Goals are all interconnected, universally apply to all, and are the blueprint to achieve a better and more sustainable future. They address the global challenges humanity faces, including those related to poverty, inequality, climate change, environmental degradation, peace, and justice (World Ports Sustainability Report, 2020). They reflect a balanced agenda of economic, social and environmental goals and objectives (The 2030 Education Agenda: from MDGs, EFA to SDG4, 2018). In order to achieve the SDGs, each country will need to recognize and appreciate the existence of potential trade-offs and develop ways to manage them.

For the maritime activity, the involved organizations address the UN SDGs can be addressed along five main themes, each of them covering a non-exhaustive list of potential topics: Resilient infrastructure, Climate and energy, Community outreach and Port - City dialogue, Safety and Security, Government and Ethics (Port of Rotterdam Authority, 2021a, b; Constantza County, 2021, Port of Constantza Authority, 2021; Sobhy M.M., Mohamed, May Salah E., 2020).

The GRI (Global Reporting Initiative) is the first global standard to support organizations in preparing for the sustainable development report. These reporting standards allow organizations around the world to be more transparent about their economic, environmental, and social impacts (The GRI Standards, 2021). They will also help organizations contribute to the 17 United Nations Sustainable Development Goals (SDGs). GRI has been helping companies prepare a report on the socio-economic and environmental impact since 1999 when it published its first draft of the guidelines.

GRI standards are built on the key concepts and information requirements presented in the G4 Guidelines. The difference is that they are now structured as a set of 36 interdependent, modular standards. Their latest version has three Universal Standards and the three series of Specific Standards and was launched in 2016 (Veira *et al.,* 2021).

3. RESEARCH METHODOLOGY

The research method

The present research used a decision method named multicriteria decision analysis to ascertain and select the best option available. "The decision is the central point of the management activity because it is found in all the functions of the management process. This is the result of a sequential process of information, analysis, and deliberation, called the decision-making process. The decision can be defined as the course of action or the modality, chosen for the achievement of one or more objectives, from a multitude of variants, taking into account certain criteria" (Dobre *et al.,* 2007).

There are several typologies of decisions, but the best known is the classification according to the knowledge degree of the decision-maker regarding the result of different alternatives, which encompasses decisions in conditions of certainty, risk, and uncertainty.

In a decision-making process developed in conditions of certainty, complete information is available, there is only one state of nature with a certain probability (pk), (p1 = 1); thus, the decision-maker knows exactly what will be the result of each variant (alternative).

As opposed, in decision-making processes under risk conditions, there are several possible results for the chosen alternatives, while in decision-making processes under uncertainty conditions, of the number of results, values and probabilities are not known.

The method applied in this study - multicriteria analysis - is a structured approach used to determine the general preferences between several alternative options, which lead to the achievement of the objectives. This method specifies the objectives pursued and identifies the attributes or indicators (criteria) corresponding to each objective.

The most widely used approach to multicriteria analysis is by using a sequence of five steps. Therefore, the stages of the decision-making process are the following:

- Step 1: Formulating the problem to be solved and determining the decision criteria;
- Step 2: Determining the performance values for each criterion;
- Step 3: Normalizing the analyzed criteria;
- Step 4: Assigning weights to the decision criteria;
- Step 5: Hierarchy of variants. Calculating the performance score and choosing the best option.

The objective of this method was to determine the performance in terms of sustainability for the maritime activity of five countries of interest involved in international sea trade: China, The Netherlands, Morocco, Romania and Egypt.

4. APPLICATION OF THE MULTICRITERIA DECISION ANALYSIS

The authors followed the classic stages of the decision-making analysis, presented in the next sections.

Step 1: Formulating the problem to be solved and determining the decision criteria

The multicriteria decision-making method was used to investigate the sustainability performance of the selected countries. The authors chose Romania and Egypt as countries of interest. Moreover, another 3 countries were selected for the comparison of their maritime activity: China, as the world's leading country for maritime trade, Netherlands, as Europe's leading country, and Morocco as Africa's leading country in maritime trade (World Shipping Council, 2021). The problem to be solved can be therefore considered a problem of a multicriteria decision in conditions of certainty, using criteria of equal importance.

Table 1 shows the sustainability indicators that were selected for the analysis and the respective sustainability pillar to which they correspond:

Table 1. Sustainability indicators analyzed (2020)

No.	*Sustainability pillar*	*Criteria (Sustainability indicators)*
1	Economic sustainability	Container port throughput (TEU) Fleet growth rate in 2020 (%) Number of port calls Ship building (GT)
2	Social sustainability	Seafarer supply (Officers)
3	Environmental sustainability	Ship recycling (GT)

As it can be observed in Table 1, the indicators for economic sustainability are majoritarian, since UNCTAD is an international trade statistics database. Therefore, for the economic pillar, the criteria included such indicators as Container port throughput (TEU), the Fleet growth rate in 2020 (%), Number of port calls, and Shipbuilding (GT). The social sustainability encompassed the seafarer supply (number of officers), while the environmental sustainability was evaluated through the Ship recycling (GT) indicator.

By comparing selected sustainability criteria of the maritime activity of these countries, the authors aimed to depict a general image of the international maritime activity in the three continents from a sustainability point of view.

Step 2: Determining the performance values for each criterion

For this analysis, six sustainability criteria (indicators) have been selected, for all three sustainability pillars: economic, social, and environmental sustainability. The six selected indicators were extracted from the UNCTAD database (UNCTAD, 2021) referring to the maritime profile of the 5 countries as reported for the last available year (2020) by UNCTAD. In Table 2, the values related to each criterion chosen for the analysis (X_{ij}) are detailed (Equation 1):

(1) X_{ij} = Performance value of i^{th} country over j^{th} criterion

Table 2. Decision matrix for the analyzed criteria

Crt. no.	*Country (ports taken into consideration)*	*Performance values for selected criteria*					
		Container port throughput (TEU)	*Number of port calls*	*Ship building (GT)*	*Ship recycling (GT)*	*Seafarer supply (Officers)*	*Fleet growth rate in 2020 (%)*
1	China (Shanghai, Ningbo, Qingdao, Xiamen, Yantian)	245103781	261269	23257200	195486	134294	3,5
2	The Netherlands (Rotterdam, Vlissingen, Moerdijk, Amsterdam, Botlek)	14522209	117420	109164	8430	9667	-1,4
3	Morocco (Tanger Med, Casablanca, Agadir, Nador)	6980958	18002	n/a	n/a	8081	20,3

Crt. no.	*Country (ports taken into consideration)*	*Performance values for selected criteria*					
		Container port throughput (TEU)	*Number of port calls*	*Ship building (GT)*	*Ship recycling (GT)*	*Seafarer supply (Officers)*	*Fleet growth rate in 2020 (%)*
4	Romania (Constantza)	643725	5331	35783	0	17708	-4
5	Egypt (Port Said, Damietta, El Sokhna, Alexandria, El Dekheila)	5928454	10825	2364	0	7021	3,2

Note: n/a = information not available

Source: compiled from UNCTAD, 2021.

Step 3: Normalizing the analyzed criteria

As is can be observed from Table 2, the analyzed criteria have different units, which makes the evaluation difficult. In order to be able to evaluate the countries with a common measure, the different performance values for the indicators must be normalized. Therefore, at the level of each criterion, the most favorable and unfavorable (beneficial or non-beneficial) consequences were determined (Equation 2; Equation 3); these consequences were then given maximum and minimum utility, respectively.

(2) $$\text{Non beneficial} = \text{Min}(X_{ij})/X_{ij}$$

(3) $$\text{Beneficial} = X_{ij}/\text{Max}(X_{ij})$$

Non-beneficial criteria are those criteria for which a lower value is desirable, while for the beneficial ones, higher values are desirable. As it can be observed, all the criteria considered for the current analysis were considered to be beneficial ones (Table 3):

Table 3. Normalized decision matrix

	Beneficial	*Beneficial*	*Beneficial*	*Beneficial*	*Beneficial*	*Beneficial*
	Container port throughput (TEU)	*Number of port calls*	*Ship building (GT)*	*Ship recycling (GT)*	*Seafarer supply (Officers)*	*Fleet growth rate in 2020 (%)*
China	1	1	1	1	1	0,172
The Netherlands	0,059	0,449	0,005	0,043	0,072	-0,069
Morocco	0,028	0,069	n/a	n/a	0,060	1
Romania	0,003	0,020	0,002	0,000	0,132	-0,197
Egypt	0,024	0,041	0,000	0,000	0,052	0,158

At this point of the analysis, it became obvious that China, the leading world country in sea international trade, obtained maximum values for most of the economic indicators, as expected. Given its abundant population, it also obtained the highest score for the Seafarer supply (number of officers) criterion. China was followed by Netherlands, the leading country in Europe for international sea trade, which also reported high numbers for the economic indicators.

Surprisingly, Morocco had the highest fleet growth rate in 2020, which made it the reference country for this criterion.

Step 4: Assigning weights to the decision criteria

The next step is to assign the appropriate weightage to the criteria. For the current analysis, the authors have allotted equal weightage to all criteria (20%), as these are considered to be equally important.

After normalizing the criteria, the penultimate step follows, in which each analyzed criterium receives a weight depending on its importance. In the case of the current analysis, it was considered that all six analyzed characteristics have equal weights (16,66%), as presented in Table 4:

Table 4. Weighted normalized decision matrix

Country	*Weightage*					
	0,1666	*0,1666*	*0,1666*	*0,1666*	*0,1666*	*0,1666*
	Container port throughput (TEU)	*Number of port calls*	*Ship building (GT)*	*Ship recycling (GT)*	*Seafarer supply: Officers*	*Fleet growth rate in 2020 (%)*
China	0,167	0,167	0,167	0,167	0,167	0,029
The Netherlands	0,010	0,075	0,000	0,007	0,012	-0,011
Morocco	0,005	0,011	n/a	n/a	0,010	0,167
Romania	0,000	0,003	0,000	0,000	0,022	-0,033
Egypt	0,004	0,007	0,000	0,000	0,009	0,026

By multiplying the performance values with the assigned weight, the weighted normalized decision matrix is obtained. This intermediate step is necessary for the calculation of the general Performance score of each analyzed alternative (country).

Step 5: Hierarchy of variants. Calculating the performance score and choosing the best option

Next, we add all the normalized performance values of each analyzed country to get the final Performance score.

After establishing the weights of each criterion, the authors calculated the performance score. The hierarchy of variants is done with the help of a global indicator. The Performance score, also known as the global utilities indicator (U), represents the sum of all utilities of a variant Vi, and is calculated using the Equation 4:

$$\boldsymbol{U} = \sum_{1}^{\mathrm{i}} \mathrm{Vi} \qquad (4)$$

The performance score is the one that provides the ranking in the multicriteria analysis. It offers a hierarchy of the analyzed countries from the point of view of sustainability performance. All normalized performance values of each alternative (country in this case) are added together in order to obtain the performance score. In an ideal case, the maximum score that an organization can get is equal to 1 (Table 5):

Table 5. Performance score and ranking

Country	*Weightage*						*Performance score*	*Rank*
	0,1666	*0,1666*	*0,1666*	*0,1666*	*0,1666*	*0,1666*		
	Container port throughput (TEU)	*Number of port calls*	*Ship building (GT)*	*Ship recycling (GT)*	*Seafarer supply (Officers)*	*Fleet growth rate in 2020 (%)*		
China	0,167	0,167	0,167	0,167	0,167	0,029	0,862	1
The Netherlands	0,010	0,075	0,000	0,007	0,012	-0,011	0,092	3
Morocco	0,005	0,011	n/a	n/a	0,010	0,167	0,193	2
Romania	0,000	0,003	0,000	0,000	0,022	-0,033	-0,007	5
Egypt	0,004	0,007	0,000	0,000	0,009	0,026	0,046	4

Based on the evaluation of the selected sustainability criteria taken into consideration (economic, social, and environmental), China has the highest performance sustainability score of all the five compared countries, indicating the best composite sustainability performance (0,862). This output was by no doubt influenced by its strong economic competitive advantage, resulting in high economic indicators which tipped the scales to its favor. According to the analysis, China is the most sustainable country in maritime activity, taking into account the four sustainability indicators considered as criteria for analysis.

Surprisingly, Morocco ranked second on the top of sustainable countries. Although the information was not available for two important indicators for this country (Ship building and Ship recycling), even by taking the worst-case scenario in which Morocco would have reported 0 (zero) for both these indicators, this country would still be on the second place due to its impressive fleet growth rate (20,3%). Therefore, the leading country in maritime trade in Africa proved to be a worthy competitor in this evaluation, from a sustainability point of view.

The third place was as expected taken by The Netherlands, which holds the biggest operating port in Europe (Rotterdam) and other several important ports (Vlissingen, Moerdijk, Amsterdam and Botlek). Although it registered a negative fleet growth rate in 2020, The Netherlands scored high in economic sustainability indicators (Container port throughput, Number of port calls, and Ship building). Another strong point for the European competitor was its constant preoccupation for environmental sustainability, reflected positively in a high score for Ship recycling.

As for the two countries which constituted the focus of this analysis (Egypt and Romania), they occupied the last two places in the sustainability performance top. Egypt scored higher than Romania, taking the fourth position. Romania was the only country to have a negative score in the analysis. Both countries scored very low on indicators such as Ship Building and Ship recycling, but Egypt definitively reported better values for the economic indicators as Container port throughput (TEU) and Number of port calls. While Romania's performance was better for the social sustainability indicator Seafarer supply (number of officers), Egypt had a better score for the fleet growth rate in 2020 (3,2%).

5. CONCLUSIONS

The objective of the paper was to determine the performance in terms of sustainability for the maritime activity of Egypt and Romania. Three more countries of interest (China, The Netherlands, and Morocco) were added to the analysis, as being representative of the world's sea trade. For this analysis, six selected indicators were chosen (values for the year 2020), representing each of the three pillars that define sustainability: for the economic pillar, the criteria included such indicators as Container port throughput (TEU), the Fleet growth rate, Number of port calls, and Shipbuilding (GT). The social sustainability encompassed the seafarer supply (number of officers), while the environmental sustainability was evaluated through the Ship recycling (GT) indicator.

The multicriteria analysis method was used for decision-making, in order to examine the sustainability performance of the companies subjected to analysis. According to the results obtained, the most sustainable country for maritime activities proved to be China, followed by Morocco, The Netherlands, Egypt, and Romania. China differed significantly from the other competitors, in particular in what concerns economic indicators related to maritime activity and trade, which are representative of the pillar of economic sustainability. The outstanding performance achieved for these indicators overcame its weak results in the field of environmental sustainability.

Morocco ranked second on the top of sustainable countries. Although the information was not available for two important indicators for this country (Ship building and Ship recycling), even by taking the worst-case scenario in which Morocco would have reported 0 (zero) for both these indicators, this country would still be on the second place due to its impressive fleet growth rate (20,3%).

The third place was taken by The Netherlands, its best comparative advantage being its high economic performance, but also environmental sustainability reflected in a high score for Ship recycling.

Egypt had the fourth place in the sustainability performance top, and Romania was left on the fifth. Egypt had better economic indicators for its maritime activity (as Container port throughput, Number of port calls, and Fleet growth rate), while Romania's scored better for the social sustainability indicator Seafarer supply (number of officers).

This analysis provides important information and insight about the sustainable performance of the maritime activity in the selected countries. First, in order to achieve a high sustainability performance, the countries should pay equal interest and attention to all pillars of sustainability. As sustainability is a complex concept, encompassing at least three equally important areas, even if they score higher in economic indicators, this is not enough to secure a high position in sustainability rankings. They should allot significant resources and support initiatives for the development of the social indicators, as well as the environmental ones.

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"Blue Economy

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CYBER-PHYSICAL SECURITY FOR PORTS INFRASTRUCTURE

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1. ABSTRACT: Taking advantage of the benefits associated with digital means has become a main priority for ports globally. The effective and smooth integration of Information Technology (IT) applications and those systems that support the conduct of operations (Operational Technology (OT) systems), along with the accurate "adjustment" of the human factor elements should be viewed as a very critical pillar for optimized safe and efficient operations in ports. The afore mentioned assimilation characterizes cyber-physical systems and entails an extended number of IT and OT modules, systems and tasks involving various data transmission routes that are advancing in a technological and operational level alongside plausible cybersecurity threats. These cybersecurity risks, threats and vulnerabilities are depicted in this article to emphasize the progression of cyber-physical systems in the wider maritime industry and port domains, along with their rising cybersecurity vulnerabilities. Existing and applicable industry and government standards and mandates associated with cybersecurity attempt to impose regulatory compliance and increase asset cybersecurity integrity with reduced emphasis however, in the existing OT (Operational Technology) components and systems. The use of security risk assessment tools and processes that are used in other industrial sectors, such as the Security Risk Assessment (SRA) and the Bow Tie Analysis methods, can support the evaluation of IT/OT infrastructure for cyber-physical security susceptibilities and then assign suitable reactive measures. The implementation of cybersecurity safeguards that arise through the implementation of the MITRE ATT&CK Threat Model can enhance the cybersecurity posture of those assets that support the logistics chain, assuming that they are intermittently adapted following evaluations for their effectiveness and suitability. Finally, the improvement of stakeholder communication and cyber-awareness along with the increase in cyber-physical security resiliency can further be aided by the effective convergence of the segregated cyber and physical security elements of waterside or landside-based IT/OT infrastructure.

2. INTRODUCTION

Ports, also referred to as seaports, are considered a major part of the critical infrastructure of a country [1]. Critical infrastructure refers to the framework of infrastructure, man-made networks and systems that provide needed goods and services to the general public [1]. Ports in turn are defined as the geographical area where ships are brought alongside the shore to load and discharge cargo [2]. Ports provide a critical interface between land and sea [2] and sustain a country's economy and prosperity. In order for the ports to function efficiently they need to provide more than a safe and secure location for vessels to discharge or load cargo or for service providers to support maritime operations. A framework of additional infrastructure is interconnected to a port which creates a complex web of assets, processes, systems and operations. Ports can include an array of facilities including equipment storage facilities, fuel storage and refueling terminals, cargo terminals, utility services and infrastructure, industrial facilities, processing facilities, road and rail transport infrastructure. In order for the ports to be efficient and provide safe and secure services they also embrace automation in their procedures and systems. IT (Information Technology)/OT (Operational Technology) components have become indispensable tools and as more complex equipment and processes are in use, they include a number of SCADA (Supervisory Control and Data Acquisition) and ICS (Industrial Control Systems) components.

The terrorist attacks of September 11, 2001 did initiate a worldwide domino effect in the development and adoption of a number of security initiatives, directives, standards and policies in ports and maritime assets in general. Measures for the security and protection of maritime assets and infrastructure were implemented and the ISPS (International Ship and Port Facility Security) code from the International Maritime Organization (IMO) was universally adopted. Cybersecurity has been included in the general concept of security, but as worldwide threats evolve, it needs to adapt and progress as well.

In 2020 it was reported that cyberattacks on the maritime industry's OT systems had increased by 900% over the last three years [3]. Since then, further attacks have been reported in ports around the world. In July 2021 four major ports in South Africa were paralyzed by a major cyberattack which caused a "force majeure" due to a complete disabling of IT systems [4]. In August 2021 the port of Houston was attacked by hackers taking advantage of IT system vulnerabilities [4]. The result of such attacks has always been the financial loss due to diminished operations both at a local and international level. The deployment of forces, both governmental and private, to mitigate such incidents has also caused the re-evaluation of vulnerabilities which in turn have led to the investment in additional resources to reinforce the cybersecurity infrastructure and systems' posture.

Aiming in exploring the cyber-physical concepts of cybersecurity for ports infrastructure and realizing the current state of threats in the cyber domain, this paper will provide a concise assessment of the major attributes of cyber-physical security in the maritime industry to include the sector of ports. The known security threats and vulnerabilities faced by ports' infrastructure will also be discussed. An overview of the major initiatives by the industry and governmental entities aiming in enforcing the necessary measures at an organizational and operational level, will also be provided. A number of assessment methods for the evaluation of cyber-physical security threats and vulnerabilities will also be briefly presented to show the potential of tools available in the industry.

3. CYBER-PHYSICAL ASPECTS IN PORT INFRASTRUCTURE AND OPERATIONS

Cyber-physical systems in general pertain to the integration of IT and OT systems along with human factors [5]. This combination is shown in Figure 1 and represents the majority of operational and technical components found in ports' infrastructure. Maritime assets such as ports' infrastructure are operated by people and encompass an IT and OT operational and technical element that links procedures, systems, components, and technical and operational performance [5]. Similar to ships, ports' infrastructure involves multiple platforms of Systems of Systems (SoS) which contain IT and OT components, aiming in the automation of processes and optimum efficiency [6]. This architecture of IT, OT and human operators is further evolving adapting emerging technological features of Industry 4.0, the Internet of Things (IoT), cloud computing, data analytics, robotics to structure an evolving systems landscape [7].

The automatic procedures that are carried out in ports include cargo management, supply chain information exchange, financial transactions and contract management. Maritime security is also provided in ports for both ships and shore assets and operations. These processes involve communication with authorities, customs, shipping companies, logistics providers, service providers, ship crews, customers and other stakeholders. As such communication at a global scale is paramount for business continuity but also creates challenges for the IT and OT cyber architecture, in achieving the basic objectives of confidentiality, integrity, and availability for cybersecurity. These challenges need to be highlighted as they pertain to cybersecurity of IT/OT systems, components and processes that digitally store, transmit or process data related to operations, financial transactions and personnel management.

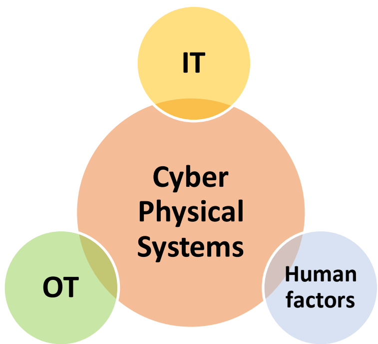

Figure 1: Cyber-physical systems interface.

4. CYBER-PHYSICAL THREATS AND VULNERABILITIES IN PORT INFRASTRUCTURE

Cybersecurity risk in the maritime industry relates to plausible threats to the confidentiality, integrity, and availability of systems and digital information and translates to the ever-present vulnerabilities in IT and OT systems and components. Port components and corresponding risks include [8]:

a) Facility access: This may involve the degradation or disruption of systems used in cargo, transportation and personnel management, which may lead to a complete halt of all operations.

b) Terminal headquarters: This may involve data access by malicious actors aiming to manipulate sensitive data related to cargo and customers. It may also include the destruction of data through malware attacks.
c) OT systems: The compromise of OT systems and components such as cargo handling equipment and fuel systems can lead to operational disruptions, physical damage to cargo and facilities and increased safety and environmental risks in case of an accident taking place.
d) Positioning, Navigation, and Timing (PNT): Loss of PNT services would lead to disruption to logistics systems and vessel maneuvering. It could also lead to physical damage to infrastructure, major safety and environmental incidents such as collisions and allisions, release of hazardous material, fires, loss of life, vessel sinking, and blocking of a navigable channel.
e) Vessel: The operational and technical compromise of vessel or port facility systems could lead to the compromise of additional waterside or landside systems. This can occur due to the interconnectivity of a vessel to shore facilities through Wi-Fi, network connections, USB storage devices, etc.

In general, similar to physical security, the cyber threats faced by ports’ infrastructure and their cyber-physical elements can be categorized as internal, external, or colluded [5]. An insider threat can be an individual, ship crew member or port personnel, that intentionally or unintentionally causes the breach of preventive cybersecurity measures (such as IT platforms and software tools) by practicing poor cybersecurity hygiene. From using a virus-infected portable USB device to the reading of malware infected unsolicited emails, the effects of poor “cyber-hygiene” can be detrimental to ports’ cyber infrastructure and components. External threats can be defined as those posed by competitors, ordinary cyber-enabled criminals, hackers, hacktivists, state adversaries or terrorists using highly advanced techniques to damage, destroy or take control of IT/OT systems [9]. Colluded threats combine the operation of internal threat actors under the guidance by external adversaries.

5. GOVERNMENTAL AND INDUSTRY INITIATIVES

The combined cyber and physical security for port infrastructure and maritime assets in general is covered mainly through the more common subject of cybersecurity. Various directives, guidelines, standards and other publications from the maritime industry and standardization organizations and various government agencies have been released to tackle the subject. Some of these are described briefly in the below subsections.

5.1 Maritime Industry Organizations

Cybersecurity to include the cyber-physical domain is covered by Resolution MSC.428(98) [10] and Guidance MSC-FAL.1/Circ.3 [11] released by the International Maritime Organization (IMO). MSC.428(98) and MSC-FAL.1/Circ.3 complement the IMO International Ship and Port Facility Security (ISPS) code for vessels with the application of maritime risk management in vessels’ safety management systems (SMSs) as required by the ISM (International Safety Management) Code.

5.2 Standardization Organizations

The US National Institute of Standards and Technology (NIST) has created the NIST Cyber Security Framework [12] and a series of standards which are widely used in various industrial sectors, including the maritime industry. The NIST Cyber Security Framework comprises of five elements: (1) Risk identification for cybersecurity of systems, assets, data and operations; (2) The implementation of safeguards for the cybersecurity protection of assets; (3) Detection of cybersecurity related incidents; (4) Response to cybersecurity related incidents; (5) Recovery from cybersecurity related incidents. The NIST Cyber Security Framework is supplemented by other NIST Special Publications 800-30 [13], 800-37 [14], and 800-82 [15], that cover the assessment and management of cybersecurity risk for Industrial Control Systems (ICS). NIST has also published Special Publications 1500-201 [16], 1500-202 [17], and 1500-203 [18], which consist of the NIST Framework for Cyber–Physical Systems. The NIST Framework for Cyber–Physical Systems studies the interface of IT and OT systems and components defining the System of Systems (SoS) state of cyber infrastructure. It also delivers a useful aid for the evaluation of cyber-physical systems and is applicable to IT/OT systems in the maritime transportation and infrastructure sectors.

The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) have released ISO/IEC 27001 [19] which can be used in the maritime sector as it assists in the evaluation and management of cybersecurity risks. Published IEC-62443 consist of a series of standards which cover cybersecurity on industrial communication networks for IT/OT systems. IEC-62443-4-2 [20] specifically outlines the requirements for Industrial Automation and Control Systems (IACS) and presents ways for the management of cybersecurity vulnerabilities. IEC 62443-3-3 [21] explains the security levels of control systems and ISO/IEC 21827 [22] outlines the Systems Security Engineering—Capability Maturity Model® (SSE-CMM®), illustrating the procedure for security engineering for organizations and assets. ISO/IEC 18045 [23] gives guidelines for the assessment of IT systems security. ISO/IEC 15408-1 [24] covers the evaluation of cybersecurity for IT systems and components, defining the Target of Evaluation (TOE) concept. ISO/IEC 27032 [25] tackles the security and protection of critical information infrastructure, data and networks, providing guidance for cybersecurity reinforcement.

The American Society for Testing and Materials (ASTM), has issued standard F3286-17 [26] which utilize the NIST Cyber Security Framework for maritime assets and critical infrastructure and relates to the mitigation of cybersecurity attacks and the reduction of the impact from such security breach incidents. ASTM standard F3449-20 [27] provides guidance for the integration of technical and operational cybersecurity features into vessel safety management systems (SMS), in accordance to the International Safety Management (ISM) Code and IMO Resolution MSC.428(98).

5.3 Government Agencies

In the USA, the US Congress issued Bill S. 4023 "Enhancing Maritime Cybersecurity Act of 2020" [28] delegates the implementation of cybersecurity protection strategies and measures to the US Cyber Security and Infrastructure Security Agency (CISA) and the Maritime Administration (MARAD). The US Coast Guard (USCG) issued Navigation and Vessel Inspection Circular (NVIC) 01-20 [29], titled "Guidelines for Addressing Cyber Risks at Maritime Transportation Security Act (MTSA) Regulated Facilities" [29] guides MTSA-regulated facilities for the assessment and management of vulnerabilities in computer and network systems. NVIC 01-20 promotes the use of the National Institute of Standards and Technology (NIST) Framework for Improving Critical Infrastructure Cyber Security and NIST Special Publication 800-82. The USCG issued Vessel Cyber Risk Management Work Instruction CVC-WI-027 (rev.2, 2021) [30], relates to the reduction of cyber risk to the Marine Transportation System (MTS) through the assessment of cyber risks and vulnerabilities in vessels.

In the United Kingdom (UK), a Good Practice Guide in Cybersecurity for Ports and Port Systems (2020) [9] was published by the Institution of Engineering and Technology (IET), the Department for Transport (DfT), the Defense Science and Technology Laboratory (Dstl) and the National Cyber Security Centre (NCSC). This document applies to systems and facilities of ports and encourages the incorporation of cybersecurity into their general security planning process for infrastructure.
Similarly, the Code of Practice for Cybersecurity for Ships (2017) [31] has also been released, providing guidance on the management of operational risk due to cyber-related incidents that could impact the safety and security of the crew, passengers, or cargo of a vessel.

In Europe, the European Union Maritime Security Strategy (EUMSS) Action Plan (2018) [32] addresses cybersecurity for the maritime industry with the intent to strengthen and improve the European Union's (EU) capacity to manage security and enhance the cyber-defense of maritime infrastructure and related systems. EU Regulation 2016/679 [33], also known as the General Data Protection Regulation (GDPR), safeguards the processing of information for various industry sectors to include the maritime industry. EU directive 2016/1148/EU [34] and the EU Cybersecurity Act (2019/881/EU) [35] delegate the operational cybersecurity to the European Union Agency for Network and Information Security (ENISA) and handle the cybersecurity of IT networks. The European Union has also developed a cybersecurity strategy through JOIN/2013/01 [36] in order to apply strategic mitigation tools and policies aiming in the increase of cybersecurity resilience. ENISA has also released related guidance reports in the subjects of cyber risk management [37] and port cybersecurity [38] for ports.

6. CYBER-PHYSICAL SECURITY ASSESSMENT FOR PORTS

The assessment and management of cyber-physical security for assets within the seaport sector requires methodologies that can adapt in the operational and technical parameters of such assets. The maritime transportation sector and its port facilities combine types of operations and assets that fall into the critical infrastructure sector and combine both industrial, facilities and maritime functions. As such the assessment of cyber-physical security risks and vulnerabilities in a proactive and reactive manner needs to adopt methodologies that consider multi-industry technical and operational parameters and provide an "outside-the-box" perspective. This section will provide a brief overview of some useful assessment tools that derive from the cyber and physical security domains in general as well as the oil and gas and industrial sectors.

6.1 API (American Petroleum Institute) Security Risk Assessment (SRA)

The Security Risk Assessment (SRA) methodology derives from the oil and gas sector and is defined in API (American Petroleum Institute) standard (STD) 780 (2013) [39]. It is applicable for a variety of security incidents to include theft, sabotage and terrorism for fixed and mobile assets. SRA can be also applied to various industrial infrastructure and operations including maritime transportation operations.

The API SRA methodology manages security risks through a risk-based, performance-oriented management process safeguarding the security and safety of assets, the environment, personnel and business continuity. As per API STD 780 (2013) [39] SRA is a 5-step process which involves: 1) The asset/facility characterization, 2) The assessment of security threats, 3) The assessment of vulnerabilities, 4) The evaluation of risk and 5) Risk treatment.

SRA is applicable to cyber-physical security applications in the maritime industry, as it can assess the physical aspect of security incidents and vulnerabilities as well as the interaction of assets with IT/OT components and infrastructure. The application of the SRA method for a cybersecurity related incident involving a maritime asset has been illustrated by Progoulakis, Rohmeyer and Nikitakos in a recent publication [5].

6.2 Bow-Tie Analysis (BTA)

Bow-Tie Analysis (BTA) is a qualitative method for safety review and as part of Process Safety Management (PSM) is used in the petrochemical, and processing sectors. BTA is primarily used in safety related incidents for the classification of risks, hazards, and consequences in systems, processes and operations. BTA is also applicable for the identification of security mitigation measures for assets, their components and processes. Bow Tie Analysis can also be used in the maritime sector, and specifically for port facilities, for the assessment of interconnections between marine equipment, systems, and processes in safety and security incidents. For cybersecurity applications, Bow Tie Analysis can be utilized to assess the appropriate security mitigation measures for IT/OT assets and processes.

The application of the Bow Tie Analysis method in the cybersecurity of various industrial sectors has been shown through various publications [40, 41, 42, 43, 44]. Specifically, the use of BTA in a cyber-physical security scenario for a maritime asset has been proven by Progoulakis, Rohmeyer and Nikitakos [5]. Bernsmed et al. [45] has also used the Bow Tie Analysis method to analyze cyber-physical security risks in the maritime sector involving navigational communication systems. Shuang-Hua et al. [46] has incorporated BTA in a methodology to concurrently assess risks for security and safety of cyber-physical systems.

As shown in the Bow Tie Analysis (BTA) diagram of Figure 2, cause scenarios are depicted on the left side of the diagram which represent the pre-event side. Results of plausible consequences and scenario are depicted on the post-event and right side of the diagram, along with their corresponding barrier safeguards. The use of the Bow Tie Analysis model showcases the importance of preventive and recovery actions in dealing with security risk. In Bow-Tie Analysis, risk is specified as the probability of a Top Event (hazard release) occurring, combined with the severity of the aftermath of the event. In general Bow Tie Analysis has proved to be an effective method in evaluating cyber and physical security hazards, risks, consequences, and mitigation measures.

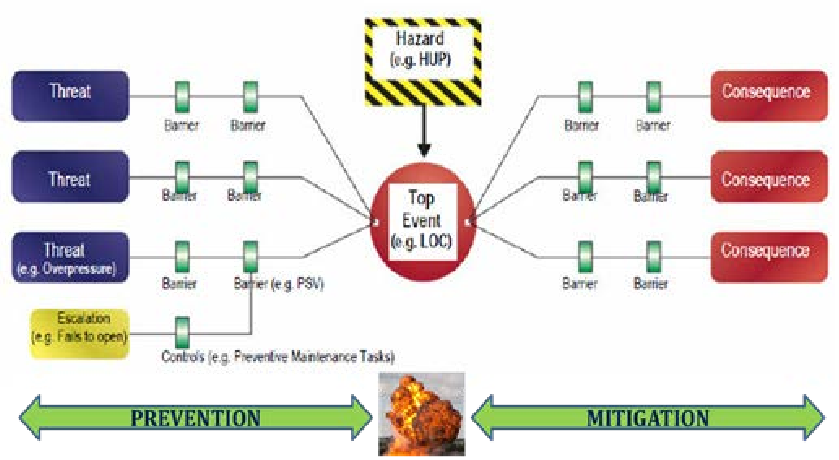

Figure 2 - Bow-Tie Analysis diagram (Source: [47] with information edited by the authors)

6.3 MITRE ATT&CK Threat Model

The MITRE ATT&CK Threat Model [48] is a vulnerability assessment tool capable of evaluating cyberattacks and organizational risks [49]. It can be used when assessment cyberattack behavior, tactics, and techniques of attackers and enables the structure of such data [50] to be utilized by the corporate Chief Information Security Officer (CISO) and cyber intervention team of the maritime asset. The MITRE ATT&CK Threat Model is known for its versatility as it enables the evaluation of IT infrastructure, cloud data storage, portable IT/OT devices, and industrial control systems (ICS) of an asset [49]. It also allows for the classification and certification of adversary behavior after a confirmed breach incident while working within IT and OT systems and infrastructure of the maritime asset.

7. CONCLUSIONS AND DISCUSSION

Ending this paper, the following conclusions and discussions points are derived:

(1) The evaluation of presented government and industry directives and standards has illustrated their inadequacy in covering the OT side of systems in ports infrastructure. Interoperability of IT and OT systems and the mitigation of credible threats are not tackled in a manner enabling the asset owners and operators in implementing the necessary measures and practices.

(2) The physical protection of assets, processes and IT and OT components needs to be enhanced so that credible threats by insider malicious actors are prevented. IT and OT components vulnerable to mishandling and manipulation need to be secured so that to mitigate potential cyber threats.

(3) The exploration of IT/OT vulnerabilities needs to be improved by port asset operators and owners. This can be achieved by the assessment of internal and external processes, stakeholder communications and IT/OT functions. Through this process existing mitigation measures can be evaluated, and potential vulnerabilities will be exposed.

(4) The use of available cybersecurity assessment methods from industrial sectors other than the maritime should be explored. The use of the API SRA method and the BTA method can be valuable tools in assessing technical and operational risks, vulnerabilities and measures in IT and OT components and functions. Their combination with the use of the MITRE ATT&CK Threat Model can enhance the insight of the attackers' behavior, and tactics and could be applied to industrial control systems (ICS), IT infrastructure, cloud storage and mobile devices.

(5) Training of port infrastructure personnel, vessel crews and maritime industry operatives in general should be pursued to a level higher that the current industry standards. It is apparent that human factors are very important in the integrity or failure of security measures in the physical and cyber domain of ports' infrastructure and operations.

(6) It is recommended that the convergence of cyber and physical security for the ports' infrastructure and vessels is pursued by asset owners and operators. This convergence involving operations and stakeholder management could improve the implementation of cyber and physical security policies, cyber risk reduction and threat mitigation.

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INVESTIGATING MARITIME ACCIDENTS THAT INVOLVE DANGEROUS GOODS USING HIERARCHICAL CLUSTERING

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ABSTRACT: Although the important progress in terms of safety and technological advances, maritime accidents remain a critical issue in merchant shipping. A high number of accidents continue to occur every year, with negative consequences both in economic and environmental terms (with often disastrous and lasting environmental impacts for marine ecosystems) and in the loss of human life. Understanding the maritime accidents phenomenon is expedient to giving shipping practitioners a focus for tailored interventions aimed at enhancing maritime safety. Using hierarchical clustering methods, this paper analyses historical data relating to maritime accidents to highlight the potential causal relationships that can describe homogeneous groups of accidents. The study explores a database consisting of 1,079 marine accidents that occurred worldwide in the 2009-2019 decade. Accident data is taken from the International Maritime Organization (IMO) database. After illustrating a description of the data set, a non-supervised hierarchical clustering analysis is applied to identify accident patterns, thus helping to better describe the phenomenon and identify potential causal relations that repeat in various accidents. A significant distinction emerges between the accidents that occur for technical reasons and those where human factors (stress, fatigue, situation awareness, decision-making, communication, etc.) play a prevalent role. Afterwards, the clustering analysis is applied to a sub-set of accidents (153 accidents) involving ships carrying dangerous goods (gases, oils, explosives, etc.). The results of the analysis point out the role of the human factor as the prevalent (or contributing) cause of the marine accidents related to work operations. Conversely, fires and explosions, which are by far the most frequent accidents involving ships carrying dangerous goods, are mainly caused by technical problems.

Keywords: Dangerous goods; Sea Accidents; Hierarchical Methods; Sea Safety.

1. INTRODUCTION

According to the International Maritime Organization (IMO), nearly one million seafarers work on about 60,000 large cargo vessels every day (IMO, 2021). Among the various risks associated with the maritime transport and storage of goods, there is the possibility of breakdowns or accidents during navigation, but also of overturning packages or leaking of material from containers, which can also cause loss of life as well as damage to the environment and properties.

When the cargo involves dangerous goods, maritime transport becomes even more complex and delicate. Dangerous goods have in fact some specific physical and chemical properties (e.g., flammability, explosion, corrosion, toxicity, radioactivity, etc.) that require greater caution and compliance with strict rules and regulations in handling. The International Maritime Dangerous Goods Code (The IMDG Code, 2020), drawn up by the IMO, is the international regulation that provides the requirements for the safe transport of dangerous goods by sea. It contains the criteria for classifying goods, packaging methods, conditions for transporting them in bulk or in tanks, indications for marking packages and transport units, criteria for drawing up transport documentation (Multimodal Dangerous Goods Form), types of tanks and vehicles suitable for transport by sea, etc.

The great volume of goods transported by sea inevitably involves significant risk of accidents. Despite several measures introduced in the last decades to increase safety levels of maritime operations (e.g., new forms of team training or new regulations), marine accidents are still a major concern. The marine accidents can be caused by a variety of factors, which are often difficult to identify. These factors can be related to the ship itself or its equipment, but can also be linked to environmental issues, navigational and operational factors, traffic aspects or human factors. They can also be caused, and often are, by more than one of the above factors (Fadda et al., 2021).

The attention of the scientific literature towards the topic is significant and growing. Luo and Shin's (2019) have revised 572 articles published from 1965 to 2014 showing that the focus of the research on maritime accident has shifted from naval architecture to human error and may continue to expand into socio-economic factors. To date, several studies have investigated the role of human errors in marine accidents and provided recommendations to decrease the risk associated to specific causes (Antão and Guedes Soares, 2019). According to Galieriková (2019), human error is the main cause contributing to up to 70% of marine accidents. Lecue et al. (2019) studied accidents in European ports from 1919 to present to better understand their main characteristics and typology, and consequent risk to society and the environment. Karakavuz et al (2020) analyzed chemicals transported in the Port of Houston and assigned an overall risk score based on public safety and environmental health effects, quantity transported, congestion and visibility in the port at the time of an incident. This was to assist government authorities, first responders, port workers and emergency planners in their decision-making processes. Effective risk control is a significant way to prevent accidents and provide port security, especially as regards dangerous goods storage (Chu and Lyu, 2018).

Wang et al (2021) have explored the relationship between the severity of marine accidents and influencing factors using an ordered logistic regression model that reflects the relationship between these factors and the severity of marine accidents.

The position of the vessel at the time of the accident should also be considered as the consequences may also vary according to the area involved: coastal waters, high seas, in port, at mooring or being maneuvered, at anchor, etc. For instance, when talking about human casualties and/or accidents in ports, one must consider that there are various activities in the port that imply a high human presence and therefore higher risks for humans. Such operations can include loading and unloading of goods, maneuvering operations in ports, oil jetty operations, shipbuilding activities, presence of fishing vessels, marina activities, dredging, construction of port infrastructure, etc.

In this study, a non-supervised hierarchical clustering analysis is applied to an IMO dataset consisting of 1,079 sea accidents that occurred worldwide between 2009 and 2019. Attention is also focused on a subset of accidents that involve ships carrying dangerous goods.

The main objectives of the study can be summarized as follows:

- identify the factors contributing to accidents at sea and compare them by homogeneous groups
- investigate the influence of human factors on maritime accidents.

The paper is organized as follows: following this introduction, Section 2 describes the data while Section 3 the methodology. The quantitative results of the application are set out in Section 4 and discussed in Section 5. The main conclusions drawn from the analysis are in Section 6.

2. DATA

According to the severity level, marine accidents can be classified into four categories of descending severity level:

- very serious marine casualties (they involve total loss of the ship, loss of life, or severe pollution)
- serious marine casualties (they result in immobilization of main engines, extensive accommodation damage, severe structural damage or pollution)
- less serious casualties
- marine incidents (of minor relevance, they are not reported in the IMO database)

In this study, only the first three types of marine accidents are considered.

Information on worldwide sea accidents used in this research has been derived from the IMO Marine Casualties and Incidents Database. The IMO database, defined as the Global Integrated Shipping Information System (GISIS), is available at: https://gisis.imo.org/. In particular, the analysis carried out in this research covers the decade 2009-2019. 4,347 ships were involved in a marine accident during the period under consideration, for a total of 3,710 reported accidents. Due to missing and uncomplete information, our statistical analysis is performed only considering the accidents that report complete information (1,079 accidents). Data cleaning operations were carried out to eliminate any redundancy and make the information in the database homogeneous and functional for the objectives of the study. This operation led to a reduction in the number of variables to be analyzed from 759 down to 70, with an increase in the degree of completeness of the database from 8% to 60%. Among the 70 variables considered, 17 relate to the vessel (IMO number, flag, length, tonnage, type of ship, type of service, etc.) and 53 to the accident (date and time, position, crew on board, initial event, etc.). The main data cleaning operations carried out were:

- aggregation of identical variables: when the same information is reported by more than one variable or when information related to one variable is reported by mistake inside the field related to another one
- aggregation of similar or infrequent variables: when several similar or infrequent variables are grouped into a single variable
- replacement of nominal qualitative variables by binary variables: when more than one mode of the same qualitative variable can be assigned to the same statistical unit
- conversion of information from several variables into a single variable: when the original database reports information from a single report item divided into several variables.

In a second step, the analysis was focused only on the accidents involving ships carrying dangerous goods. Since the original database did not contain the precise information about the type of goods transported by each vessel, this information was derived by assuming that the maritime transport of dangerous goods is mainly performed by tankers. Only the accidents involving this type of vessel where thus selected, including oil tankers, chemical tankers, gas tankers, other types of tankers. The resulting subset included 153 accidents and consisted of 447 records (more than one ship can be involved in the same accident), each characterized by the same 70 variables mentioned above.

3. METHODOLOGY

This study applies hierarchical clustering with the aim of identifying characteristic groups of marine incidents. This type of analysis allows grouping the incidents in such a way that those belonging to the same cluster have similar characteristics to each other and different from those of the other clusters. Several clustering techniques are available in the literature (Rai and Singh, 2017), in this study a multiple correspondence analysis followed by hierarchical clustering is used.

Multiple correspondence analysis is a technique of factor analysis applicable to qualitative data (Abdi and Valentine, 2006) that allows to extract a series of factors that synthesize the information contained in the original data. This analysis makes it possible to work on a space of reduced dimensions representative of the original variables while obtaining the quantitative variables necessary to perform hierarchical clustering. We decide to keep 20 dimensions for performing the hierarchical clustering analysis. They capture 84% of the overall variability of the original data.

The analysis was carried out on a subset of the 70 variables. Some of them (Ship name, IMO number etc.) were excluded because not suitable for the purposes of this analysis. In the remaining cases, the selection process was a subjective assessment based on two criteria. The first criterion is how interesting we considered the variable for the purposes of the analysis. The second criterion relates to the percentage of completeness of the variable in the database. Since this methodology can be applied on a dataset with no missing values, the inclusion of a variable with many missing values can be costly as it reduces the total number of accidents to be included in the analysis. Based on these considerations, we obtained a complete dataset composed of the following 17 variables: Ship type, Type of casualty, Loss of life, Location of the casualty, Consequences to the ship, Pilot on board, Human errors, Human violations, Technical failure, Problem with ship's cargo, Adverse weather conditions, Navigational tools problem, Communication, Standards of personal competence or lack of training, Fatigue, stress, or excessive workload, Hardware issues, Software issues.

Hierarchical clustering was then applied to create a hierarchical decomposition of the data represented by the dendrogram which is cut at a certain height set by the researcher to define the number of clusters of interest. The length of the branches indicates how homogeneous the group is. The greater the length, the greater the homogeneity within the group.

4. RESULTS

The resulting dendrogram has been divided at the level where it decomposes into 16 branches corresponding to the same number of clusters. The decision to divide into 16 clusters was taken with the aim of selecting the smallest number of clusters with the highest homogeneity (Fig.1).

Hierarchical tree

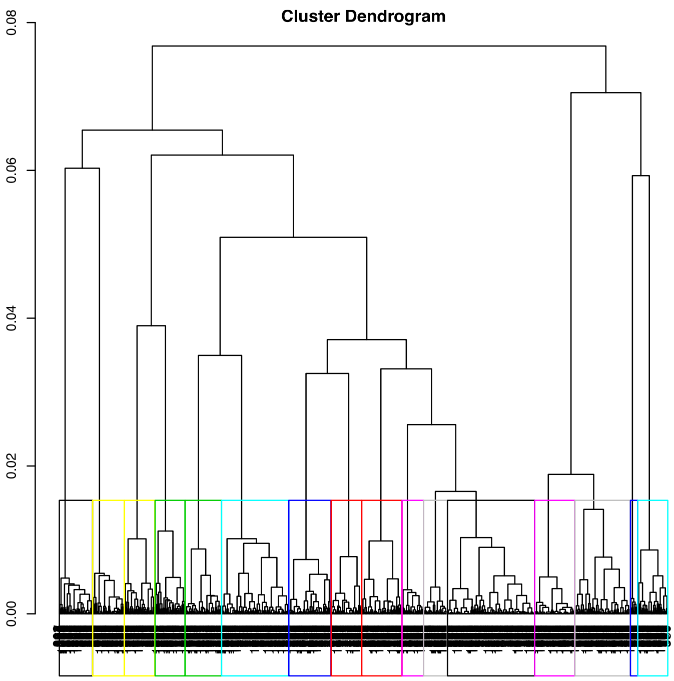

Figure 1: Dendogram – whole dataset (1,079 accidents)

Table 1 shows a description of the 16 clusters obtained. The first row shows the global composition of the variables while the remaining ones refer to each cluster and show the category of each variable significantly different from the global distribution that characterizes the most the clusters. In parenthesis, the first value is the cla/mod that is the proportion of all observations in the category belonging to the cluster and the second value is the mod/cla that is the proportion of all observations in the cluster belonging to the category.

The following list presents the types of maritime accidents identified by interpreting each cluster:

- Cluster 1: it groups the accidents where a machinery failure was registered, and the vessel was reported not able to continue navigation. In this cluster there are no registered problems related to human factors, but accidents are mostly caused by technical problems.
- Cluster 2: collisions and groundings of cargo vessels in territorial waters are grouped together. In most of these observations, the pilot was on board the vessel.
- Cluster 3: this cluster includes only accidents involving passenger vessels where no loss of life is reported. The most common type of accident in this cluster is fire and most of the vessels involved were not able to continue their navigation after the accident.
- Cluster 4: this group consists of stranded cargo ships. No loss of life is reported. Main causes include adverse weather conditions and, to a smaller part, the inappropriate choice of shipping route.

- Cluster 5: most of the accidents are related to fires caused by technical problems of the vessel. Most of the vessels involved are fishing vessels. No problems related to human factors are reported.
- Cluster 6: it groups accidents involving recreational vessels, which in most cases were involved in a collision. The accident usually took place in near-shore waters and the vessel was unable to continue navigation.
- Cluster 7: it includes accidents with damage to the vessel caused in most cases by a technical problem. In almost all observations the vessel was able to continue navigation.
- Cluster 8: it groups vessels involved in collisions. In most cases these accidents were recorded in open sea and loss of life was reported. No human factors issues were reported.
- Cluster 9: it is the largest cluster and includes collisions involving cargo ships. Most of these accidents were recorded in ports. Among the most common causes are adverse weather conditions and human errors related to lack of communication or errors in dealing with the correct operations.
- Cluster 10: all tankers are grouped together, and the most frequent accidents are related to work operations. In most cases the vessel was able to continue navigation. Communication problems and the presence of the pilot on board are reported.
- Cluster 11: it groups the incidents that report problems with protocols and/or working standards, as well as communication problems, thus relating to human factors in general. In most cases there were problems with on-board instrumentation. The most recorded incident was grounding.
- Cluster 12: it is the smallest cluster and includes all accidents involving water on board. Most of the vessels involved in this type of accident are fishing boats. The lack of adequate training of the maritime operators is reported.
- Cluster 13: it groups accidents involving capsizing. In many cases, the vessels involved are pleasure crafts and loss of life is reported. Problems related to the lack of adequate training of maritime personnel are highlighted.
- Cluster 14: it groups accidents involving work operations at sea. Loss of life is reported, but problems related to human factors are not specified.
- Cluster 15: it groups accidents related to problems with working protocols and standards. In addition, fatigue of seafarers and communication problems are reported as problems. A large proportion of the incidents were recorded in sub-coastal waters.
- Cluster 16: it groups accidents related to cargo loading operations. In most cases these accidents occurred in ports and resulted in loss of life. In this cluster, problems with working protocols and standards are evident, particularly in relation to poor communication and lack of adequate training of personnel.

Table 1: Clusters' size and features – Whole dataset (1,079 accidents)

No.	Size	Type of casualty	Ship type	Location	Loss of life	Consequences to the ship	Pilot on Board	Hardware factors	Software factors	Personnel factors	Human error	Human violations	Other causes
Overall	**1151**	Capsizing (5%), Collision (34%), Damage to the ship (5%), Fire (15%), Flooding (1%), Grounding (14%), Machinery Failure (6%), Work Accident (20%)	Cargo (57%), Fishing (12%), Passenger (10%), Special Craft (8%), Tanker (13%)	Coastal waters (25%), Inland waters (8%), Open Sea (27%), Port (40%)	Yes (32%) No (68%)	Ship remains fit to proceed (49%) Ship rendered unfit to proceed (28%) Total loss of the ship (23%)	Yes (19%) No (81%)	Yes (19%) No (81%)	Yes (40%) No (60%)	Communication (11%), Standards of personal competence (18%), Fatigue (8%), Other (11%), No (66%)	Error in judgement (29%), Failure to respond appropriately (12%), Incorrect operations of control (11%), Inappropriate choice of route (5%), Forgetting to report information (2%), Failure to advise officer on the watch (2%), Deciding not to pass on information (4%), Failure to report due to distraction (2%), Other Errors (24%), No (46%)	Necessary (6%), Routine (12%), Other (9%), No (75%)	Problem with cargo (10%), Technical failure (33%), Structural failure (8%), Adverse weather (29%), Navigational tool problems (6%), No (40%)
1	63	Machinery failure (98%, 100%)			No (7%, 91%)	Ship rendered unfit to proceed (9%, 44%)				No (8%, 91%)	No (10%, 79%)	No (7%, 89%)	Technical failure (13%, 78%), Structural failure (21%, 30%)
2	58	Collision (9%, 64%), Grounding (11%, 29%)	Cargo (8%, 89%)	Inland waters (60%, 100%)	No (7%, 93%)	Ship rendered unfit to proceed (7%, 40%)	Yes (19%, 71%)	No (6%, 93%)	No (7%, 80%)				
3	69	Fire (15%, 38%)	Passenger (62%, 100%)	Coastal waters (9%, 36%)	No (8%, 94%)	Ship rendered unfit to proceed (11%, 52%)					No (8%, 61%)		
4	80	Grounding (50%, 100%)	Cargo (9%, 75%)	Coastal waters (13%, 45%)	No (10%, 98%)	Ship rendered unfit to proceed (10%, 39%)				Other (14%, 21%)	Inappropriate choice of route (25%, 19%)		Adverse weather (12%, 51%)
5	127	Fire (63%, 87%)	Fishing (24%, 25%)	Open sea (21%, 50%)	No (13%, 76%)	Total loss of the ship (18%, 39%)	No (12%, 91%)	Yes (17%, 30%)	No (13%, 72%)	No (15%, 87%)	No (18%, 75%)	No (13%, 91%)	Technical failure (21%, 63%), Problem with cargo (21%, 19%)
6	41	Collision (7%, 68%)	Special Craft (43%, 100%)	Coastal waters (6%, 44%)	No (5%, 90%)	Ship rendered unfit to proceed (6%, 46%)	No (4%, 93%)		No (5%, 80%)				No (6%, 61%)
7	60	Damage to ship (100%, 100%)				Ship remains fit to proceed (8%, 77%)					No (8%, 73%)	No (6%, 90%)	Technical failure (10%, 67%)
8	45	Collision (11%, 98%)	Fishing (27%, 80%)	Open sea (8%, 53%)	Yes (8%, 62%)	Total loss of the ship (11%, 67%)	No (5%, 96%)	No (5%, 96%)		No (6%, 93%)			No (8%, 78%)
9	165	Collision (40%, 95%)	Cargo (24%, 96%)	Port (18%, 49%)	No (18%, 85%)	Ship remains fit to proceed (17%, 58%)	Yes (19%, 25%)	No (17%, 96%)	No (18%, 75%)	No (17%, 78%)	Failure to respond appropriately (27%, 23%), Error in judgement (19%, 39%), Deciding not to pass on information (26%, 7%)		Adverse weather (20%, 40%)

10	76	Work accident (12%, 37%)	Tanker (50%, 100%)			Ship remains fit to proceed (9%, 70%)	Yes (12%, 33%)	No (7%, 90%)		Communication (12%, 21%)			No (12%, 74%)
11	57	Grounding (15%, 40%)		Inland waters (10%, 18%)	No (7%, 91%)				Yes (9%, 70%)		Inappropriate choice of route (25%, 26%), Error in judgement (9%, 51%), Incorrect operations of control (11%, 25%), Failure to respond appropriately (9%, 23%)	Necessary (11%, 14%)	Navigational tool problems (87%, 97%)
12	14	Flooding (100%, 100%)	Fishing (4%, 43%)	Coastal waters (3%, 64%)		Total loss of the ship (5%, 86%)			Yes (2%, 72%)	Standards of personal competence (3%, 43%)			
13	57	Capsizing (98%, 100%)	Special Craft (18%, 30%)	Coastal waters (9%, 44%)	Yes (9%, 56%)	Total loss of the ship (19%, 90%)	No (6%, 97%)	Yes (9%, 33%)		Standards of personal competence (8%, 28%)			Problem with cargo (20%, 40%)
14	76	Work accident (33%, 99%)	Cargo (11%, 92%)	Open sea (10%, 41%)	Yes (19%, 93%)	Ship remains fit to proceed (13%, 93%)		No (8%, 100%)	No (8%, 72%)	Other (13%, 21%)			No (13%, 75%)
15	58	Work accident (9%, 34%)		Coastal waters (9%, 43%)					Yes (9%, 72%)	Communication (12%, 28%), Fatigue (67%, 100%), Other (12%, 26%)	Failure to report due to distraction (33%, 14%), Other (10%, 47%), Error in judgement (8%, 48%), Deciding not to pass on information (14%, 10%), Failure to respond appropriately (9%, 22%), Forgetting to report information (18%, 7%)	Necessary (14%, 17%)	
16	105	Work accident (40%, 86%)	Cargo (13%, 83%)	Port (14%, 61%)	Yes (23%, 80%)	Ship remains fit to proceed (16%, 88%)	No (11%, 94%)	Yes (27%, 57%)	Yes (16%, 72%)	Standards of personal competence (26%, 50%), Communication (26%, 32%), Other (16%, 19%)	Incorrect operation of control (19%, 24%), Other (18%, 48%), Error in judgement (16%, 52%), Failure to advise officer on the watch (25%, 5%), Failure to respond appropriately (16%, 21%), Forgetting to report information (32%, 7%)	Necessary (30%, 20%), Routine (21%, 29%), Other (18%, 17%)	Problem with cargo (27%, 30%), Technical failure (14%, 53%),

A second cluster analysis was then applied considering only the subset of accidents involving the vessels carrying dangerous goods. The resulting dendrogram was cut to obtain a three-group partitioning (Figure 2) that proved to be the clearest and most functional for the objectives of this analysis. Table 2 lists the main features of each cluster. The first row shows the global composition of the variables while the second row the composition of the variables for tanker ships only. The remaining rows refer to each cluster and show the category of each variable significantly different from the global distribution that characterizes the most the clusters. A brief description is provided below:

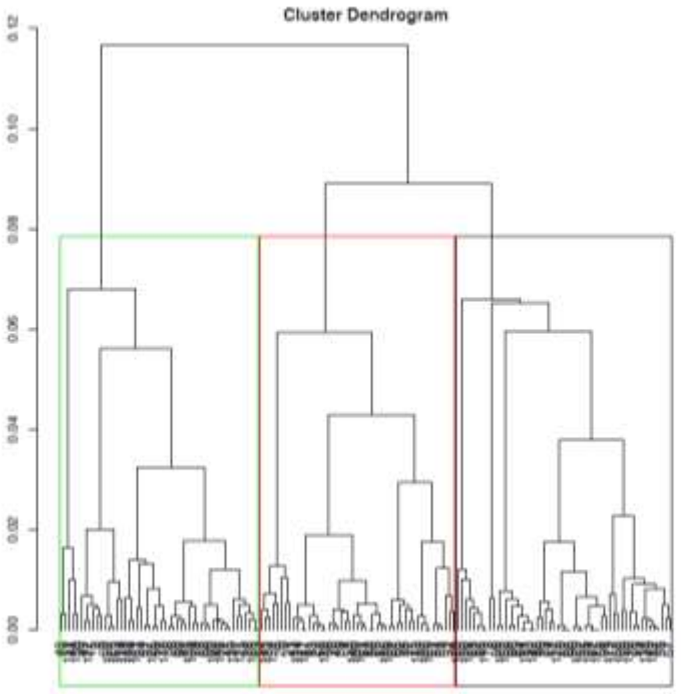

Figure 2. Dendrogram of accidents involving ships carrying dangerous goods

- Cluster 1: the main cause of these accidents is a fire or mechanical failure or damage to the ship, often (65% of cases) caused by a technical problem. The human factor is not a major factor in most of these accidents.
- Cluster 2: the cause of these accidents is a collision or grounding that occurs frequently in inland waters and with the pilot on board. Insufficient support of vessel traffic services equipment is reported in one out of six cases.
- Cluster 3: the causes of these casualties are accidents at work mostly caused by human errors or violations. In these accidents, inadequate supervision or mismanagement of resources (software factors), communication problems and/or inadequate training of the workers resulting in violations and errors of judgement are reported as the main or contributory causes of the accidents.

Table 2: Clusters' size and features – Subset of accidents involving ships carrying dangerous goods (153 accidents)

No.	Size	Type of casualty	Location	Loss of life	Consequences to the ship	Pilot on Board	Hardware factors	Software factors	Personnel factors	Human error	Human violations	Other causes
Overall	**1151**	Capsizing (5%), Collision (34%), Damage to the ship (5%), Fire (15%), Flooding (1%), Grounding (14%), Machinery Failure (6%), Work Accident (20%)	Coastal waters (25%), Inland waters (8%), Open sea (27%), Port (40%)	Yes (32%) No (68%)	Ship remains fit to proceed (49%) Ship rendered unfit to proceed (28%) Total loss of the ship (23%)	Yes (19%) No (81%)	Yes (19%) No (81%)	Yes (40%) No (60%)	Communication (11%), Standards of personal competence (18%), Fatigue (8%), Other (11%), No (66%)	Error in judgement (29%), Failure to respond appropriately (12%), Incorrect operations of control (11%), Inappropriate choice of route (5%), Forgetting to report information (2%), Failure to advise officer on the watch (2%), Deciding not to pass on information (4%), Failure to report due to distraction (2%), Other Errors (24%), No (46%)	Necessary (6%), Routine (12%), Other (9%), No (75%)	Problem with cargo (10%), Technical failure (33%), Structural failure (5%), Adverse weather (29%), Navigational tool problems (6%), No (40%)
Tanker	**153**	Capsizing (1%), Collision (28%), Damage to the ship (5%), Fire (22%), Flooding (1%), Grounding (14%), Machinery Failure (7%), Work Accident (22%)	Coastal waters (22%), Inland waters (9%), Open sea (28%), Port (41%)	Yes (33%) No (67%)	Ship remains fit to proceed (53%) Ship rendered unfit to proceed (34%) Total loss of the ship (13%)	Yes (23%) No (77%)	Yes (18%) No (82%)	Yes (35%) No (65%)	Communication (18%), Standards of personal competence (16%), Fatigue (8%), Other (11%), No (63%)	Error in judgement (27%), Failure to respond appropriately (9%), Incorrect operations of control (7%), Inappropriate choice of route (2%), Forgetting to report information (1%), Failure to advise officer on the watch (2%), Deciding not to pass on information (5%), Failure to report due to distraction (3%), Other Errors (29%), No (43%)	Necessary (4%), Routine (16%), Other (5%), No (77%)	Problem with cargo (4%), Technical failure (29%), Structural failure (8%), Adverse weather (25%), Navigational tool problems (5%), No (40%)
1	54	Fire (74%, 46%), Machinery failure (100%, 20%), Damage to the ship (100%, 15%)		No (41%, 78%)	Total loss (85%, 32%)	No (41%, 89%)		No (42%, 76%)	No (48%, 85%)	No (54%, 65%)	No (43%, 93%)	Technical failure (80%, 65%)
2	49	Collision (77%, 67%), Grounding (76%, 33%)	Inland waters (79%, 23%)	No (47%, 98%)		Yes (60%, 43%)	No (38%, 96%)					Navigational tools problem (100%, 16%)
3	50	Work accident (94%, 64%)		Yes (74%, 74%)	Fit to proceed (47%, 76%)			Yes (53%, 56%)	Communication (63%, 34%), Standards of personal competence (60%, 30%), Fatigue (100%, 26%), Other (59%, 20%)	Error in judgement (54%, 44%), Other (56%, 50%), Failure to advise officer on the watch (100%, 6%), Failure to report due to distraction (80%, 8%)	Routine (71%, 34%), Other (86%, 12%)	Problem with cargo (83%, 10%)

5. DISCUSSION

The clusters described provide a general overview of the phenomenon of maritime accidents. From the results obtained in the analysis of the general dataset there seem to be two main variables that mostly guide the formation of the clusters. The main one is the one describing the type of accident, while the second one describes the type of vessel. Looking more closely at the clusters, the types of accident that occur most frequently are collisions and accidents during work operations. These types of accidents can be subdivided by vessel type (the vessels most involved in maritime accidents are cargo vessels), and by the location of the accident (port, open sea, inland waters, coastal waters).

As can be seen in Table 1, clusters 1 to 8 do not report problems related to human factors, unlike the remaining clusters 9 to 16. In particular, the probability of human errors and/or violations causing an incident increases when problems related to "Software issues" (problems with protocols, standards, and company policy) and "Personnel factors" (inadequate staff training, excessive workloads and communication problems) are reported.

In the specific case of accidents involving ships carrying dangerous goods, the described three-group partitioning proved to be the most functional for the objectives of this analysis. Clusters 1 and 2 highlighted how the human factor is not determining in causing these types of accidents. Fires and explosions are indeed mainly caused by technical problems. Conversely, Cluster 3 groups the accidents during working operations where the human factor plays a crucial role.

In general, the accidents involving dangerous goods do not show any noticeable peculiarity compared to the overall dataset. The only distinguishing feature is a higher percentage of fire and explosion cases than the rest of the sample (22% against 15%).

6. CONCLUSIONS

Despite recent technological and safety advances, numerous maritime accidents continue to occur every year, with causes not always known and ineffective prevention mechanisms.

This study applied clustering methods to incident data derived from an IMO database that collects the maritime accidents occurred around the globe between 2009 and 2019 in an attempt to identify causal links between the various causes of accidents.

A notable distinction emerged between the accidents due to technical causes and those where the human factor plays a predominant role. The latter, in the sense of error and violation, occurs most frequently when there is a lack in company protocols, standards and policies, or a problem with maintenance and the malfunctioning of on-board equipment.

The same methodology was applied to a subset of accidents involving ships carrying dangerous goods. The results confirmed the distinction between the accidents where the human factor is important and the accidents where it is not. Error in judgement, communication problems and low standards of competence of the personnel are pointed to be critical in causing the accidents during work operations. On the other hand, fires and explosions turned out to be more frequent for ships carrying dangerous goods, but they are mainly caused by technical problems.

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THE ROLE OF VESSEL MONITORING SYSTEMS (VMS) IN MITIGATING ILLEGAL, UNREPORTED AND UNREGULATED (IUU) FISHING

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ABSTRACT

Blue Economy is a broad concept that explore the sustainability within different industries including the shipping, fisheries, and maritime transport, moreover, a sustainable blue economy aims to provides social and financial benefits for next generations , in this regard the applications of smart technology in the marine industry aims to relish the previously unattainable ocean resources , moreover the implementation of the IOT in the fishery industry can enormously boost the degree of fishery modernization which plainly feature the need to speed up the improvement of the fishery Internet and large information industry, The purpose of this paper is to review the sustainable technologies implemented in the blue economy , especially the vessel monitoring system (VMS) ,In order to identify the best technological solutions applied in the blue economy.

Keywords: technology development, fisheries, maritime transport, shipping, Blue Economy, vessel monitoring system (VMS), The UN Sustainable Development goals (SDGs), The Internet of Things (IOT), illegal, unreported and unregulated fishing (IUUF).

INTRODUCTION

The concept of "blue economy " was firstly revealed on the Rio+20 United Nations Conference on Sustainable Development, held in Rio de Janeiro in June 2012. This convention addressed key themes: the in addition improvement and refinement of the Institutional Framework for Sustainable Development and the development of the "green economy" concept. The final recommendations of the assembly considered poverty eradication as a key objective and encouraged the developing and developed countries to promote sustainable development initiatives that eradicate poverty and protect the environment. [30]

The Blue Economy encompasses mainly five major sectors which – Renewable energy, Biotechnology, Coastal and maritime tourism, Aquaculture, Mineral resources – and mentions the other four above listed fields – Shipbuilding and ship repair, Transport, Fishery, Offshore oil

and gas – as "other sectors" of the Blue Economy [33], the above mentioned sectors includes twenty sixth industries and services which constitute about 20 percent of the employees in some countries [23]
.
From an economic perspective, "Blue Economy" is meant to boost economic growth and create using sustainable procedures especially on the marine industry including construction, transportation, mineral resources development, ship building, communication cable laying, pharmaceutical enterprises, equipment deployment, sustainable energy from waves, currents, seaside leisure tourism, and fisheries and aquaculture[14], in this respect the blue economy supports the progress towards 'low carbon' economies that relies on the Blue Carbon to realize their sustainable development goals .[28]

Generally speaking, blue economy evidently affect the global maritime security as the inefficient use of the natural resources will probably lead to economic crises and political instability , which fuels insecurity, stimulate illicit activities and even radicalization.[11]

In such manner, fishing innovation, has a significant role to play in the fishery development, consequently a dramatic change is happening in the design, management and the navigation on board fishing vessels, which will facilitate the synchronization of different operations on board of the fishery vessels , the expected development of the fishing operations from manual to automated operations that relies more on IOT technologies, will consequently boost the entire fishery industry, the development of the fishery industry is expected to accelerate during the next few decades, Indeed some of the IOT applications in the fishery industry are widely adopted in Canada, Denmark and Iceland.[3]

This paper is organized as follows The first section gives a brief overview of the concept of Blue Economy, The second section demonstrates countries blue economy strategic Plan , the third section reviews different IOT solutions for blue economy ,the fourth section reviews the implementation of the vessel monitoring systems (VMS) in the fishery industry , Our conclusions are drawn in the final section.

BACKGROUND

The UN Member States agreed on the 2030 Agenda for Sustainable Development in 2015, which present a framework for the Sustainable Development agenda that aims to maintain peace and prosperity for people and the planet today and in the future. The 17 Sustainable Development goals (SDGs) encourages all countries - developed and developing - to align together to fulfil the agreed upon goals, that mainly aims to eradicate ,poverty , improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.[32]

In this regards ,(Lee, K.-H, et al, 2020) studied the relevancy of the United nations Sustainable Development Goals (SDGs), the research reviewed the number of published research concerning the blue economy and the 17 sustainable development goals , according to the research results the BE is highly linked to SDGs 14–17 , As the blue Economy deals mainly with the optimization use of the mineral resources and aquatic resources ,consequently the SDG 14 Life Below Water , SDG 15 Life On Land and SDG 12 Responsible Consumption & Production were highly linked to the blue economy concept .[16]

Mesut S. (2021) referred to the Blue economy as a blue ocean strategy that creates new markets that promote productivity and boost economic productivity within a country. [19]

BLUE ECONOMY STRATEGIC PLAN

It's fair to say that around ninety seven percentage of the world's fishers lives in a developing countries where the fishing activities provides them with income and nutrition's [11], Indeed, The National Oceanic and Atmospheric Administration (NOAA) indicated that the US fishery industry generated more than $244 billion in sales and supported more than 1.7 million jobs in 2017. [36]

Blue Economy account for around 1.5 percent of European Union (EU-27 GDP) and 4.5 million direct jobs, or 2.3 percent of overall employment in the European Union. New Blue Economy industries, such as ocean renewable energy, blue biotechnology, and algae manufacturing, are creating new markets and jobs. [7]

The emerging concept of the blue economy has led many governments to set out framework that supports the Blue Economy expansion as a main contributor to the economic and social development, indeed as a mean for achieving sustainable economic development based on an ocean-based economy, Meanwhile, many countries started to include their blue economy vision in their strategic plans, in order to sustainably maximize its wealth from the nautical resources.

In this regard, In January 2021, The National Oceanic and Atmospheric Administration NOAA of the united states released the country Blue Economy Strategic Plan for 2021-2025, that provides the guideline to promote the American Blue Economy and to improve the global maritime economy, The Strategic Plan was based on five main pillars that the NOAA will rely on in achieving the strategic objectives which includes the development of the following sectors : marine transportation, ocean exploration, seafood competitiveness, tourism and recreation, and coastal resilience. NOAA plans to develop these industries significantly by encouraging the public-private sectors cooperation , support more innovation, and implementing creative STEM education and outreach programs to prepare the next generation of Blue Economy leaders.[.31]

Bari, A. (2017). Analyzed the blue economy performance in Bangladesh in comparison with other south-Asian countries , given the fact that the fishing productivity of Bangladesh is quite high in comparison with the other regional countries ,however the number of merchant fleets is very small in comparison with other regional countries .[1]

In this regard, the seventh Bengaline five year plan FYP has set the following actions to be taken in order to "create and maintain a prosperous and sustainable blue economy":

- securing and dealing the marine resources for the present the future,
- fostering a solid renewable resources using the ocean ,wind and other natural resources
- Keeping up with the technological development in the ship building industry
- Extending the fishing areas using new technologies, in order to increase the fishing capacity beyond the "Exclusive Economic Zone (EEZ)" of Bangladesh that the country currently rely on.
- Fostering a solid capacity building programs that develop the labor force for the upcoming challenges in the global marine industry.
- Substantially increasing fisheries production and export earnings through improved aquaculture and introduction of marine culture.
- give special priority to anticipated Climate Change impacts on all relevant matters, and adjust policies and plans
- Increasing the contribution of the maritime economy to the country nominal GDP by the expansion of domestic fleet, destinations, transshipment, transit provisions, linking sea-ports. give unique need to expected Climate Change impacts on every single pertinent matter, and change approaches and plans
- Keep up with the inland waterway frameworks and environments for fishery, dregs transport, and inland delivery,
- Implementing R&D Strategies that encourages research in the topics related to the blue economy development .
- The establishment of a marine institute in Khulna

(Bax, N., et al , 2020) conducted a comparative study between New Zeeland and Myanmar to define the main challenges facing the blue economy in both countries and the undertaken initiatives , part of the initiatives was the development of the legislation and regulations that were enforced to protect the fertility of terrestrial and marine resources , moreover the informative channels as www.gbif.org and futureearth.org that raise the awareness about the global biodiversity .[2].

With the aim of protecting aquatic ecosystem, the European Union issued an amendment to the common fisheries policy (CFP) in 2018 , to modernize, strengthen and simplify the EU fisheries control system, ensure sustainability and increase the level playing field in fisheries control.[4]

In a similar context ,(Voyer, D. M., & van Leeuwen, D. J. 2019) investigated the challenges faced to issue a Social license to operate in the Blue Economy (SOL), the study suggested the implementation of the SOL as a part of the formal, regulatory approvals process that integrate different stakeholders from the governmental and nongovernmental organizations (NGOs) , in order to abide the legislative and environmental concerns , especially the ones associated with seabed mining and oil and gas explorations .[34]

THE BLUE ECONOMY TECHNOLOGIES

The Internet of Things (IOT) can be defined as an interconnected processing gadgets, mechanical and computerized apparatus, things, and individuals with unique identifiers and the capacity to transfer data without expecting human-to-human or human-to-PC association, according to an individual point of view, from a personal perspective, the Internet of Things (IOT) can be defined as the collection of devices connected to a smart home network that provides them an IP address and allows them to communicate with one another directly or through the cloud networking.[27]

Maksimovic (2017) defined the green IoT (G-IoT) as a concept based on the same computing hardware, communications protocols, and networking architectures as the IoT, but with more environmentally friendly and energy efficient manufacturing paradigms (significantly reduced energy usage, carbon emissions, and toxic pollutions). Consequently , the G-IoT includes RFID, Wireless Sensor Networks (WSN), cellular networks, Machine-to-Machine communications (M2M), energy harvesting devices and communications, cognitive radio, Edge/Fog/Cloud computing, and Big data analysis as well [20]

In this regard ,the implementation of Internet of Things technologies in the blue economy industries is still at early stages in many countries , and in many instances its used for exploration and examination but not adopted as an alternative solution, for instance , the application of fishery Internet of Things is very limited , due to the associated cost and the required know how to implement the IOT solutions in the fishery industry , accordingly , the technological developed countries are more likely to examine and implement IOT technologies to realize their blue economy objectives .

According to Spalding, M. J. (2016), the blue technology sector includes providers of infrastructure, including producers of sensors, instruments, through the establishment of frameworks that securely shares the data among the different stakeholders, in order to realize a sustainable aquaculture development [26]

In a similar context ,Ji, J., & Li, Y. (2021) analyzed the effect of the information technology utilization on the fishery industry in china, the research results indicated that the IT infrastructure and the human capacity are mainly affecting the fishery economic efficiency, as the technological solutions increases the efficiency of the fishery associated processes , which includes : the fishery resource management, environmental protection, fishing situation detection and forecasting, fishing vessel navigation, and real-time command of offshore operation.[18].

According to Song, Y., & Zhu, K. (2019) Fishery internet of things and big data industry have the Following characteristics:

1) Universalization of perceptual recognition
2) Interconnection of heterogeneous equipment
3) Intelligent management and control
4) Chain of application services [27]

(Fujii, H.,et al ,2017) referred to the Organization for Economic Co-operation and Development OECD fishery technologies in their analysis for the fishery technology development in the top north-east Asian markets , the OECD classified the fishery technology in to three categories : harvesting technology, aquaculture technology, and new products technology. , in this respect the research investigated the technology development of these three sectors in china , south Korea and Japan , the results of the cross sectional data analysis showed that the aquaculture and harvestings technologies attracted most of the R&D investments among the three countries.[8]

In February 2020 , UNISOT, unveiled a new Block-chain supply chain solution that servers the Seafood and Aquaculture industries , the new revealed solution aimed to help the supply chain stakeholders to record and display insights into the supply chain by using Smart Digital Twins and Product DNA. The Global Traceability, Proof-of-Quality and Product Provenance capacities give upgraded straightforwardness and satisfaction , by developing the supply chain network that offers the end customer to evidently monitor the supply chain process to assure the timeliness and quality of the transport. The new block chain technology offers a more simple way to comply with the legal and regulatory requirements . [25]

In a similar context, Jæger, B., & Mishra, A. (2020) deployed an IOT tracing platform for seafood product using electronic product code technologies and Serial Shipping Container Code (SSCC) as a unique identifier to trace the fish crates along the supply chain process , the platform proved that IoT technology can improve quality management capability, logistics management competence, and competitiveness of domestic and international trade in the process of seafood traceability.[35]

Accordingly,(Vedachalam, N.,et al ,2018) demonstrated the different adopted technologies to protect the marine environment in India , which includes deep ocean mineral exploration using remotely operated vehicle (ROSUB 6000), LIDAR-based data collection platforms to measure the wind electricity generating capacity and PROVe monitoring system designed to protect the coral reefs.[35]

Mulema, S. A., & García, A. C. (2019) proposed an IOT that monitor water quality using four different sensors that measures temperature, dissolved oxygen, potential hydrogen (pH) value and water level, the data was calculated in a specific time span and then transferred to the central processor. The central processor processes the parameters received and if the parameters are exceeding the threshold values it gives the buzzer signal and then corresponding relay is activated to bring back the measured value to the normal level, moreover the system send the measured value back to the authorized person for review via email and short message .[21]

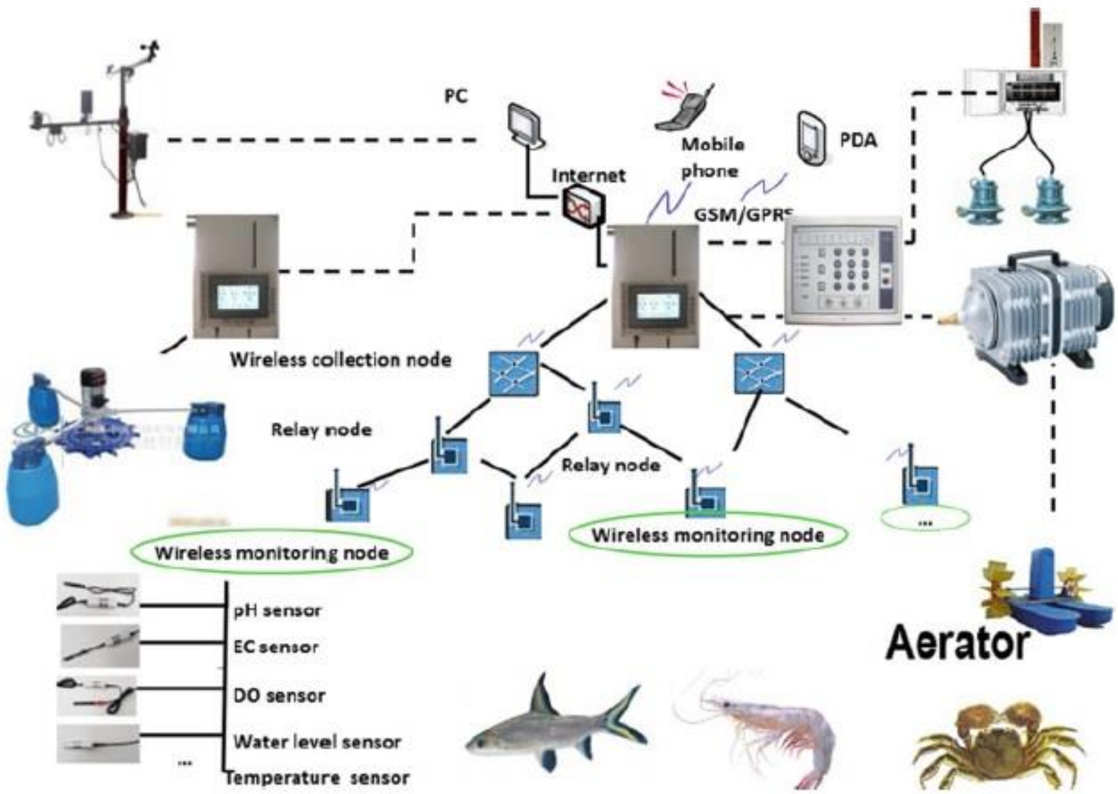

Figure (1) depicts the IOT utilize in aquaculture [29]

SATELLITE-BASED VESSEL MONITORING SYSTEM (VMS)

Recent developments in the fishery industry have increased the need to monitor fishing fleets, in order to predict fishing grounds and to deal with illegal, unreported and unregulated fishing (IUUF), given the fact that the International Maritime Organization (IMO) mandates that all vessels with a gross tonnage of 300 GT and larger to install automatic identification system (AIS) on board , henceforth the vast majority of fishing boats are not required to install any tracking system on board .

Vessel Monitoring System (VMS) could be defined as the system utilized in monitoring the fishery activities within the countries territorial water, in this regards the with the country business fishing inside the country Marine domain, in this regard this inn (VMS) is considered as a very useful tool that aid in the realization of the blue economy strategic objective as the aquaculture sustainability and economic sustainability , moreover, VMS can be utilized to monitor vessels navigating in the exclusive economic zone (EEZ), by monitoring vessels the navigation of vessels navigating within the range of 200 nautical miles (370.4 km) from the regional waters, consequently, VMS system is utilized by different administrations to guarantee legitimate fishing, forestalling illicit fishing and consequently securing and working on the livelihoods of anglers. [37]

Consequently government authorities have taken various regulatory actions to prevent fishing illegal activities , in this aspect the European Union (EU) enacted Commission Regulation (EC) No 2244/2003 that prohibited fishing vessels from engaging in fishing activities unless they have installed on board a device, which allows them to be detected and identified by remote monitoring systems , in this regard fishing vessels flying a EU member flag and with a length exceeding 15 meters are required to install a satellite-based Vessel Monitoring System (VMS)on board .[6],accordingly the Indonesian government in 2015 requested all the vessels of a gross tonnage greater than 30 tons to install a VMS transmitter before starting fishing activities on the Republic of Indonesia Water Region and the high seas .[29], alternatively , many Arab countries including : Morocco[22] ,Tunisia [9] and Oman[10] requires a VMS terminal to be installed on board of fishing boats , indeed the united kingdom (UK) requires I-VMS which is similar to VMS tracking devices to be installed on board of y fishing vessels 12 meters and greater in overall length. [12]

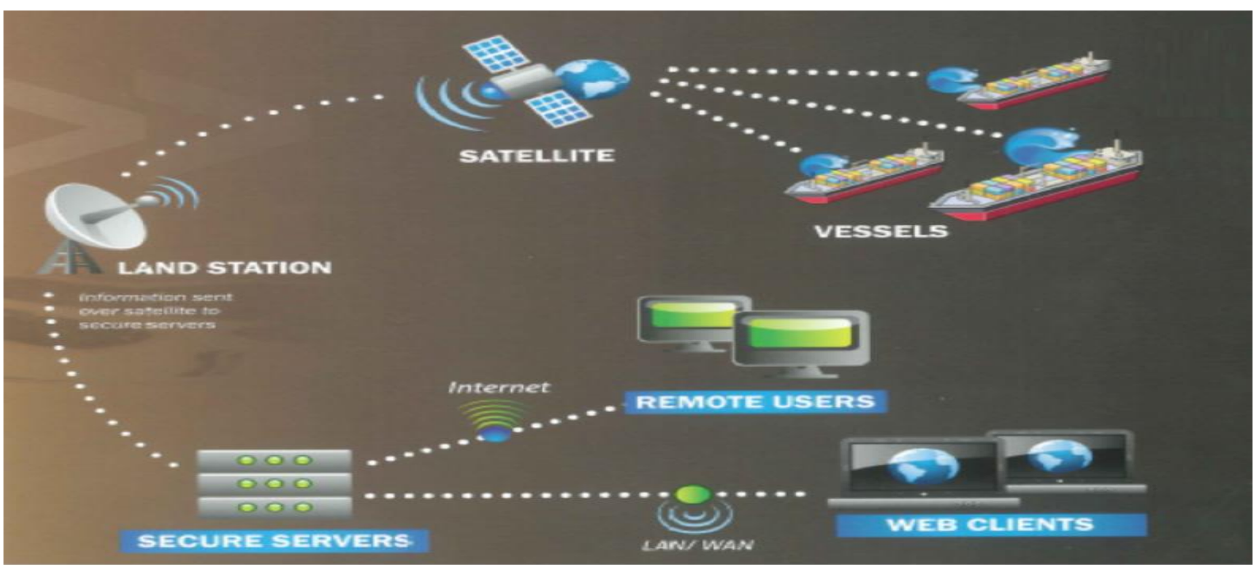

Figure (1) demonstrates how vessel monitoring system works

Source: https://www.bhsfu.gov.bz/mcs/vms/

The above figure shows that the Vessel Monitoring System (VMS) comprises of a following unit on board of vessel, a Mobile Transceiver Unit (MTC), the transmission medium. In the BHSFU's VMS, MTU's with inherent global positioning system (GPS) to transmit data of the vessel position, course and speed through an Inmarsat correspondences satellite to land earth station. This data is sent by secure web network to the data base of the Fisheries Monitoring Center (FMC) , the FMC maps the coordinates of the vessel location view using an installed software , further the FMC staffs can adequately monitor fishing activity of individual vessel by creating tracks between polls as the information enters the FMC [24]

(Li, J.,et al ,2021) analyzed the lighting fisheries in china based on VMS data transmitted via Beidou navigation system, the research results showed a highly significant positive between the lighting fisheries activities and the catching rate .[20]

Two of the main goals of fishery monitoring is to determine the fishery exploitation and abundance estimation of fish stocks , in this respect (Ducharme-Barth, et al , 2018) reviewed the abundance pattern of the fishing species, the research compared the catch per unit of effort (CPUE) provided by the indices standardized by the Delta-GLM and the data collected by the VMS , the results showed the VMS method is comparatively simpler than delta-GLMs, and robust to changes in species and effort distributions. [5]

CONCLUSION

The Blue Economy is meant to boost economic growth using sustainable procedures especially ,on the marine industry including construction, transportation, mineral resources development, ship building, communication cable laying, pharmaceutical enterprises, equipment deployment, sustainable energy from waves, seaside leisure tourism, and fisheries and aquaculture , from a global perspective, the blue economy employs over 350 million in fishing, aquaculture, beach and marine tourism, five millions of them located in Europe [13]

In many countries, the blue economy isn't just represented in a few initiatives but rather in a broad strategy that encourage the Aquaculture & Blue economy development Programs, indeed , the countries efforts to achieve the UN sustainable development goals (SDGs), encouraged the government's to recognize the growth opportunities of the Blue Economy and its strategic position within the world's economy .

One of the main challenges facing the blue economy is the adoption of new technology that serves the blue economy, in order to regulate, and control fishing, to maintain food security and nutrition, to increase the proportion of renewable energy in the world's energy supply.

In this paper, we presented the adoption and use of digital technologies and IoT in the blue economy, many IOT solutions could be implemented to boost the performance of the blue economy related industries which includes; Biotechnology, Coastal and maritime tourism, Aquaculture, Mineral resources.

Given the fact the International Maritime Organization (IMO) doesn't require the small fishing vessel 15 meter length and over to install a tracing system on board of vessels , many countries enforced the fishing vessels to install a vessel monitoring system (VMS) to operate in the country territorial water.

Vessel Monitoring Systems (VMS) and Automatic Identification System (AIS) are widely used in monitoring fishing vessels from different aspects, however, VMS offers an efficient monitoring of the fishing vessels navigating through the territorial water at a lower cost in comparison with other monitoring technologies.

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Universal Journal Bearing Test Rig Uncertainty and Validation Measurement to Enhance Marine Shafting Performance

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ABSTRACT

Enhancing the ship power transmission is surely a target sought by all those involved in the marine applications, mainly due to its beneficial results regarding making tangible reduction in fuel oil consumption, consequently considerable reduction in emissions to environment. The oil film lubrication within journal bearings is certainly a key factor in attaining that goal. Besides, journal bearings being essentially intrinsic structures by which numerous experimental tests could successfully be carried out. The first vital step in the uninterrupted series of the research efforts at hand has been to design and construct a journal bearing test rig (JBTR) characterized by sufficient validity for embracing all aspired experiments. Additionally, following the construction of the test rig, there emerged the need to realize the second step which mainly focused on enhancing and promoting the range and capabilities of the journal bearing, which ultimately turned it into a universal journal bearing test rig (UJBTR). Such step has granted the structure the ability to embrace even more sophisticated and much wider range of experiments. Further, one of the main consequences resulting from conducting versatile experiments and tests are the inevitable errors, or rather more precisely the uncertainties. Conducting such essential tests would entail making measurements, which in turn would incur necessary uncertainties. Consequently, there arose the need to introduce the current paper presenting a thorough investigation relating to the uncertainty measurement with view to better identifying the nature of such errors, with view to keeping them to a minimum and trying to overcome their hazardous consequences in as far as the experimentation procedures and outcomes are related.

Keywords: Universal Journal Bearing Test Rig (UJBTR), hydrodynamic lubrication, pressure sensors, uncertainty measurement, validity.

INTRODUCTION

To start with, the term (error analysis), also known as the experimental uncertainty, is a technical term that is often referred to when it comes to the issues related to the study and evaluation of uncertainty in measurements. No measurements can be completely free of uncertainties. Also, being mainly dependent on measurements, the whole structure and application of science can never do without a precise evaluation of these uncertainties with view to keeping them to a minimum. More important still, in science the word "error" doesn't essentially carry the usual connotations of mistake or blunder. The term "error" is always utilized to indicate the inevitable uncertainties necessarily existing in all measurements. It cannot be avoided via careful procedures, and the best thing to be done is to try to ensure that the experimental errors are as small as reasonably possible in all measurements. There are basically two types of errors, either of which can occur during scientific experimentation and accompanying measurements. The first is "Random Errors" which can be treated statistically and may be revealed through repeating the measurements. In such case, the measurement results are either overestimated or underestimated and the only possible solution for attaining reliable estimates of such random errors could be via the spread in results statistically. On the other hand, the other type of error is the systematic error, where the results of measurements always push in the same direction. Such systematic errors are hard to evaluate or detect. Further, they cannot be discovered by statistical analysis used in identifying random errors.

Again, real measurement devices always suffer from different kinds of imperfections which negatively affect and limit our knowledge of the true value of any measurement. Such deficiencies mean that the exact value of any measured quantity will always be uncertain. Consequently, uncertainty can be deemed to be an unavoidable part of the measurement process. It is just sought to reduce measurement uncertainty whenever possible. However, ultimately there will remain some basic uncertainty that cannot be removed. The main task is to estimate thoughtfully the size of the uncertainty and clearly communicate the result. Further, quantifying uncertainty could be accessible via defining a value's uncertainty in terms of the range focused on our measured value within which we are 95% sure that the true value would be found in case measurement is carried out perfectly. This means that we expect that there is but one chance in 20 that the true value doesn't lie within the specified range. This range is called the 95% confidence interval or 95% confidence interval. Also, this conventional method of determining this range is to state the measurement value plus or minus a specific number. Here, the uncertainty would have a magnitude that is equal to the variation between the measured value and either extreme edge of the uncertainty range. Hence, uncertainty is definitely an uncertain concept which represents rough estimates. Notwithstanding, knowing the uncertainty of a measured value is essential, if the meaning of a measured value is to be correctly interpreted.

A study by (Wale and Mba, 2005), was focused on highlighting sources of error for experimental journal bearing studies. Also, it presented a coherent source of information on best practice in the field of experimental bearing research, offering a clearly prescribed methodology to estimate uncertainty and reduce errors. Additionally, it was shown that hidden errors would well account for the widely reported scatter and variance of results in the experimental bearing studies. One suggested solution was the better dissemination of information on best practice, and more widespread adoption of quality systems.

The year of 2007 has witnessed an attempt by (Wale and Mba 2007), for the sake of presenting results from a design study for a new journal bearing test rig aiming at setting new standards of accuracy. Sources of errors such as those related to the measurement system and build errors were involved in the study. Also, the study introduced a numerical assessment of the sensitivity to errors in selected experimental configurations. It was found that significantly lower uncertainty in the dynamic coefficients could be obtained by excitation at (0^0, 90^0). Moreover, the simulation has given a guide to the required accuracy in the measurements and in the build accuracy.

Additionally, it is quite known that one of the most crucial parameters in the precise determination of the quality of results quantitatively is the stability of the pressure measuring instruments over the years. It helps the user to decide the optimum calibration interval of the particular instrument. Based on the fact, a number of analogue / digital pressure transducers / transmitters / calibrators and pressure dial gauges have been investigated by (Yadav, Gupta, and Bandyopadhyay, 2010). Utilizing several pressure dial gauges and transducers in the pressure range up to 500 MPa, a new approach for the establishment of measurement uncertainty has been established. Further, using more than 50 pressure dial gauges and transducers, a nova approach was proposed for the estimation of measurement uncertainty of such devices. Also, the study has ascertained that curve fitting could be utilized regarding the establishment of different pressure instruments.

It was in the year of 2012 that I. Farrance and R. Frenkel (Farrance and Frenkel, 2012), launched a beneficial study, aiming at providing the general rules concerned with the evaluation and expression of uncertainty in measurement. Additionally, the research has outlined the method by which the general equation for combining uncertainty components could be used and also how it could be applied regarding versatile relationships for the sake of deriving a combined standard uncertainty for the output value related to the particular function.

A research carried out by (Taylor, 2012), has mainly been concerned with illustrating two methodologies for establishing measurement uncertainty for a family of digital pressure transducers by means of calibration data. Besides, a use has been made of the lumped method, assuming calibration data at each level to be statistically independent while lumping all errors together into a single propulsion disregarding pressure level. Also, defining propulsion parameters which were the basis for measurement uncertainty has been accessible via utilizing statistics. The study has ascertained the possibility of increasing the calibration interval via separating the facility pressure measurement into high-accuracy as well as low-accuracy requirements. Also, the study has recommended reviewing the measurement uncertainty requirements regarding each pressure that was being measured, utilizing this family of digital transducers.

Noteworthy that the factors affecting the measured signals would incur effects such as signal drift and response time changes, entailing techniques to distinguish between signal changes from plant or subsystem performance deviations and those from sensor or instrumentation issues. One important study carried out by (P Ramuhalli, G Lin, SL Crawford, 2014), has comprised isolating the sensor from the system applying an artificial load and recording the result, as well as comparing the obtained result with the recorded one. Based on the conducted study, simulation models of a flow loop with a counter-flow heat exchanger were found to help generate data from the simulation model, representing conditions the experimental flow loop might not be able to achieve.

In addition to that, a research work was carried out by (Gralde, 2014), aiming at realizing and evaluating a start-stop journal bearing test rig. It also involved manufacturing, building and evaluating of a start-stop journal bearing test rig. Further, it comprised developing software for the test rig. Also, factorial design was utilized and compared to a simple theoretical model. The test rig has been realized and evaluation showed good correspondence to frictional values at starting of similar material combinations. The test-rigs concept has been proven to work.

It was in the year of 2017, that an attempt has been made by (Blomstedt, 2017), to create measure and control system for test parameters of tribological values, and also to validate those results from results of validation tests conclusions. It was shown that different measured values represented bearing operational conditions. Also, the study involved investigating previous measurements system and other similar systems in engine testing environments. The study has also comprised performing and presenting measurements, as well as calibration of the system. A new measurement and control system for bearing test rig was developed and built to get more accurate results.

(Schiering and Schnelle-Werner, 2019), have launched a beneficial study in 2019, which aimed at evaluating uncertainty in industrial pressure measurement. They presented the approach in which the measurement uncertainty could be calculated in industrial pressure measurements. The study has clearly shown the importance of introducing an example of a measurement uncertainty budget, as being an important tool in the measurement uncertainty calculation. In addition to that, the study assured the need to include factors like the calibration procedure, the ambient conditions, and the calibration procedure in the process of measurement of uncertainty determination.

(Barsanti, Ciulli, and Forte, 2019), have carried out an analysis with view to determining the dynamic coefficients of Tilting Pad journal bearings via a new statistical method. The most significant result of the study was obtaining the random uncertainties associated to each stiffness or damping coefficient. Also, the dynamic coefficient was found to be dependent on the excitation frequency. Besides, the study has presented random error propagation as well as uncertainty analysis, which could help determine the dynamic coefficients of Tilting Pad journal bearings.

(Garoli and Castro, 2019), conducted an analysis of a rotor-bearing nonlinear system model, considering fluid-induced instability and uncertainties in bearings. Besides, the study could account for the uncertainties of radial clearance and fluid lubricant viscosity in the journal bearing. Also, the study could prove the possibility of modeling the stochastic dynamic response of a rotor-bearing system through applying stochastic collocation within generalized polynominal chaos expansion.

Aiming at modeling the kinetic friction coefficient and determining its uncertainty, (Vale and Silva, 2020), have presented a detailed assessment of a tribometer developed for dry journal bearing tests. More important still, the study involved modeling of kinetic friction coefficient, as well as uncertainty measurement evaluation for a journal bearing test apparatus. Based on the conducted study, it was found out that the load cell uncertainty varied over the tribometer's operating range. Furthermore, the last digit fluctuation error was also found to dominate the behavior pertaining to the load cell total standard uncertainty.

UJBTR DESIGN AND MANUFACTURE

In fact, the design and manufacture procedures have comprised numerous research programs that aimed at ultimately introducing a structure that is quite capable of embracing a wide range of enhanced and sophisticated experiments and that is also characterized by the highest possible degree of validity. Such efforts have initially been oriented towards launching a study entitled "Journal Bearing Performance – State of The Art" (Marey et al. 2021), aiming at tracing and examining all the critical and influential factors affecting the journal bearing. Furthermore, the research scope has been extended to achieve the second step focused on accomplishing the crucial calculation processes related to the design requirements of acquiring a UJBTR. Also, each step in the stages of planning, manufacture and assembly has been conducted with special care given to a number of considerations comprising the design material stresses, manufacturing standards and also the assembly risk assessment criteria. More important still, one of the foremost qualities marking the structure has been the inclusion of fully controlled and monitored systems, facilitating the process of obtaining versatile readings and graphs via SCADA system, and hence controlling of all the factors influencing the lubrication film. Noteworthy that the research program concerned with the previously mentioned UJBTR is currently under publishing, coming under the title "Development of A Universal Journal Bearing Test Rig (UJBTR) and Experimental Setup for Oil Film Lubrication Enhancement Regarding Marine Applications".

For better illustration of the comprehensive research efforts conducted, the following (Figures from 1 to 7) would best represent the whole UJBTR structure comprising firstly the shafting system, which in turn involves the drive shaft, the journal shaft, the main journal bearing, the supporting journal bearings and the thrust bearing. Also, the UJBTR comprises the lubricating oil system which consists of the lubricating oil pump unit, the filters, the lubricating oil cooler, the regulator valves, the pressure gauges and transmitters, the thermocouples and the oil hoses. Besides, the structure contains the hydraulic oil system comprising the hydraulic power pack unit, filters, two hydraulic pistons, hydraulic hoses, proximity sensors and pressure gauges and transmitters. Finally, for guaranteeing the perfect performance of all the previously outlined components, the UJBTR is marked by comprising a fully control system which ensures all procedures and experiments are accurately and efficiently manipulated and void of any sort of error. Such control system comprises a number of three control panels. The first one is concerned with the full control of the hydraulic oil system, the second ensures full control regarding the lubricating oil system, whereas the third and last one works on fully monitoring, controlling and manipulating the whole UJBTR structure via the advanced and highly precise SCADA control system. Noteworthy that the following figures would best illustrate the detailed components involved in each individual system regarding the whole UJBTR structure.

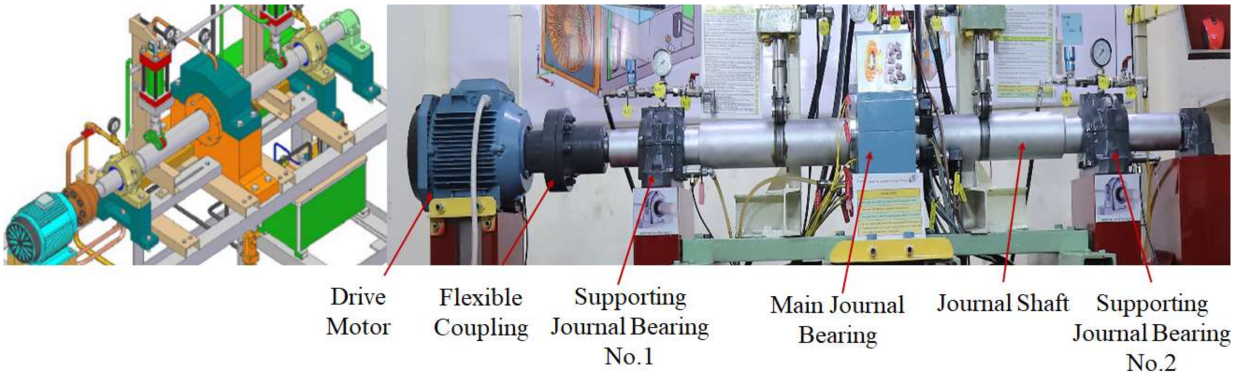


Figure 1. The shafting system of UJBTR

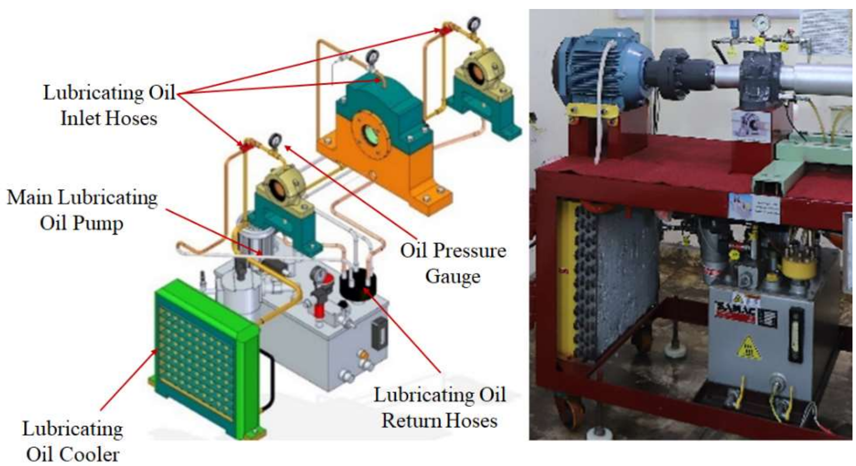


Figure 2. Main lubrication oil system

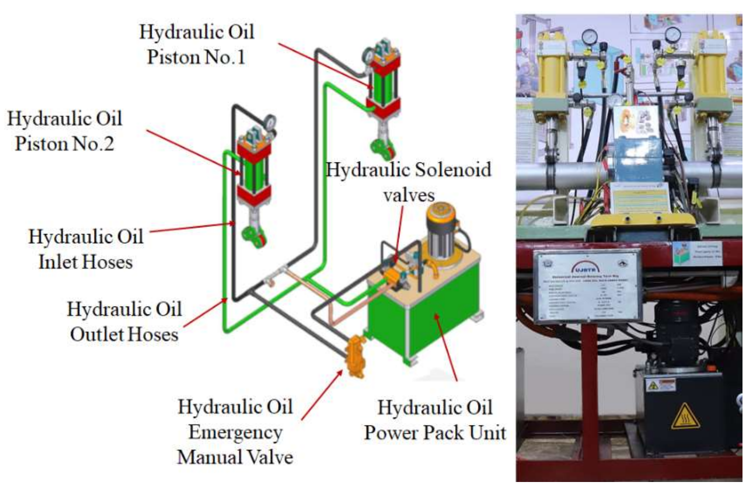


Figure 3. The hydraulic oil system

Figure 4. The first control panel contents

Figure 5. The second control panel contents

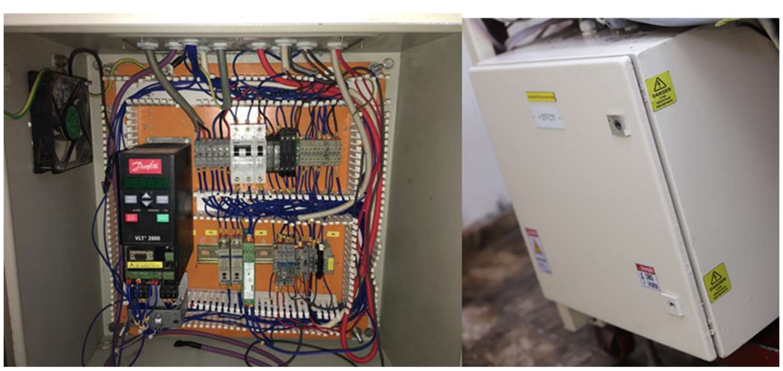
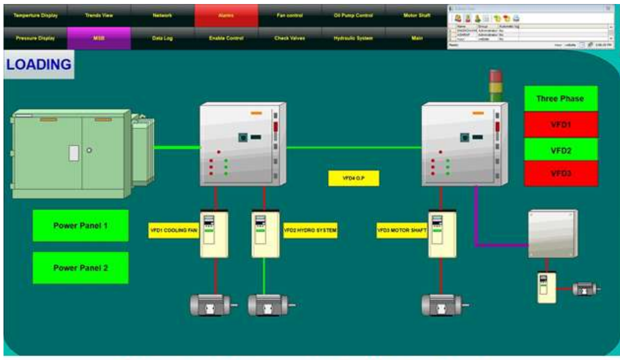
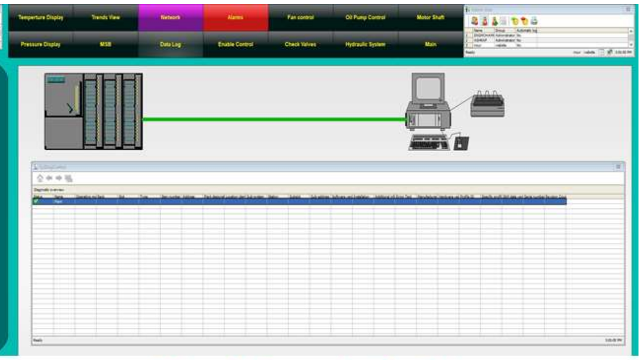


Figure 6. The third control panel contents

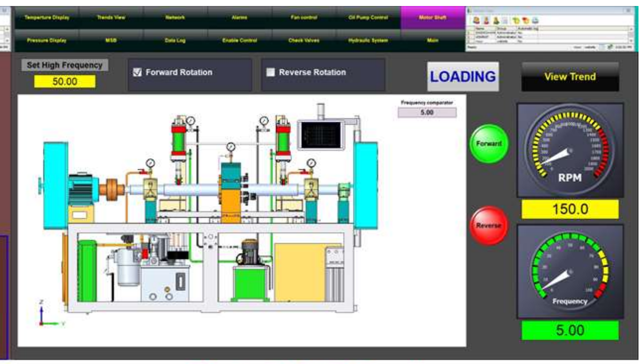


Main Switch Board (MSB) Display Page



Network Communication Status

Main Page of SCADA System



Motor Shaft Display Page

Main Lubricating Oil Pump Control Page

Monitoring of UJBTR Valves Display Page

Lubricating Oil Cooling Fan Control Page

Oil Film Pressure Distribution Display Page **Oil Film Temperature Distribution Display Page**

Figure 7. The SCADA system

EXPERIMENTAL UJBTR UNCERTAINTY AND VALIDATION CALCULATIONS

It was for the sake of identifying and assessing the uncertainty and also for carrying out the validation processes that the UJBTR has been operated, based on and in accordance with the operation checklist related to the UJBTR. Closely observing such procedures would ensure the accurate operation of the UJBTR that is void of defects, that may otherwise result from human error. Figure 8 would outline the operation checklist.

UJBTR **Universal Journal Bearing Test Rig**

Start of the UJBTR Checklist	
Important: To ensure a safe and reliable operation of the UJBTR, all operation procedures of the UJBTR should be carried out only by skilled personnel.	
Making sure that the power is properly connected via (3 phase 380 V, single phase 220 V and frequency 50Hz). Also, all of the referred to indications ought to be checked to appear on the multimeter, and it is necessary to make sure the lights of the L1, L2 and L3 are all on.	
Ensuring the power switch regarding the first control panel is connected	
The source power switch related to the second control panel ought also to be selected.	
Further, the connection of the power related to the second control panel should be checked where the lights of L1, L2 and L3 should all to be on.	
The next step would be switching on the computer and waiting for the SCADA program to be downloaded.	
Following the download of the SCADA program, it is necessary to turn the PLC operation switch from the stop mode to the run mode and then wait for the PLC run mode to occur.	
After that, the Manual /Auto mode ought to be selected.	
The lubricating oil pump switch would be selected.	
Logging on the check valve page in the SCADA system, where all lubricating oil system valves that were opened would be selected.	
The oil pump page would then be chosen, where the start pump icon would be selected and the value pertaining to the lubricating oil pump frequency would be appointed.	
All pressure transmitter and temperature sensor pages ought to be checked for the sake of ensuring that all sensors are properly working.	
A set point regarding the oil supply temperature in the fan control page ought to be appointed, where the cooling values of the cooling fan would be added as (Low speed, Medium speed and High speed).	
Regarding the operation of the drive shaft, a number of procedures ought to be observed and they would comprise (selecting the rotation direction of the shaft via the local control switch provided with an indication lamp and located on the second control panel.	
Heading for the motor shaft page, where both the username and the password would be determined for the sake of selecting the rotation direction i.e. forward or reverse.	
Utilizing the potentiometer located on the second control panel, the shaft rpm would be appointed.	
The hydraulic oil pump would be operated via a control switch located on the first control panel, where the operation condition would be checked via an indication led.	
Ensuring the oil discharge pressure value concerning the oil hydraulic pump is within the required range, via the hydraulic system page within the SCADA system.	
For manipulating the hydraulic pistons, two push buttons (Up / Down) would be utilized with the function of determining the loading and whether it is a loading or unloading mode.	
Utilizing the alarm page in the SCADA system, the condition of the UJBTR would be checked regarding whether it is normal or abnormal.	

Figure 8. The operation procedure checklist

In addition to that, the UJBTR has been operated according to the operation parameters elaborately illustrated below.

Experimental parameters

The bearing performance characteristics were obtained through the following parameters:

1. Constant load at 100 kg_f.
2. Journal speed variation from 25 rpm to 200 rpm.
3. Lubricant used (shell helix HX8 ECT 5W-40).
4. Type of bearing (Circumferential groove journal bearing).
5. Material for bearing (White metal).

Further, in order that the uncertainty concerning the UJBTR could be measured, the UJBTR has been operated for each individual speed limit five times for the sake of obtaining the readings related to the pressure transmitters pertaining to the oil film pressure distribution within journal bearing. The following illustrations would best represent the detailed methods by which the uncertainty value would be precisely determined and calculated:

Firstly, the journal bearing test rig would be operated, utilizing a number of fourteen sensors circumferentially distributed around the groove journal bearing. The main objective would be to better identify the oil film pressure distribution within the groove journal bearing. Additionally, the measurement readings recorded regarding each individual sensor would be taken five times.

The next step would be to obtain the average value x of the recorded five readings related to each of the fourteen pressure transmitters individually via the following equation:

$$\overline{\boldsymbol{X}} = \frac{\boldsymbol{Measured\ Values}}{\boldsymbol{Number\ of\ Values}} \qquad (1)$$

The following step would be focused on obtaining the deviation $\boldsymbol{d_i}$, by means of obtaining the difference between the measured value $\boldsymbol{X_i}$ and the average value $\overline{\boldsymbol{X}}$ as shown below:

$$\boldsymbol{d_i = X_i - \overline{X}} \qquad (2)$$

The step to follow would involve acquiring the standard deviation estimate. The importance of such measurement would be to avoid the fluctuations that would otherwise be encountered regarding the average deviations $\boldsymbol{d_i}$. In other words, it is a technique utilized to avoid being at loss regarding various positive and negative values. Standard deviation would be estimated based on the following equation:

$$\boldsymbol{\sigma_x = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(d_i)^2}} \qquad (3)$$

It is in this way that the average uncertainty estimate would accurately be identified.

Finally, for the sake of appointing the standard error value or the uncertainty of the means, the following equation would be done:

$$SE = \frac{\sigma}{\sqrt{n}} \tag{4}$$

UNCERTAINTY OF UJBTR

Experimental procedures

The UJBTR has been operated according to the operation checklist instructions previously pointed out. Additionally, a routine check has been carried out regarding the UJBTR so as to carry out and ensure the following:

1. There is no abnormal noise.
2. There is no abnormal vibration.
3. There is no oil leakage of any sort.
4. There are no activated alarms which is assured via the alarm system page.
5. Adjusting the oil film supply temperature at 40 ^{0}C.
6. Setting the journal shaft speed at 25 rpm.
7. Recording the readings related to the oil film pressure distribution within journal bearing under a constant load of 100 kg_f via the SCADA system.

Stoppage of that case in accordance with the stop checklist procedure, then operating once again under the same case outlined before for four additional times, this makes the number of trials reach five times in all. Noteworthy that all the experimental trials have been carried out under the different speeds of 50 rpm, 75 rpm, 100 rpm, 125 rpm, 150 rpm, 175 rpm and 200 rpm respectively.

The derived results were the basis for extracting the outcomes of uncertainty calculations. Those calculations were related to the average values, the measured values, the deviation values, the standard deviation values and finally the standard error values. Next to that, a relation has been created between the journal shaft speed and the average value of the fourteen pressure sensors, circumferentially distributed around the groove journal bearing. Such relation is shown by (Figure 9), representing the variations recorded for the average value of pressure sensors (PS), resulting from changing the journal shaft revolution. Firstly, the average values of the pressure sensors taken at PS4, PS5 and PS6 are almost constant under all speeds of the journal shaft. On the other hand, the average values of pressure sensors recorded at PS9 and PS12 are noted to increase gradually as increments in shaft speed are made. Besides, the average value of the pressure sensor PS9 has reached a peak at 200 rpm shaft speed representing the highest value regarding all recoded pressure sensor measurements. Moreover, the tendency of all pressure sensor values to rise with the increases imposed in shaft speed is regarded as a doubtless indication of the validity of the UJBTR, the result which is in complete accordance with the hydrodynamic lubrication theory.

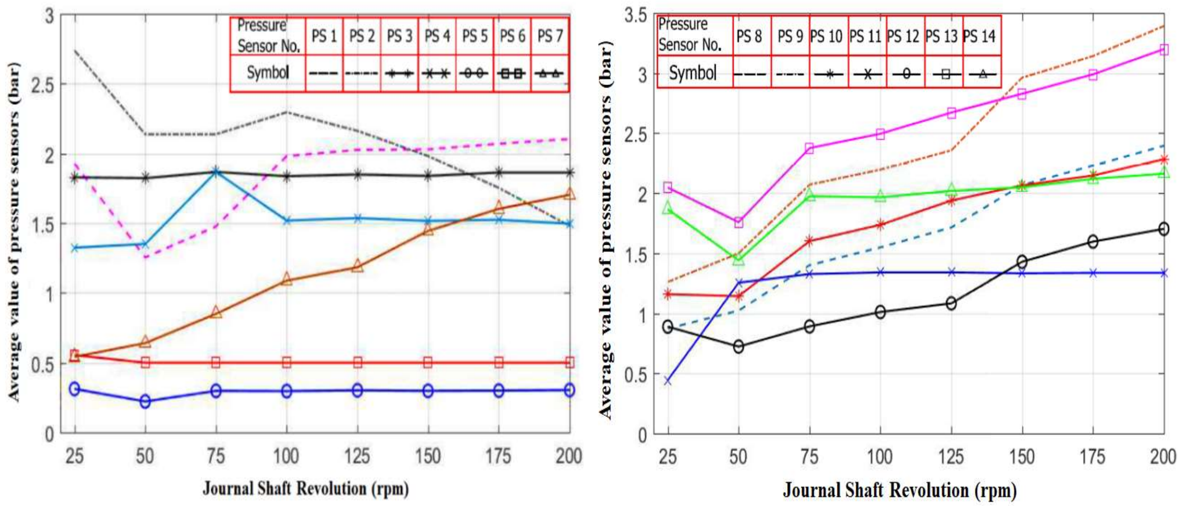


Figure 9. Sensitivity of the average value of pressure sensors to variations in shaft speed

Based on the derived outcomes related to the experimental trials conducted for identifying the uncertainty criteria Table 1, a number of facts concerning both the standard deviation ($\boldsymbol{\sigma}$) and the standard error (SE) may be derived. The minimum standard deviation value has been equal to zero, whereas the maximum has acquired the value of 0.05. On the other hand, the minimum standard error has obtained the value of 0, while the maximum value has been recorded for PS13 and it was equal to 0.031 at 50 rpm. Also, the measured accuracy value related to the pressure sensors has recorded a value of $\pm\mathbf{1.0}$ % of span (WIKA, 2021). The derived results represent a certified and doubtless indication that the uncertainty regarding the conducted experimental trials has been kept to as much minimum degree as possible, the fact which also ascertains the efficiency and accuracy of experimental procedures related to the UJBTR. Additionally, Table 1 shows values of the standard deviation and the standard error attained from the data provided by the fourteen pressure sensors working under different speeds.

Table 1. Values of standard deviation and standard error under different speeds

Press Sens No.	Speed (rpm)	σ	SE	Press Sens No.	Speed (rpm)	σ	SE
1 at 0^0	25	0.02	0.009	**8 at 180^0**	25	0.05	0.02
	50	0.01	0.004		50	0.05	0.02
	75	0.01	0.004		75	0.01	0.004
	100	0.05	0.022		100	0.03	0.014
	125	0.02	0.008		125	0.05	0.02
	150	0.03	0.012		150	0.05	0.028
	175	0.02	0.011		175	0.03	0.014
	200	0.02	0.006		200	0.01	0.004
2 at 36^0	25	0.02	0.007	**9 at 198^0**	25	0.02	0.008
	50	0.05	0.023		50	0.05	0.009
	75	0.05	0.023		75	0.01	0
	100	0.03	0.014		100	0.02	0.01
	125	0.04	0.019		125	0.03	0.012
	150	0.03	0.012		150	0.02	0.01
	175	0.03	0.013		175	0.03	0.011
	200	0.01	0.003		200	0.02	0.007
3 at 72^0	25	0.02	0.009	**10 at 216^0**	25	0.01	0.004
	50	0.01	0.003		50	0.05	0.02
	75	0.02	0.008		75	0.02	0.01
	100	0.04	0.019		100	0.02	0.009
	125	0.03	0.015		125	0.05	0.02
	150	0.02	0.011		150	0.01	0.006
	175	0.02	0.011		175	0.03	0.011
	200	0.01	0.003		200	0.01	0.004
4 at 108^0	25	0.05	0.022	**11 at 234^0**	25	0.002	0.008
	50	0.01	0.004		50	0.001	0.004
	75	0.01	0.003		75	0.014	0.014
	100	0.01	0.003		100	0	0
	125	0.03	0.012		125	0	0
	150	0.02	0.008		150	0.01	0.005
	175	0.01	0.002		175	0.01	0.004
	200	0.03	0.015		200	0.01	0.004
5 at 126^0	25	0	0.002	**12 at 252^0**	25	0.01	0.003
	50	0.01	0.005		50	0.03	0.014
	75	0.01	0.003		75	0	0
	100	0.01	0.002		100	0.02	0.007
	125	0	0.002		125	0.01	0.004
	150	0	0.002		150	0.02	0.007
	175	0	0		175	0.02	0.008
	200	0.01	0.002		200	0.02	0.008
6 at 144^0	25	0.02	0.009	**13 at 288^0**	25	0.02	0.009
	50	0	0		50	0.05	0.031
	75	0	0		75	0.02	0.006
	100	0	0		100	0.05	0.022
	125	0	0		125	0.04	0.016
	150	0	0		150	0.02	0.011
	175	0	0		175	0.03	0.008
	200	0	0		200	0.03	0.014
7 at 162^0	25	0.1	0.04	**14 at 324^0**	25	0.01	0.006
	50	0.05	0.02		50	0.01	0.003
	75	0.05	0.02		75	0.01	0.002
	100	0.03	0.015		100	0.05	0.024
	125	0.05	0.02		125	0.03	0.014
	150	0.04	0.016		150	0.02	0.011
	175	0.02	0.009		175	0.01	0.003
	200	0.02	0.008		200	0.02	0.009

VERIFICATION OF UJBTR RESULTS

Experimental Procedures

On carrying out an experimental study on the groove journal bearing using the UJBTR under consideration, it is important to check the consistency and validation of its derived results for its potential targets. The material of groove bearing was white metal and the utilized lubricating grade oil was of the type shell helix HX8 ECT 5W-40. It should be observed that the value required in relation to the density was 850 kg/m^3 at 15 ^{0}C, whereas the kinematic viscosity was 84.7 cSt at 40 ^{0}C. Further, the lubricant was supplied to the groove bearing at an inlet port on the vertical center line of the bearing. Also, it should be noted that the oil film pressure distribution working on the groove journal bearing has been accurately measured and registered at different speeds ranging from 25 rpm up to 200 rpm at a constant load of 100 kg$_f$. The fourteen pressure transmitters were installed all around the circumference of the main journal bearing, with the aim of indicating the pressure variations occurring in the groove bearing. The positions at which the pressure transmitters were fitted were carefully chosen according to the theoretical calculation considerations, so as to experimentally reflect the values relating to the pressure distribution within the groove journal bearing. Based on the previously mentioned factors, the oil film pressure distribution working on the UJBTR would be derived as shown in Figure 10, whereas Table (2) represents the technical data obtained experimentally in relation to the maximum- film pressure ratio ($\frac{P_0}{P_{max}}$) at different speeds. Noteworthy that while $\boldsymbol{P_0}$ refers to the terminating oil film pressure, $\boldsymbol{P_{max}}$ indicates the maximum oil film pressure.

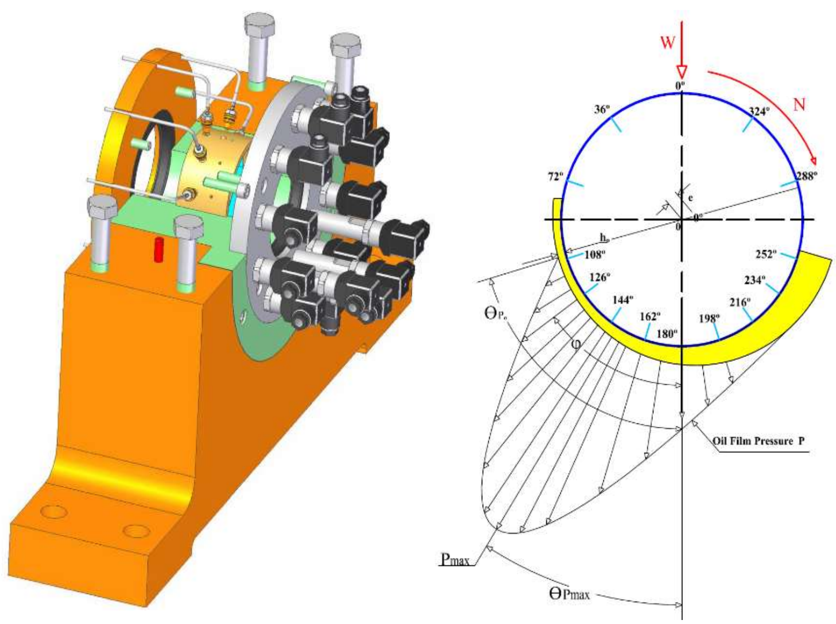


Figure 10. Polar diagram of oil film pressure distribution

Table 2. Maximum- film pressure ratio ($\frac{P_0}{P_{max}}$) obtained experimentally at different speeds

Journal shaft Speed (rpm)	**Experimental**
	P_0/P_{max}
25	0.367
50	0.422
75	0.429
100	0.452
125	0.456
150	0.470
175	0.504
200	0.510

Theoretical calculations

Table 3. Journal bearing parameters

Bearing length (L)	58.0 mm
Inner diameter for plain bearing (Φh = D)	105.05 mm
Shaft diameter (d)	104.85 mm
The radius for journal shaft (r)	52.425 mm
Total clearance (C_0)	0.1 mm
Radial clearance (C)	0.05 mm
Applied load	100 kg_f
Oil viscosity (μ)	0.0847 Pa.s

To check the validity of UJBTR results, the following procedures were followed.

Calculation of the nominal bearing pressure:

$$\boldsymbol{P = W/2rL} \tag{5}$$

Calculation of the bearing characteristic number (Summerfield number, S) at different speeds ranging from 50 up to 200 rpm is as follows:

$$S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P} \tag{6}$$

Where μ, $\boldsymbol{c}$ and $\boldsymbol{N}$ are the oil viscosity, the radial clearance and the angular velocity respectively. The values of $\boldsymbol{N}$ are taken from 25 to 200 rpm. The $\boldsymbol{L/d}$ is equal to approximately 0.55.

Using the charts of "Raimondi and Boyd" (Shigley et al, 2002), the value of the maximum film pressure ratio ($\frac{p_0}{P_{max}}$) are reproced here for different speeds (see Table 4).

Table 4. Theoretical values of $(\frac{P_0}{P_{max}})$ *obtained under various speeds* (Shigley et al, 2002)

Journal shaft Speed (rpm)	S	Theoretical P_0/P_{max}
25	0.24	0.327
50	0.47	0.402
75	0.71	0.439
100	0.95	0.46
125	1.19	0.475
150	1.43	0.48
175	1.67	0.498
200	1.91	0.50

THE VALIDITY OF UJBTR

UJBTR validity is ascertained through experimental and theoretical values, which are proportionally on the rise, in relation to both the experimental ratio ($\frac{P_0}{P_{max}}$), and that derived theoretically (see Figure 11). On carrying out a quick scanning of Table 5, it is noted that at 25 rpm, the deviation extent of the ($\frac{P_0}{P_{max}}$) relating to both of the theoretical and the experimental results has assumed the value of – 0.04, representing the highest recorded value related to the deviation. Moreover, the deviation outcomes taken at both 50 and 125 rpm have been observed to be very close to each in value with just marginal variation. Additionally, the deviation extents registered at 75 rpm, 150 rpm and 200 rpm have levelled off, assuming exactly the same values of 0.01, 0.01 and – 0.01 respectively.

Furthermore, the error percentage shown in Table 5 would outline the resulting theoretical and experimental error percentage which was 1.2 at lowest and 12.2 at highest. The error likelihood is thus noted to be very limited, insignificant and obviously very marginal. That would safely account for **the validity** of the introduced UJBTR. The difference between technical data obtained theoretically and those obtained from experimental study is shown in Table 5.

Table 5. Experimental results Vs Theoretical results

RPM	Experimental P_0 / P_{max}	Theoretical P_0 / P_{max}	Deviation P_0 / P_{max}	Error %
25	0.367	0.327	**-0.04**	**12.2%**
50	0.422	0.402	**-0.02**	**4.90%**
75	0.429	0.439	**0.01**	**2.27%**
100	0.452	0.46	**0.008**	**1.74%**
125	0.456	0.475	**0.019**	**4.00%**
150	0.470	0.48	**0.01**	**2.08%**
175	0.504	0.498	**-0.006**	**1.20%**
200	0.510	0.50	**-0.01**	**2.00%**

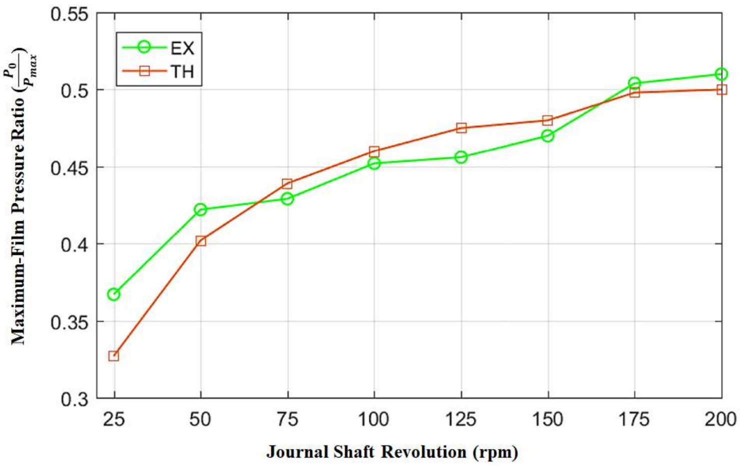


Figure 11. Experimental results Vs Theoretical results

CONCLUSION

In conclusion, the UJBTR has been designed, developed and modified for the sake of simulating the practical conditions of standard journal bearing for a ship power transmission. The UJBTR has mainly been constructed and has also been fully monitored and manipulated, utilizing the most accurate SCADA control system, for enhancing the oil film lubrication within journal bearing and providing the most optimal operating conditions. In this way, considerable promotions could be attained in relation to the ship power efficiency, the most crucial target on which the whole study has essentially been focused. Further, the paper at hand has comprised extensive experimental trials related to the uncertainty measurements under various speeds but under a constant load. Also, the UJBTR has been tested repeatedly under the above mentioned experimental conditions, and UJBTR validity has been ascertained through experimental and theoretical values, which were proportionally on the rise, in relation to both the experimental ratio ($\frac{\mathbf{P_0}}{\mathbf{P_{max}}}$), and that derived theoretically.

NOMENCLATURE

A	Cross-Section area of cylinder, m^2
A	Current, A
D	Inside diameter of cylinder, mm
F	Force, N
N	Rotational speed of journal, rpm
n	Number of trials
P	Pressure, bar
P_O/P_{max}	Maximum film pressure ratio
P_O	Terminating oil film pressure
P_{max}	Maximum oil film pressure.
SCADA	Supervisory Control and Data Acquisition
SE	Standard error
σ	Standard deviation

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Biological monitoring of inhibitory effects of antifouling agent Irgarol 1051 on growth and essential metabolites of marine alga *Chlorella salina*

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Abstract:
Irgarol 1051 (2-(tert-butylamino)-4-(cyclopropylamino)-6-(methylthio)-1,3,5-triazine) is a biocide used in antifouling paint on ships to prevent fouling growth. It is widely used booster herbicides and it may exert potent toxic effects on marine primary producers such as microalgae, where majority of the toxicity data are based on changing in growth and inhibition of essential metabolites. Data of the toxic effects on microorganisms may be used to define the upper limits for concentration of pollutants and to predict environmental toxicity risk. So, the aim of this work was concentrated on the effect of the booster biocide Irgarol 1051 on growth and content of some essential metabolites namely protein, carbohydrates, amino acids and fatty acids of marine planktonic alga *Chlorella salina*. The result obtained proved that, increasing of antifouling concentration caused notable decreasing in growth depending on the concentration used. The presence of antifouling agent Irgarol 1051 in the seawater especially in areas with heavy shipping activity due to its application in antifouling paints will cause decreasing in nutrient value of proteins in this type of algae as well as the negative impact on the essential amino acids. Carbohydrates content decreased by increasing the concentration of Irgarol. A serious decrease in the content of Omega-3 fatty acids and in turn this will affect the crop of the marine fish since fishes cannot synthesis these types of fatty acids.
Keywords: *Chlorella salina,* Irgarol 1051, protein, carbohydrates, amino acids, fatty acids

Introduction

The main cause of pollution is the discharge of solid or liquid waste products containing pollutants onto the land surface, or into the aquatic habitats. The wastes that contribute towards water pollution may be broadly grouped into: domestic, industrial, and agricultural types. Sewage is literally the contents of sewers and these comprise the sewerage system that carries the water-borne waster of communities **(Becher and Bjoresth, 1987)** and **(Seiki *et al.*, 1991)**. Pollutants can -be categorized as four types: nontoxic, toxic, thermal and radioactive, although overlap between theses broad categories is of course possible. Toxic pollutants are metabolic poisons that can seriously injure or destroy the photosynthetic organisms upon which the food chain depends **(Doudoroff and Katz, 1953)**.

An additional environmental problem, which has increased during recent years, is the soluble compounds that have been released from the antifouling paints that contained usually very toxic compounds. These in turn cause damage to living organisms in aquatic environments. Usage of antifouling paints differs regionally according to legislation, location of the manufacturer, marketing and consumer preferences. Whilst the list of potential booster biocides provided above is substantial, not all compounds are marketed. For example in the UK, although recent legislative changes have occurred, during the last decade usage of antifouling agents was massively dominated by copper oxide followed by (in order of usage) diuron, Irgarol 1051, zinc pyrithioone and dichlofluanid **(Environment Agency,1998)**.

Irgarol 1051 (2-(tert-butylamino)-4-(cyclopropylamino)-6-(methylthio)-1,3,5-triazine) is a biocide widely used in antifouling paint on ships. The s-triazine herbicide Irgarol 1051 is now widely distributed through European coastal waters. Irgarol 1051 has also been showed to be very toxic to growth of fresh water and

marin microalgae **(Ciba-Geigy, 1995; Dahl and Blanck, 1996),** and to the early growth of macroalgae zoospores, **(Scarlett *et al.*, 1997)**.
The sensitivity and response of microalgae to organotin compounds varies from species to species according to shapes and size of the cell wall composition may have different uptake capacities as well as different enzymes for their degradation, so some species appear to be resistant to organotin compounds and possess the ability to accumulate and or degrade these compounds **(Tsang *et al.*, 1999)**. However, very little information is available on uptake of lrgarol and sea nine uptakes and degradation by microalgae. The use of triazine herbicides, including Irgarol 1051, poses environmental risks in the coastal waters due to cause suppression of algal growth by destroying of photosystem II (PSII) (**Yang *et al.*, 2019**).
Irgarol is widely distributed in coastal water, seawater samples were taken from 26 locations in Singapore measuring TBT, TPhT, and Irgarol. Irgarol was found in 13 samples, (**Basheer *et al*., 2002). .** High Irgarol 1051 concentrations were found in Korean sediment samples from shipping and shipbuilding areas. 40 percent of measurements in bays and 20 percent of samples from harbours exceeded the Environmental Risk Limit for sediment set by the Dutch National Institute for Public Health at 1.4 ng/g. Overall, Irgarol 1051 was detected,(**Kim *et al*., 2015**). (**IMO, 2018**)
Marine plants appear particularly vulnerable to many of these biocides. The first published study on the herbicidal properties of the booster biocides was by **Dahl and Blanck,(1996)** on the toxicity of Irgarol 1051 to periphyton communities. In recent years, the toxic organic materials that are released into the environment as a consequence of human activity especially antifouling compounds have had a growing impact on coastal ecosystems. Longterm effects were detected at 0.25 to 1 nM (63 to 250 ng L-I), which is within the range of concentrations reported for coastal waters. Previously used antifoulants, such as TBT and heavy metals, all have broad negative impacts on most marine organisms, and could also be concentrated and transferred across the food chain., (**Wang *et al*., 2020**).
The widespread application of antifouling compounds give rise to contamination of marine and fresh water environments. Microorganisms including algae has been used as powerful tools to assess in vitro the toxicity of several environmental pollutants. So, the aim of this work will be: the metabolic response of the marine unicellular alga *Chlorella salina* to toxicity of the antifouling agent Irgarol 1051 .This work was concentrated on the effect of the biocide antifouling agent Irgarol 1051 on growth and content of some important metabolites: proteins (soluble, insoluble and total) , carbohydrates (soluble , insoluble and total) , amino acids (free, conjugated and total) , fatty acids (saturated , mono and poly-unsaturated) of the marine alga *Chlorella salina* that usually used for fish feeding.

Materials and Methods:

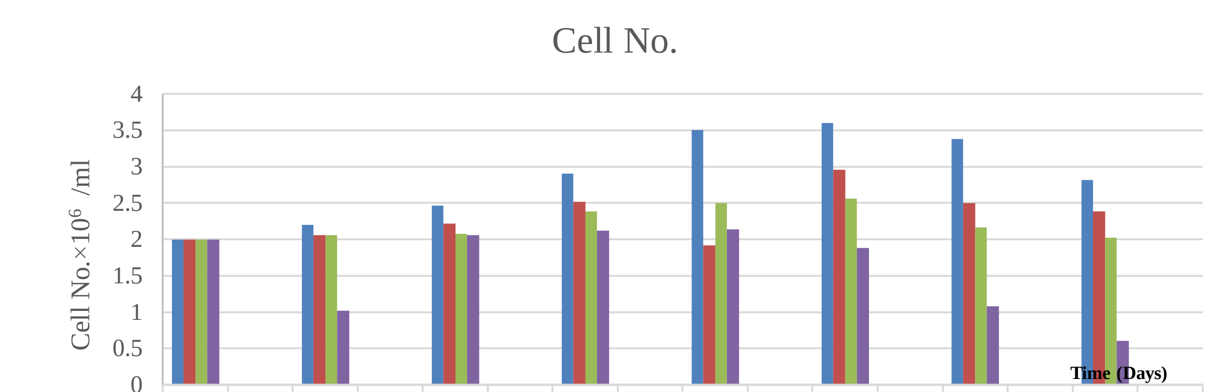
The biological materials chosen in this thesis were the axenic unicellular green alga *Chlorella salina* obtained from culture collection Botany Department, Faculty of Science, Alexandria University. The basal medium was used in this work described by **Boussiba *et al.*,(1987)**. The growth of the investigated algae was determined every couple day by cell count using the hemacytometer slide.
The herbicide (Irgarol 1051) was purchased from Fluka company, Cairo, Egypt. The stock solution 1000 mg of the standard Irgarol was prepared in acetone and kept in dark at 4°C. Dilution of this stock solution was mixed with the medium. Different concentrations were prepared and added each to one liter medium. EC50 obtained was 0.50 µg/L. Chosen of two other concentrations (lower and higher) to measure the different parameters for *Chlorella salina.*

1- Carbohydrates content were estimated according to the method described by **Dubois *et al*.,(1959).**
2- In this investigation protein was determined by the method described by **Hartree, (1972)** which is the modification of the original folin-phenol method of **Lowery, *et at.*, (1951).**
3- The free and total individual amino acids were extracted by the method described by **Speckman, *et at.*, (1958).**

4- Preparation of fatty acids methyl ester was performed according to the procedure followed by **Radwan, (1978).**

Statistical analysis:
The obtained data were analyzed statistically using two ways ANOVA (Analysis of variance). The difference between means probability levels were analyzed using Duncan's New Multiple Range Test ($P< 0.05$). F- test were also analyzed (LSD) the least significant difference at 0.05.

Result and Discussion
This work will be concentrated on the effect of the biocide antifouling agent, Irgarol 1051, on growth and content of some important metabolites proteins (soluble, insoluble and total), carbohydrates (soluble, insoluble and total), amino acids (free, conjugated and total) and fatty acids (saturated, mono and poly-unsaturated) of marine algae *Chlorella salina* that usually used for fish feeding .
Under the effect of concentrations (0.25, 0.50 and 0.75 µg/L) the tested organism remained alive but with different rates of growth. The results cleared also that, the effective concentration (EC50) of Irgarol for *Chlorella salina* was recorded nearly in concentration 0.5 µg/L at the 8^{th} day.
The data obtained cleared that, suppression of algal growth under the effect of the different tested concentrations of Irgarol may be due to the increasing of toxicity of this biocide. The same results were also obtained by **Munnas, (2003)** and **Singla and Garg,(2005).** However, **Gatidou *et al*., (2003),** found that Irgarol 1051 inhibit growth of *Dunaliella tertiolecta* at concentration higher than 0.8µg/l and at concentration 3.0µg/l, the compound killed almost all the cells. The result obtained goes with harmony with those obtained by **Kaamoush and El Agawany, (2021)** who observed that Irgarol inhibit growth in *Dunaliella salina* at concentrations 0.012 µg/L. The stress effect of booster biocides on growth of algae may be due to the metals found in this compound which cause inhibition of normal cell division **(Fisher and Jones ,(1981)**.Also, **Visyiki and Rachlin, (1991)** speculated that, inhibition of cell division and cessation of new daughter cells could be due to binding the metals to sulfhydryle groups which are important in regulation cell division. **Khalaf *et al*., (2007),** observed that, there was significantly decreased in cell number
and dry weight after 7 days, the growth of *Chlorella vulgaris* towards increasing concentrations of diuron, the dry weight of *C. vulgaris* after seven days of 0.1 and 0.5 µm diuron treatment was lowered by 2.5 and 5.5 fold, respectively in comparison to control.



	0		2		4		6		8		10		12		14	
Control	2		2.2		2.46	0	2.9	0	3.5		3.6		3.38	0	2.82	0
0.25 µg/l	2	0	2.06	0	2.22		2.52	0	1.92	0	2.96		2.5		2.38	
0.50 µg/l	2	0	2.06	0	2.08	0	2.38	0	2.5	0	2.56		2.16	0	2.02	0
0.75 µg/l	2	0	1.02	0	2.06	0	2.12	0	2.14	0	1.88		1.08	0	0.6	0

Figure (1): Effect of different concentrations of Irgarol 1051 (0.25 , 0.50 and 0.75 µg/l) on growth of *Chlorella salina* cultured for 14 days.

Carbohydrates contents

Results obtained from the experiments that have been carried out on the effect of Irgarol on the carbohydrates content revealed that, all the tested concentrations of Irgarol were inhibitor to carbohydrates content of *Chlorella salina*. These results go in harmony with those obtained by **Sidharthan *et al.*, (2002)** who reported that, high concentration of TBT on 1.0 ng/l, the proteins and carbohydrates were inhibited in *Nannochloropsis oculata* and bring about drastic change in its biochemical compositions. **Khalaf *et al.*, (2007),** reported that, there was significant decrease in carbohydrate contents (total & soluble) of Chlorella with increasing dose of antifouling diuron.

Khodse and Meana,(2007) found that, antifouling agents like TBT and Irgarol influenced cellular and extracellular carbohydrate production. The results obtained in this investigation are in harmony with those recorded for such authors. **Kaamoush and El Agawany,(2021)** reported that, there was supression in carbohydrate content in *Dunaliella salina* in culture containing 0.012, 0.025 and 0.050 µg/L of Irgarol. Also, **Mishra *et al.*, (2008)** reported that, among different solute accumulating in response of stress, sugar play a key role to maintain the osmotic regulation in cells. There are earlier reports on carbohydrates accumulation on response of various abiotic stress during reproductive development **(Meier and Reid, 1982)**. It was found also by **Prado *et al*.,(2000)** that, accumulation of sugars is enhanced in response of verity of environmental stress. However, our work cleared that, the content of carbohydrates whether soluble, insoluble and total in the two tested algae depended mainly on the concentration of the stress compound and the length of culturing period. The decrease in carbohydrates content may indicate that, the efficiency of photosynthesis began to decrease owing to the destruction of chloroplast pigments **(Adjei-Twun and Spliusloesser, 1976).**It is worth noticing that, a change in carbohydrates content in the advent of the stationary phase showed nearly parallel similarity to the growth rate of the tested two organisms **(El-Mostafa, 1998)**.

The exposure of microalgae to toxic antifoulings may cause serious physiological alterations that can be readily observed via changes in proteins, carbohydrates, pigment and biomass production of *Scenedesmus quadricauda*, that's because inhibition of antifouling compound to chlorophyll as well as inhibition of photosynthesis activities which affect production of carbohydrates and other metabolites, **Chia *et al*., (2015)**.

Table (1): Content of carbohydrate fractions (soluble , insoluble and total in mg/l) in *Chlorella salina* under the effect of different concentrations of Irgarol 1051 (0.25 , 0.50 and 0.75 µg/l).

Time (Days)	Parameter	Control	Irgarol 1051 concentrations (µg/l)			F (p)	LSD
			0.25 µg/l	0.50 µg/l	0.75 µg/l		
0	Soluble	8.21 ±0.023[a]	8.21±0.023[a]	8.21±0.023[a]	8.21±0.023[a]	547295.70** (<0.001)	0.002
	Insoluble	18.53±0.035[a]	18.53±0.035[a]	18.53±0.035[a]	18.53±0.035[a]	4591126.6** (<0.001)	0.002
	Total	*26.74*	*26.74*	*26.74*	*26.74*		
4	Soluble	13.23±0.058[a]	17.90±0.013[b]	12.62±0.023[c]	10.15±0.015[d]	8971030.1** (<0.001)	0.003
	Insoluble	31.26±0.053[a]	20.25±0.005[b]	17.51±0.017[c]	16.85±0.029[d]	52187348** (<0.001)	0.003
	Total	*44.49*	*38.15*	*30.13*	*27.00*		
8	Soluble	32.30±0.064[a]	29.95±0.017[b]	20.90±0.019[c]	16.21±0.035[d]	66316109** (<0.001)	0.002
	Insoluble	30.62±0.063[a]	19.95±0.001[b]	17.15±0.014[c]	13.40±0.012[d]	81673874** (<0.001)	0.004
	Total	*62.92*	*49.90*	*38.00*	*29.61*		
12	Soluble	29.13±0.012[a]	28.21±0.012[b]	19.75±0.002[c]	16.15±0.071[d]	4410864** (<0.001)	0.003
	Insoluble	33.21±0.081[a]	18.21±0.005[b]	15.82±0.058[c]	13.25±0.018[d]	2.46×10^{8}** (<0.001)	0.002
	Total	*62.34*	*46.42*	*36.57*	*29.40*		
16	Soluble	19.74±0.026[a]	19.05±0.015[b]	20.54±0.012[c]	12.26±0.012[d]	434608.82** (<0.001)	0.003
	Insoluble	32.62±0.060[a]	21.90±0.005[b]	10.72±0.017[c]	8.51±0.033[d]	7210688.6** (<0.001)	0.002
	Total	*52.63*	*40.95*	*31.26*	*20.77*		

F (p): F-test (ANOVA) and its significance between groups.
*** : Statistically significant at p ≤ 0.05.**
Different subscribts are significant .
LSD: Least significant difference at 0.05.
****: Statistically significant at p ≤ 0.01.**
Data are expressed in mean ±SD

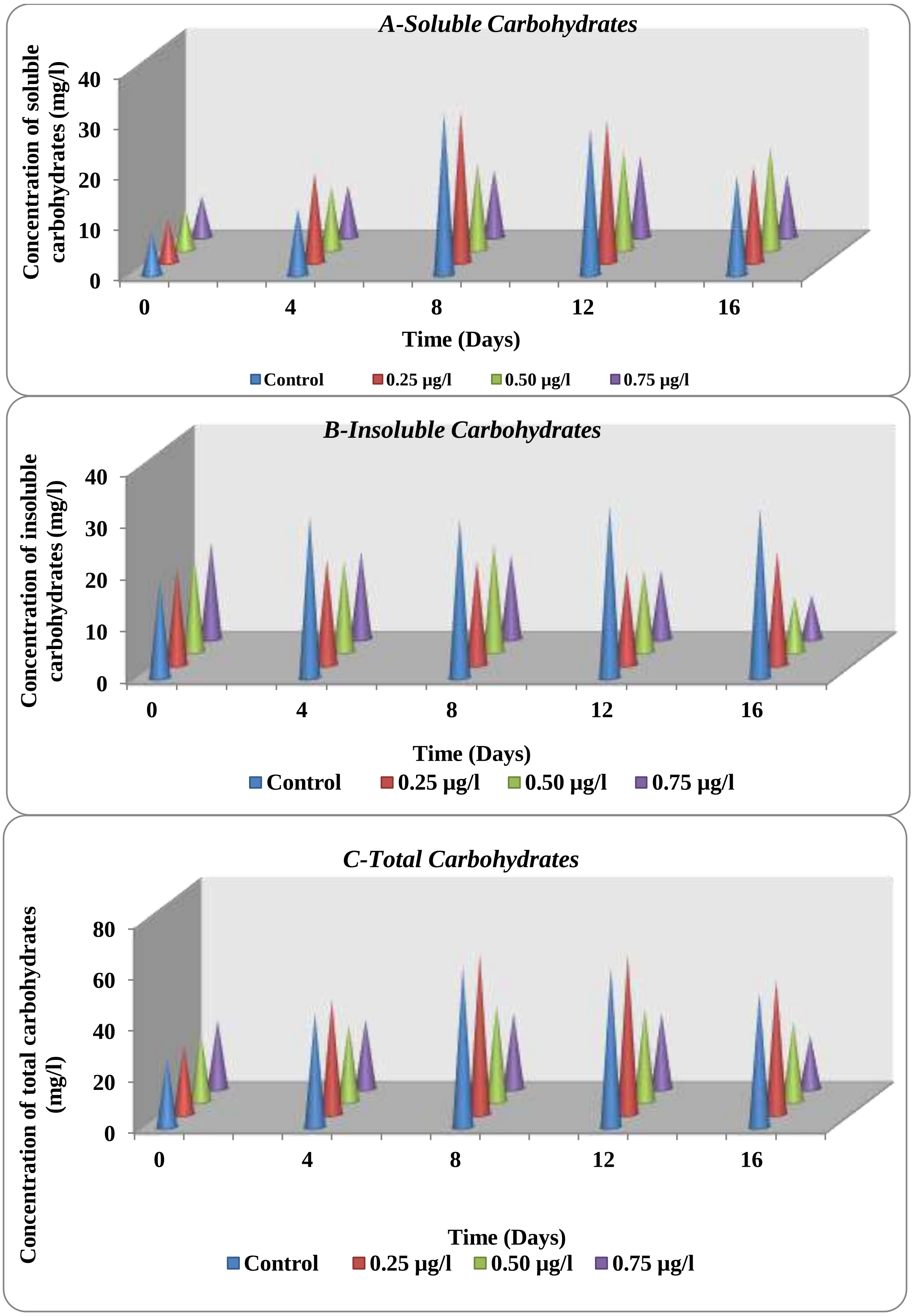


Figure (2): Content of carbohydrate fractions (soluble , insoluble and total in mg/l) in *Chlorella salina* under the effect of different concentrations of Irgarol 1051 (0.25 , 0.50 and 0.75 µg/l).

Protein

Taking into consideration, the effect of the antifouling agent Irgarol 1051 on content of protein fractions in *Chlorella salina* after 4, 8, 12, 16 days of culturing, the results that recorded in table (2) and graphed in figure (3) highlights that, at concentrations 0.25 , 0.50 and 0.75 µg/L Irgarol 1051 the content of total proteins increased nearly till the 8th day of culturing then began to decrease reaching minimum at the 16th day of culturing. Irgarol block conversion of excitation energy into chemical energy **(Jones,2005 and Sheikh *et al*., 2009).** Total protein contents of the investigated species under normal conditions, as revealed from our data, showed that, *Chlorella salina* tends to has high levels of proteins. This might be attributed to the fact that, most of algal species have similar physiological functions which are related to either biosynthesis or biodegradation of the same protein macromolecules (**Ahmed, 2010).**

Numerous species of microalgae such as *Spirulina*, *Chlorella* and seaweed including *Laminaria*sp. and *Ulva* sp. can be considered as source of protein to the diets of cattle, poultry, sheep and rabbits due to high protein content (**Holman & Malau-Aduli, 2013**).

Dhargalter,(1986) concluded that, the change of biochemical composition of some green algae may be related to the chemical or morphological changes associated with the various metabolic process of the algae. This conclusion seems to explain the different changes of the total amount of proteins content of *Chlorella salina* in the present investigation. It is also clear from the results that, protein content increased gradually by increasing period of culturing. However, at the 16th day of culturing, the content of total proteins began to decrease. The decrease in the content of total proteins at the end of the experiment may be due to decrease in insoluble concentration and deficiency of nutrients which increase protolysis **(Cooke *et al*., 1980)** and/or to decrease in the rate of protein synthesis **(Vaodia and Waisal, 1967)**. **Tam and Wong,(1995)** stated that, sever depletion of nutrient supply might be lead to progressive cell death as time proceeded at the end of the experiment. It must be mentioned that, the ability of Irgarol degradation was considered to be species dependant upon expense to Irgarol. The first phase would be its rapid biosorprtion onto the cell surface. This antifouling compounds then accessed to the cell interior through diffusion or via some ion channels as proposed by **St-louis *et al*., (1997)**.

The ability of some microorganisms to resist toxicity of antifouling agent may be due to the fact that, some microorganisms could prevent the entry of booster biocides into their cells by excreting sorbent to the cellular surface to biosorb this compounds, **(Gadd *et al*., 1990)**. **Luan *et al*.,(2006)**, found that, alginate immobilize *Chlorella vulgaris* was able to continuously remove and degrade the booster biocides even at the highest contamination levels. Also, **Exss-Sonne *et al.* (2000)** recorded that the tolerance of micro algae to stress conditions could be elaborated through synthesis or accumulation of new protein. **El Agawany *et al*., (2021)** suggested a highly recommendation that the behavior of algae, rich in protein, should be investigated in response to different environmental pollutants.

Table (2): Content of protein fractions in *Chlorella salina* cultured for 16 days under the effect of different concentrations Irgarol 1051 (0.25 , 0.50 and 0.75 µg/l).

Time (Days)	Parameter	Control	Irgarol 1051 concentrations (µg/l)			F (p)	LSD
			0.25 µg/l	0.50 µg/l	0.75 µg/l		
0	Soluble	17.820±0.250[a]	17.820±0.250 [a]	17.820±0.250 [a]	17.820±0.250 [a]	80899.416** (<0.001)	0.002
	Insoluble	12.410±0.150	12.410±0.150 [b]	12.410±0.150 [c]	12.410±0.150 [d]	66591.709** (<0.001)	0.002
	Total	*30.230*	*30.230*	*30.230*	*30.230*		
4	Soluble	25.970±1.620 [a]	26.210±1.720 [b]	28.620±2.000 [c]	28.820±1.410 [d]	19788705* (<0.001)	0.003
	Insoluble	32.850±0.710 [a]	30.420±0.410 [b]	25.430±0.050 [c]	22.310±0.210 [d]	23529446** (<0.001)	0.003
	Total	*58.820*	*56.630*	*54.060*	*51.130*		
8	Soluble	32.720±2.000 [a]	29.350±0.820 [b]	28.310±1.540 [c]	25.710±0.720 [d]	30039208** (<0.001)	0.003
	Insoluble	45.510±2.000 [a]	44.200±0.060 [b]	26.160±1.020 [c]	20.420±0.560 [d]	42989758** (<0.001)	0.003
	Total	*78.230*	*73.550*	*54.470*	*46.130*		
12	Soluble	50.640±1.430 [a]	45.120±0.720 [b]	30.150±1.320 [c]	28.350±2.510 [d]	42989758** (<0.001)	0.003
	Insoluble	82.530±0.920 [a]	38.030±0.420 [b]	24.270±0.46 [c]	17.240±1.430 [d]	52066091** (<0.001)	0.004
	Total	*133.17*	*83.150*	*54.420*	*45.590*		
16	Soluble	60.210±2.000	36.410±0.640 [b]	30.240±0.420 [c]	25.760±1.510 [d]	189355.03** (<0.001)	0.002
	Insoluble	54.470±2.240 [a] a	42.230±0.820 [b]	22.500±0.670 [c]	14.150±1.200 [d]	42666.09** (<0.001)	0.002
	Total	*114.68*	*78.640*	*52.740*	*39.910*		

F (p): F-test (ANOVA) and its significance between groups.
*** : Statistically significant at p ≤ 0.05.**
Different subscribts are significant .

LSD: Least significant difference at 0.05.
****: Statistically significant at p ≤ 0.01.**
Data are expressed in mean ±SD

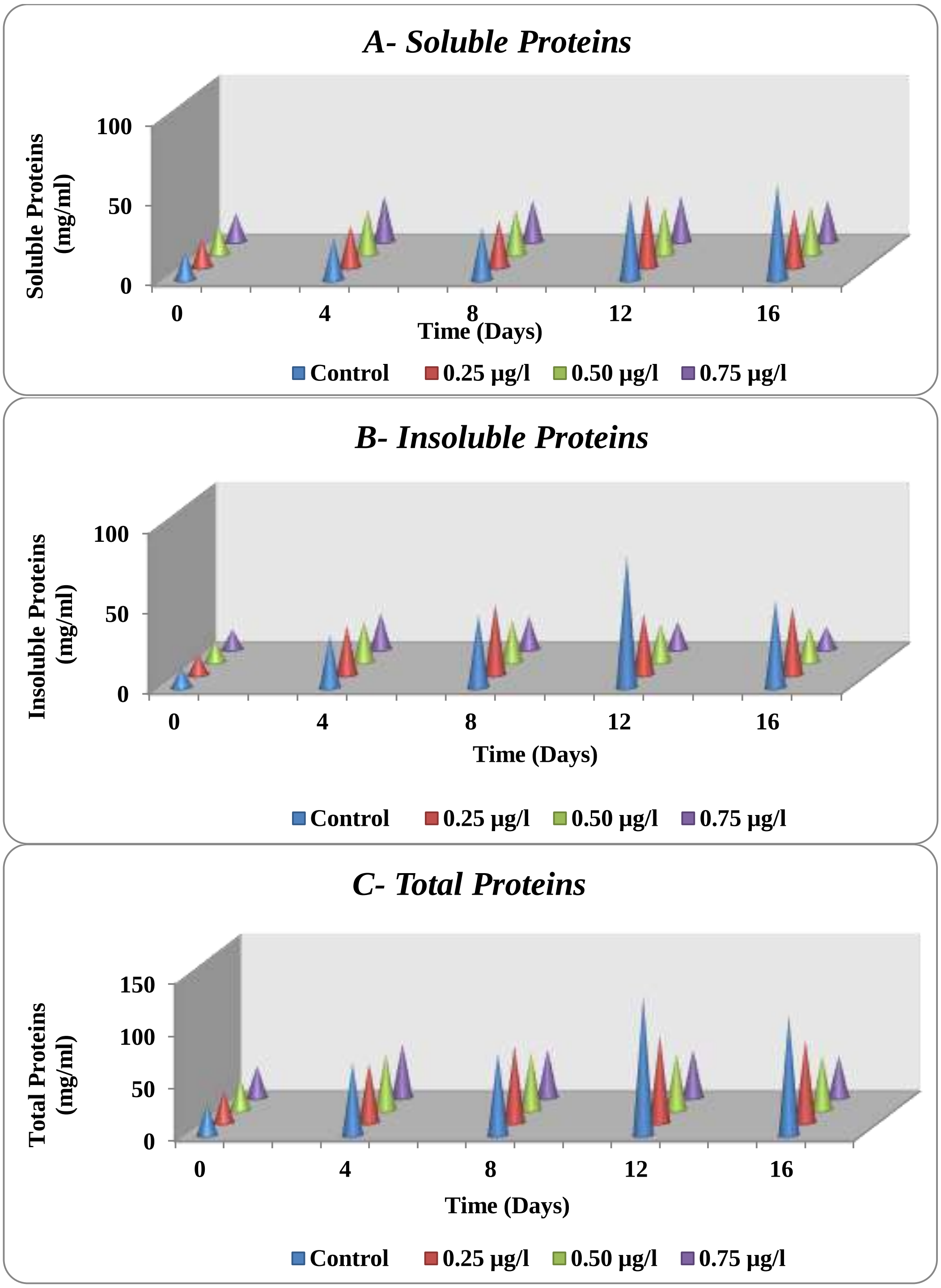


Figure (3): Effect of different concentrations of Irgarol 1051 (0.75 , 0.50 and 0.25 µg/l) on protein fractions content of *Chlorella salina* cultured for 16 days.

Amino acids

The results obtained for the analysis of free, conjugated and total amino acids for *Chlorella salina* cleared that, the amino acids of Krebs cycle family (glutamate and aspartate families) surpassed the other families of amino acids. The two families represented nearly 62.34% of the total amino acids in *Chlorella salina*. The total free amino acids increased gradually under the stress of all the studied concentrations of Irgarol when compared to control. However, **Fernandes and Meena,(2007)** studied the effect of TBT (antifouling agent) on amino acids of a marine bacteria. They found that, amino acids concentrations decreased with the increase the concentration of the antifouling agent. This idea coincides with our results where total amino acids decreased gradually by increasing the concentration of the antifouling agent. This idea was explained by **Song and Huang, (2000)**, who cleared those antifouling agents like TBT and Irgarol have an inhibitory effect on nitrate reductase activity and consequently a nitrogen metabolism in algae is changed and the equilibrium of nitrogen metabolism destroyed which might influence the nitrogen cycle of the ecosystem. Amino acids were found to be superior to algal extract. Amino acids are very important in plant growth, development and metabolite synthesis, since they are the basic building blocks of proteins, the synthesis of amino acids in plants is very energy consuming

In the light of the experimental results on the effect of different concentrations of Irgarol on the content of essential amino acids, it is clear that, total essential amino acids in untreated cultures represented nearly 3.94 % of the total free amino acids for *Chlorella salina*, while in the conjugated amino acids they represented 96.02 % of the total conjugated ones for *Chlorella salina*. At the same time, the total amino acids represented nearly 39.37% of the total amino acids. Owing to the fact that nutritional value of protein depends mainly on proportion and availability of its constituents of essential amino acids,**)**, this idea goes in harmony with those obtained by **(Brown and Jeffery, 1995).** Also, **Khalaf *et al.*, (2007)** reported that, Proline and total amino acids contents mL-1 of *Chlorella vulgarids* suspension were significantly decreased with

increasing diuron doses to those of the control. Also, **Wenqiu *et al.*, (2021)** observed that significant decrease in amino acids content obtained in culture of containing different concentrations of copper which used as antifoulant, which suggested that copper materials inhibit biosynthesis of total amino acids.

Xiangyuan, (2012) reported that Irgarol 1051 is toxic to *Synechococcus* sp. it stimulated cyanobacterial growth, increased the soluble protein content, and enhanced the catalase (CAT) activity at low concentrations, but inhibited them at high concentrations, it may be due to protolysis of insoluble protein.

Table (3): Content of free , conjugated and total amino acid fractions (mg/100mg protein) of *Chlorella salina* cells cultured for 8 days under different concentrations of Irgarol 1051 (0.25 , 0.50 and 0.75 µg/l).

Amino acids			Type of amino acid	Control			0.25µg/l			0.50µg/l			0.75µg/l		
				Free	Conjugated	Total	Free	Conjugated	Total	Free	Conjugated	Total	Free	Conjugated	Total
Krebs cycle family	Glutamate family	Glutamic	Acidic	0.96	15.09	16.05	0.86	9.38	10.24	1.38	14.57	15.95	1.34	10.47	11.81
		Arginine*	Basic	0.08	4.42	4.50	0.18	5.14	5.32	0.15	4.45	4.60	0.15	2.99	3.14
		Proline	Secondary a.a.	0.61	11.38	11.99	0.64	6.98	7.62	1.05	10.00	11.05	0.92	6.64	7.56
		Histidine*	Basic	0.12	1.64	1.76	0.09	1.86	1.95	0.08	1.17	1.25	0.05	2.52	2.57
		Sub total		**1.77**	**32.53**	**34.30**	**1.77**	**23.36**	**25.13**	**2.66**	**30.19**	**32.85**	**2.46**	**22.62**	**25.08**
	Aspartate family	Aspartic	Acidic	0.35	8.64	8.99	0.39	9.95	10.34	0.34	8.80	9.14	0.35	9.01	9.36
		Threonine*	Aliphatic	0.20	3.79	3.99	0.09	4.47	4.56	0.15	3.67	3.82	0.16	5.06	5.22
		Lysine*	Basic	0.15	4.42	4.57	0.21	5.93	6.14	0.16	4.15	4.31	0.17	4.29	4.44
		Isoleucine*	Aliphatic	0.11	3.42	3.53	0.11	3.79	3.90	0.10	3.20	3.30	0.11	3.64	3.75
		Methionine*	S. containing	0.27	1.69	1.96	0.20	1.90	2.10	0.18	2.85	3.03	0.31	2.53	2.84
		Sub total		**1.08**	**21.96**	**23.04**	**1.00**	**26.04**	**27.04**	**0.93**	**22.67**	**23.60**	**1.10**	**24.53**	**25.63**
	Total			**2.85**	**54.49**	**57.34**	**2.77**	**49.40**	**52.17**	**3.59**	**52.86**	**56.45**	**3.56**	**47.15**	**50.71**
Triose- pyruvic acids family	Triose-family	Glycine	Aliphatic	0.14	5.21	5.35	0.14	5.23	5.37	0.14	5.02	5.16	0.14	5.07	5.21
		Serine	Aliphatic	0.21	3.11	3.32	0.18	3.71	3.89	0.15	3.29	3.44	0.16	4.19	4.35
		Cysteine	S. containing	0.16	0.11	0.27	0.36	0.32	0.68	0.13	0.17	0.30	0.21	0.14	0.35
		Sub total		**0.51**	**8.43**	**8.94**	**0.68**	**9.26**	**9.94**	**0.42**	**8.48**	**8.90**	**0.51**	**9.40**	**9.91**
	Pyruvate family	Alanine	Aliphatic	0.49	5.88	6.37	0.47	6.30	6.77	0.44	5.77	6.21	0.43	6.58	7.01
		Valine*	Aliphatic	0.09	4.51	4.60	0.10	5.48	5.58	0.08	4.26	4.34	0.08	4.92	5.00
		Leucine*	Aliphatic	0.23	6.36	6.59	0.27	8.24	8.51	0.21	5.87	6.08	0.22	7.13	7.34
		Sub total		**0.81**	**16.75**	**17.56**	**0.84**	**20.02**	**20.86**	**0.73**	**15.90**	**16.63**	**0.73**	**18.63**	**19.36**
	Total			**1.32**	**25.18**	**26.50**	**1.52**	**29.28**	**30.80**	**1.15**	**24.38**	**25.53**	**1.24**	**28.03**	**29.27**
Shikimc acid family	Phenyl alanine*		Aromatic	0.19	4.52	4.71	0.18	4.50	4.68	0.18	4.16	4.34	0.19	4.89	5.08
	Tyrosine		Aromatic	0.26	3.17	3.43	0.24	3.33	3.57	0.23	3.12	3.35	0.24	3.53	3.77
	Total			**0.45**	**7.69**	**8.14**	**0.42**	**7.83**	**8.25**	**0.41**	**7.28**	**7.69**	**0.43**	**8.42**	**8.85**
Grand total				***4.62***	***87.36***	***91.98***	***4.71***	***86.51***	***91.22***	***5.15***	***84.52***	***89.67***	***5.23***	***83.60***	***88.83***

*Represents essential amino acids.

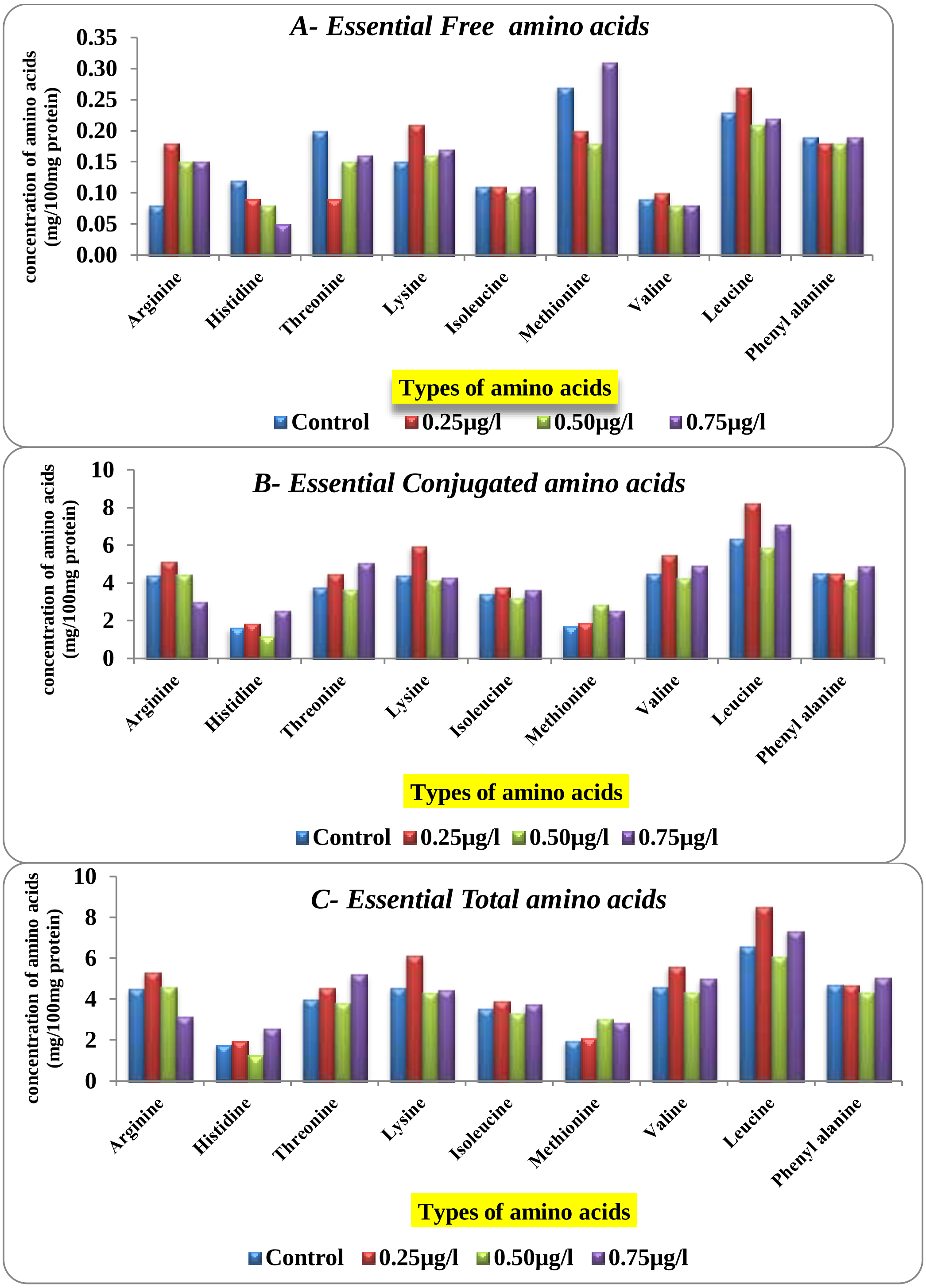


Figure (4): Content of free (A) , conjugated (B) and total (C) essential amino acids fractions of *Chlorella salina* cells cultured for 8 days at different concentrations of Irgarol 1051.

Fatty acids

It is well known fact that, lipid production including fatty acids usually differed between genera species and strains of micro-organisms, **(Johansen *et al.*, 1987).** These results coincide with those obtained in our work where *Dunaliella salina* was found to be more sensitive to Irgarol than *Chlorella salina*. However, total lipid fractions in healthy phytoplankton vary substantially from less than 1% to more than 40% of dry weight **(Dubinsky *et al.*, 1978).**The stress response was more prominent in mono-unsaturated fatty acids than in the other two groups of fatty acids and the more the increase in the concentration of Irgarol, the more the stress effect and consequently the more the decrease in the content of total fatty acids.

Environmental factors were found by many authors to affect the proportions of fatty acids. Also, **Simonopoulos,(1991)** found that, microalgae were a good source of Omega-3 fatty acids which are protective factors against chronic diseases, diabetes and cancer. **Chu and Dupuy, (1980)** concluded that, the changes in the relative amount of poly-unsaturated fatty acids may be attributed to effects on the destruction bath way of fatty acids. **Xu *et al.*, (1997&1998)** reported that, the reduction of the poly-unsaturated fatty acids fractions might be due to reduction in membrane fluidity and permeability. These results go in harmony with our results where some poly-unsaturated fatty acids specially those belonging to Omega-3 disappeared completely at higher concentrations (0.75µg/l Irgarol) in *Chlorella salina*, while at concentration 0.025µg/l only one fatty acids (archidonic acid) disappeared. Our results are in agreement with those obtained by **Soizic *et al*.,(2021)**, who observed that Diuron and irgarol are photosynthetic inhibitors and they cause inhibition of fatty acids synthesis.

Saturated fatty acids are the only group of fatty acids that increased under the stress of the three tested concentrations of Irgarol in the studied organism. **Dowidar, (1983)** mentioned that, saturated fatty acids were more dominant than unsaturated ones under stress conditions. The same conclusion was also reported in our results. In our laboratory it was found that, the maximum values of fatty acids usually attained at the end of the log or at the beginning of the stationary phases. At these two phases, the nutrient values of culture medium usually decrease. So, we usually analyze the fatty acids in the tested organisms cultured for 12 days. These results coincide with those obtained by **El-Maghrabi,(2002) and Al-Osaimi, (2010).**

Environmental factors can affect both the relative proportions of fatty acids **(Fisher & Schwarzenbach, 1978)** as well as, the total amount of lipids **(Conover, 1975)**. This idea coincide with those obtained in our work where the total fatty acids in theorganism decreased by increasing the concentration of Irgarol.

+ Table (4) :Effect of different concentrations of Irgarol 1051 on fatty acids content of *Chlorella salina* cultured for 12 days .

Fatty acids		Control	Irgarol 1051 concentration		
			0.25 µg/l	0.50 µg/l	0.75 µg/l
Saturated	C 14:0 Myristic	1.021	1.708	1.751	1.481
	C 16:0 Palmitic	2.724	2.138	2.129	2.429
	C 18:0 Stearic	0.016	---	---	---
	C 20:0 Arachidic	0.193	0.194	0.205	0.147
	Total	3.954	4.040	4.085	4.057
	% of increasing (+) or decreasing (-)	100%	(+) 2.18%	(+) 3.31%	(+) 2.61%
Mono -un saturated	C 18:1 Oleic	6.232	2.722	1.011	0.113
	C 16:1 Palmitoleic	0.451	0.365	0.300	0.040
	C 22:1 Erucic	0.158	0.132	0.102	---
	Total	6.841	3.219	1.413	0.153
	% of increasing (+) or decreasing (-)	100%	(-) 52.95%	(-) 79.35%	(-) 97.76%
Poly- un saturated	C 18:2 Linoleic	0.221	0.055	0.041	0.025
	C 18:3 Linolenic	4.621	4.293	2.450	0.631
	C 20:4 Archidonic	6.072	6.036	3.480	---
	C20:5Eicosa-pentaenoic	1.325	0.630	0.243	---
	*C22:*6Docosa-hexaenoic	2.490	2.250	1.049	0.419
	Total	14.729	13.264	7.263	1.075
	% of increasing (+) or decreasing (-)	100%	(-) 9.95%	(-) 50.69%	(-) 92.70%
Total fatty acids		25.524	20.523	12.761	5.285
% of increasing (+) or decreasing (-)		*100 %*	*(-)19.59%*	*(-)50.00%*	*(-)79.29%*

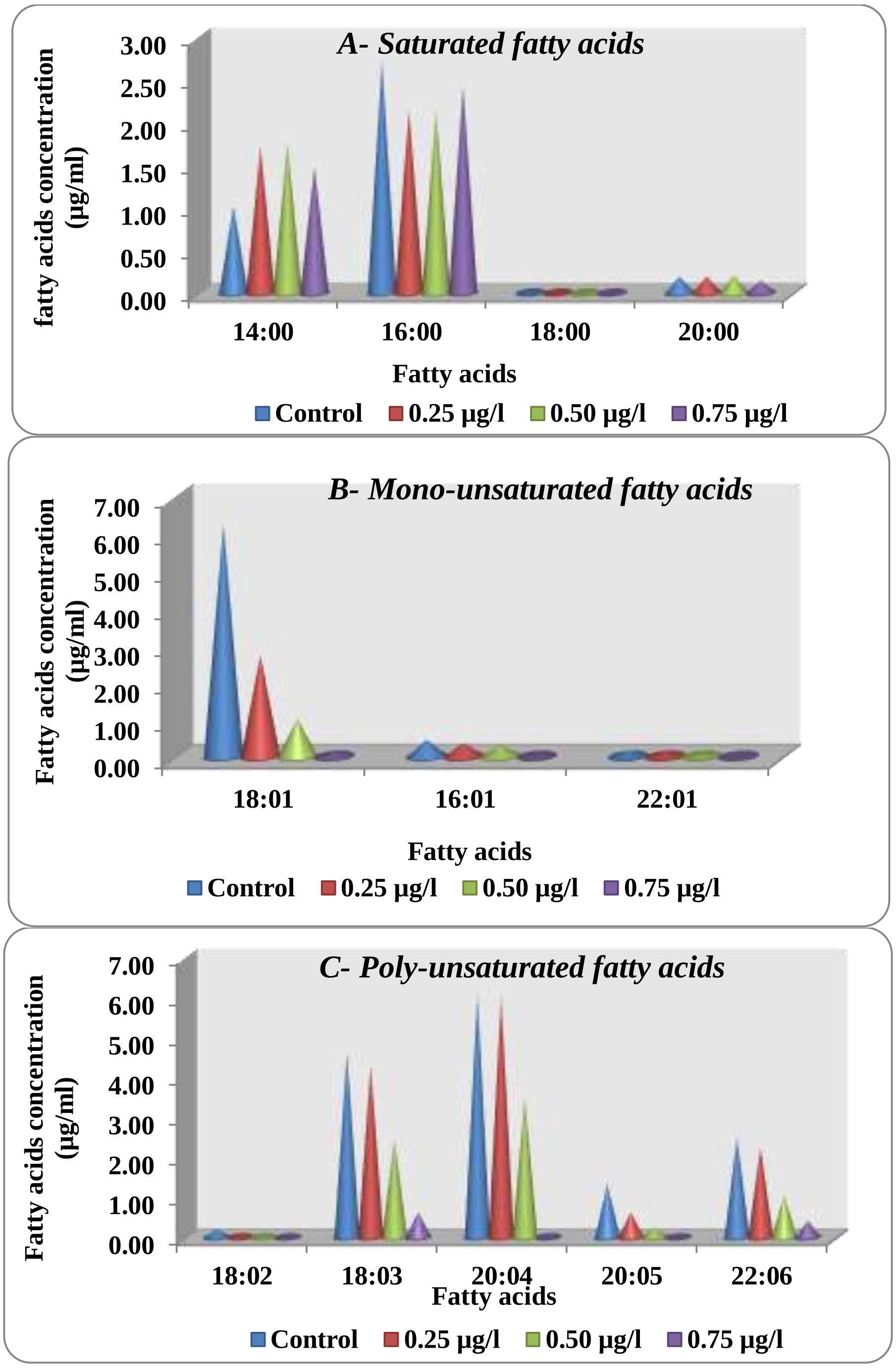


Figure (5): Effect of different concentrations of Irgarol 1051 on fatty acids content of *Chlorella salina* cultured for 12 days.

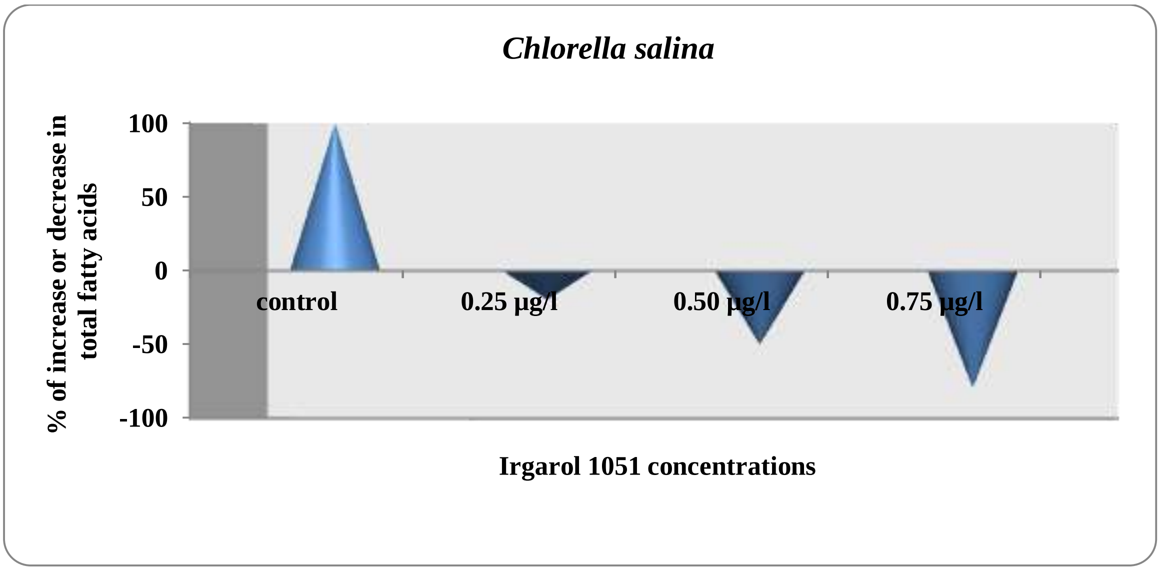


Figure (6): Percent of increase (+) or decrease (-) in total fatty acids under the effect of different concentrations of Irgarol 1051 in *Chlorella salina* cultured for 8 days .

Conclusion:

Irgarol 1051 (2-(tert-butylamino)-4-(cyclopropylamino)-6-(methylthio)-1,3,5-triazine) is a biocide widely used in antifouling paint on ships to prevent fouling growth. It is used booster herbicides in antifoulants and may exert potent toxic effects on marine primary producers such as microalgae, where majority of the toxicity data are based on growth inhibition of essential metabolites such as proteins, carbohydrates, amino acids and fatty acids. The results cleared also that, the effective concentration (EC50) of Irgarol for *Chlorella salina* was recorded nearly in concentration 0.5 µg/L at the 8th day. The data obtained cleared that, suppression of algal growth under the effect of the different tested concentrations of Irgarol may be due to the increasing of toxicity of this biocide. all the tested concentrations of Irgarol were inhibitor to carbohydrates content of *Chlorella salina*. At concentrations 0.25 , 0.50 and 0.75 µg/L Irgarol 1051 the content of total proteins increased nearly till the 8th day of culturing then began to decrease reaching minimum at the 16th day of culturing. The stress response was more prominent in mono-unsaturated fatty acids than in the other two groups of fatty acids and the more the increase in the concentration of Irgarol, the more the stress effect and consequently the more the decrease in the content of total fatty acids.

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ENVIRONMENTAL SUSTAINABILITY OF COASTAL AREAS AND BUILDING-WITH-NATURE, 10 YEARS OF EXPERIENCE IN A DUTCH NATURE COMPENSATION PROJECT

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Keywords: harbor extension, compensation of nature damage, dune ecosystems, building with nature, dune landscape development

1. ABSTRACT: The paper discusses 10 years of experience with a unique dune compensation project at the Dutch coast (total project duration 20 years). The compensation was needed because a large extension of Rotterdam harbor would damage two high-quality dune ecosystems nearby. EU legislation obliged to compensate these two ecosystems. The compensation area was constructed and developed according to the principles of Building-with-Nature. The use of local natural materials and processes and a minimum of human interference is a leading principle. Careful monitoring is done for evaluation. However, over time some important human interferences were necessary to stay 'en route' and to reach the two compensation targets. The management measures and their results are discussed. The insights gained and their importance for environmental sustainability of coastal areas in general, are given.

2. INTRODUCTION

First, the principles of building–with-nature are given. Next, the paper discusses how the recent extension of Rotterdam harbor will damage two existing high-quality dune ecosystems nearby. According to EU-legislation, they need to be compensated. For the compensation, an entirely new dune area was constructed. The construction and the following development of this area, were done according to the principles of building-with-nature. But compensation of nature and nature development takes time, sometimes several decades. While a minimum of human interference was the intention at the start, over the past ten years some drastic management actions were necessary. Particularly at the level of geomorphology, groundwater and vegetation development. The management actions and their results are discussed. The paper concludes with lessons learned from the project so far and conclusions about environmental sustainability of coastal areas and transfer to other countries.

Building-with-nature

Building-with-nature is a new way of engineering, which makes use of the local properties of nature (green technology) (Waterman 2008, van Eekelen and Bouw 2020, World Bank 2017, 2018). At the coast, this means respecting and using the coastal ecosystems and processes, as much as possible and with minimal human interference. As such, building **with** nature contributes more to environmental sustainability than does the traditional building **in** nature. The latter often ignores and destroys nature. In that case, we may even speak of building **against** nature**.** An example: at sandy coasts, building coastal defense structures is traditionally done with hard solutions, like groins, breakwaters and concrete slabs. But soft, more nature-based solutions can also be considered, like sand nourishment. This is more in line with building-with-nature principles (fig 1).

Figure 1: Developments in coastal engineering: change from hard designs (left)to softer more nature-based designs (right; beach nourishment, Netherlands). Hard structures with alien materials, like basalt rock, decrease natural properties of the coast (building in nature). Soft ones with local material, are more in line with coastal characteristics (building with nature).

Extension of Rotterdam harbor and compensation of nature damage

In 2010, a new dune area (called Spanjaards Duin; size 35ha) was constructed at the dutch coast, in the southwestern part of The Netherlands, by beach nourishment (6 million m^3) (figs. 2, 3). The nourishment was laid out in front of the exiting coastline. This new area is meant to compensate for the damage to existing Natura 2000 dunes, caused by the extension of Rotterdam harbor (Maasvlakte 2; www.maasvlakte2.com) (fig 2). Natura 2000 is a network of European high-quality nature reserves. EU regulations required compensation of the damage (van der Meulen et al 2015, van der Meulen 2016). The damage to nature that was expected, is high airborne deposition of NOx (N is an important nutrient for plants), caused by the increase of harbor traffic. This high NOx deposition is detrimental for two high-quality and nutrient-poor dune ecosystem types: Grey dune and Dune marsh. (fig. 4). So, these two types are the targets for compensation in Spanjaards Duin. The time period for the compensation project ends at about 2030, the same year in which the new harbor extension would be in full operation (and full emission of NOx). Under normal conditions, these ecosystems will take about 20 and 5-10 years to develop, respectively.

Figure 2: Part of the southwestern Netherlands coast. Extension of Rotterdam harbor with Maasvlakte 2 (white). Nature damage (red) and nature compensation (green).

Figure 3: The new dune area, two years after construction (2011). Prospective dune marsh to develop in the lowest parts of the valley (middle). Prospective Grey dune to develop on the surrounding, more elevated sites. In the distance the new harbor extension of Rotterdam (Maasvlakte 2). Yellow line marks the border between existing dunes (left) and nourished dunes (right).

Figure 4: Compensation targets, two high-quality and nutrient poor ecosystems: dry Grey dune (left) and Dune marsh (right).

From the start, the compensation project was carried out along the principles of building-with-nature. In 2010, the new dune landscape was constructed by beach nourishment with local sand taken from the nearby North Sea bottom. Once the sand was deposited, local, natural processes were given free hand, without human interference as much as possible. This implies: shaping of dunes and dune valley by wind, fresh ground water development by rainfall (the initial nourished sand had a salinity of 300mg/l, the salinity of North Sea water. The nourishment had to desalinize first before a fresh groundwater dome could develop in the new dune body. This takes some 5-10 years), and natural vegetation development by pioneer colonization and succession. So, the landscape development started in 2010.

A unique experience of worldwide interest

The compensation project is unique worldwide. Never before was, in the context of a large civil engineering harbor project, at the same time, a dune building project undertaken to develop specific dune ecosystems of high nature value in about 20 years. The development of the area was yearly monitored for evaluation. After more than 10 years of monitoring and experience we can make up a first balance, halfway the project duration time (2010-2030).

3. DEVELOPMENT OF THE NATURE COMPENSATION PROJECT AND HUMAN INTERVENTION

The initial Building-with-nature philosophy, of development with minimal human interference, appeared too optimistic. Nature is not always makable and predictable. In the field, there were unexpected developments. At the political level, there was increasing pressure to speed up the ecosystem developments into the desired direction. This is important to note, because it means that political arguments can become dominant over nature/ecological arguments. Most often, the available time is the crucial factor for success. Politicians think in terms of elections, which is in periods of 4 years of election time. Nature, on the other hand, needs more time, often decades. This can cause friction. In order to steer the development towards the two compensation targets, it was decided to make some drastic management interventions. In the past ten years, following actions were carried out.

Management interventions

Process 1-Dune dynamics and morphology: too much sand dynamics The nourished sea-bottom sand was rich in sea-shell fragments (ca 30%). After this sand was deposited, ongoing wind erosion blew out the sand particles from in between these shell fragments. After some years, the substratum surface was largely covered with shell fragments, appearing like a kind of desert pavement (fig. 5).

Figure 5: Left: numerous shell fragments at the surface, forming a 'desert pavement', difficult for plants to colonize. Right: large gap in the fore dune ridge to be closed to reduce sand dynamics. (Photo: Bert van der Valk).

Such a 'sealed' soil surface and strong sand blasting is an obstacle for the colonization and establishment of Grey Dune vegetation. At the same time, the sealed surface blocked further erosion of the valley floor down to the ground water level. This was an obstacle for the colonization and establishment of Dune marsh. Several years of monitoring showed that these obstacles where indeed persistent and the compensation project appeared to be in danger. Finally, intervention was necessary to stay 'en route' towards the two compensation targets.

Over the years 2017-2019 it was decided to minimize the overall sand dynamics in order to create better ecological conditions for Grey Dune vegetation development (no more sand blasting and less shell fragments at the surface). Some large openings in the fore dune ridge gave way to large amounts of sand from the beach to enter the valley (fig. 5). These gaps were closed with sand that was stabilized with marram grass.

Process 2. Groundwater dynamics. Excavate and lower the valley floor

To create better ecological conditions for the Dune marsh, the valley bottom floor was excavated further down to the groundwater level (fig. 6). Five oval depressions were dug out, aligned with the prevailing southwest-northeast wind direction and looking like natural blow-outs. By this work the groundwater-level now was near or at the surface, the right ecological condition for Dune marsh vegetation development.

Figure 6: Excavating the valley floor (left; photo: Bert van der Valk) and creating oval depressions with ground water near the surface (dark grey colors in right picture).

Process 3. Vegetation development. Introduce plant material to boost the seed bank

The monitoring of vegetation showed that the development towards the targets, Grey Dune and Dune Marsh, went very slow. Soil profile studies revealed that, even after about 8 years, there was hardly any seed bank in the sediment. Not a surprise, because the original sediment was taken from the sea bottom and all plant seeds have to be brought in (f.e. by wind, birds) from nearby dunes.

In 2019 it was decided to bring in plant material (clippings, that were cut yearly) from Grey dune and Dune marsh elsewhere. The clippings were brought in and spread out over the soil surface (fig. 7). The clippings contained a lot of seeds from plant species that are characteristic for Grey Dune and Dune Marsh. This measure will give the seed bank a boost and speed up vegetation development. Similar experiments from other comparable dune areas in northwestern Europe, all had positive results.

Figure 7: Bringing in plant material from high quality ecosystems nearby, to give the seed bank a boost.

4. RESULTS OF THE INTERVENTIONS

The interventions were done to provide for better ecological conditions and to speed up the development of the target vegetations. Three characteristic dune processes were managed: (i) dune morphology and sand dynamics, (ii) ground water development and (iii) vegetation development. Although the time is still short for a solid evaluation, the first positive results can already be seen: the overall sand dynamics in the area are greatly reduced thus providing stable conditions for plants to germinate and for vegetation to grow. At places where grass material was spread out, several characteristic species of high-quality Dune marsh already appeared after one year. Examples are some orchids (*Orchis* spec.), Grass of Parnassus (*Parnassia palustris*) and Yellow-wort (*Blackstonia perfoliata*).

The project and the monitoring will go on till 2033. This is the same year that the new harbor is expected to be in full operation. There is good evidence that the near future will show more positive results of the interventions, in favor of the compensation aims.

5. LESSONS LEARNED ABOUT BUILDING WITH NATURE

The following lessons can be learned now the project is about halfway.

(1) Nature is not always makable and predictable

(2) Building-with-nature (and few interventions) is a good concept to apply in practice, but one should always be aware that small or larger adaptations may be needed. In this project this meant, for example, that, even if local material is used (sand from the nearby sea bottom), adaptations were necessary because the material differs from aeolian dune sand. This caused deviating dune developments, which made extra management necessary.

(3) Always monitor and evaluate to make the right adaptations at the right time and place.

(4) Monitoring also helps to learn more about the ecosystem (behavior); learning by doing enhances your expertise.

(5) Have patience; nature development takes time; often more than politicians have or want. This is often a crucial point in the debate between nature and economic development. The 'dynamics' of nature differ largely from those of governmental politics, but the latter is often deciding.

(6) Protect the building-with-nature area right from the start, to allow an undisturbed development. In the beginning the actual ecological quality may not score high. The reason for protection is not the present quality but the prospective and intended, future quality.

6. CONCLUSION: ENVIRONMENTAL SUSTAINABILITY OF COASTAL AREAS AND TRANSFER TO OTHER COUNTRIES

This example is taken from Dutch coastal dunes. But knowledge gained here can be transferred to other coastal countries that want to develop a policy for environmental sustainability of their coasts, for example in the future of adaptation to climate change.

Some main points to consider are:

(1) Always compensate nature damage

(2) Civil technical solutions should be weighed against nature technical solutions to assess which one is a more sustainable solution or a better combi of both.

(3) Install monitoring to learn more about the coastal ecosystems in question and to apply more green technology in future coastal development.

(4) Consider building-with-nature as an added and valuable technique in all future coastal engineering projects.

(5) Cooperation between various disciplines, ecological, civil engineering, nature management and policy making, is essential.

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MEASUREMENT OF STRESS AMONG MARINE ENGINEERS: A METHODOLOGICAL INTERVENTION

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ABSTRACT: Stress measurement has been an issue on the backburner for maritime sector. In this sector, job related stress has been considered as a way of life. With the onset of pandemic, understanding stress and its management on board ships has become a challenge and of paramount significance to seafarers and shipping companies. Extended contracts of employment, constraints on ships, work fatigue, away from family have all highlighted the need for scientific research on understanding stress on board ships, particularly during challenging times. Most of the studies on stress management and measurement among seafarers employ generalized stress management techniques which do not illuminate sector specific stressors, particularly during uncertain times like Covid-19, let along illuminating general job related stressors. Lack of scientific understanding of stress and stressors in maritime sector adds on to this challenge and thus calls for a sector specific methodological intervention to understanding of stress and stressors among seafarers. In this backdrop, based on previous evidences and discussion with seafarers, a methodology is developed to use a structured questionnaire covering stressors like job itself, company policies, planning activities, away from family, cultural differences and lack of socialization. Since pandemic posed dynamic constraints in the maritime ecosystem, such a structured questionnaire would help in understanding stress and stressor among marine engineers during Covid-19 and facilitate in the development of appropriate stress management strategies by firms in maritime sector. Reliability and validity of the questionnaire has been checked.

INTRODUCTION

Marine industry is one of the oldest industry and profession in human history. Such industry also led to not just new discoveries but also fostered integrated and more globalised world. However, working environment on board ships is not a smooth carpet. Resource constraints on ships and escalated demands from environment particularly during COVID-19 have resulted in staking health and well being of seafarer in terms of stress. Although provisions and regulations are in place to ensure ship safety, exclusive focus on the stress coping and management among seafarer has been at the back burner till COVID-19 set in. Although, adaptive behaviour to stress is considered to be organic and part of jobs in marine industry, not addressing stress suitably may have negative health impact on the long run. This is particularly true when stress coping strategies are so much inadequate in marine industry. In this context, the existing methodologies to study occupational stress may not be adequate to study the entire dynamics of stress and its management among seafarers. It is at this juncture, that this paper comes as an intervention to study stressors in marine industry in a sector specific framework using a questionnaire. The objective of this paper is to illuminate a questionnaire as an instrument that is prepared to understand stress among marine engineers exclusively during the time of uncertainty like COVID-19, outbreak of SARS virus, etc. Necessary statistical tests are conducted to ensure the suitability of the questionnaire for the said purpose.

The scope of the present paper is limited to marine engineering domain and not to entire seafarer community due to ease of access to understand the sector and thus understand level of stressors and stress. However, this questionnaire may be used for other categories of seafarers subject to achievement of statistical reliability and validity.

ORGANISATIONAL BEHAVIOUR IN ENGINE ROOM OF A SHIP

A ship comprises of Deck department, Engine department and Catering Department. Engine department is responsible for operational and maintenance of all ship board machinery and engineering equipment on board ship. Organisational structure in engine department is linear which comprises of Chief Engineer, Second Engineer, Third Engineer, Fourth Engineer, and Trainee. The Chief Engineer is the higher managerial role in the engine department essentially involved in managerial functions like planning, organising, directing concerning operational, repair and maintenance of machinery and equipment on board ship. The second engineer reports his/her work to Chief engineer and is essentially involved in supervisory and operational roles. The second engineer's functional role is in line with a team leader who not just involved in supervising operational and maintenance work of his subordinates but also has his operational roles. The second engineer is also part of engine room watch keeping along with other engineers. The third and fourth engineers are subordinates to second engineer. In some ship, trainee engineer is also hired and often taken on rolls to provide a first-hand experience of working on board to such employee. Such trainees are on board in a phase of learning by doing of their shipping career.

In terms of regulation effecting organisational behaviour in engine department, SOLAS chapter V illuminates safe manning principles as in the number of people required for safe operation of a ship. Thus, the number of people working on board depends on the nature of the ship like tanker, container ship, bulk carrier, and RORO vessel, etc. In practice, chapter III of the STCW convention which sets training, certification and competencies of personnel working in engine department on board as per safe manning. Further, the Ship Safety Management System which clearly draws job roles of human resource on board from safety perspective. Finally, the Maritime Labour Convention (MLC) which sets out labour practices on board which includes rest hours for personnel working on board, for instance, engine room. These provisions and regulations act as guiding yard sticks for ship owners and maritime administration i.e., flag state and port state controls for safe operation of a ship.

A close examination of the regulations and provisions highlighted earlier signifies that a competent crew is required to work for a specified period of hours to maintain safety on board. Therefore, these regulations are in place for the safety of the ship and not for the welfare of the seafarer. As Baumler (2020) illuminates that IMO's fatigue management approach essentially focuses on a safety of a ship rather than welfare of seafarers.

Further, the size and design of the ship puts much constraint. The design of the ship which may include compact engine rooms where there is not much free space to work for the marine engineers is itself acknowledged as one of the factors that makes crew work in inappropriate manner and staking not just their safety but all others on board (Lundh *et al*, 2011). Design constraints leading to adapting inappropriate operational procedures and staking safety in engine room of a ship is also confirmed by Saatcioglu *et al* (2017). Moreover, working in engine room is quite daunting due to noisy environment, cramped space at the same time challenging demands due to technological innovations requiring engineer officers to be in line with such development (Man *et al*, 2018). With the adoption of new technologies coupled with profit oriented motives, the size of the ships are increasing only to accommodate more cargo. Increasing load of cargo with a constrained number of engineering officers on board has increased the work pressure and work load of every engineer on board ships. Thus, following international safety regulations in view of constrained in terms of size of the ship, design of the engine room, limited number of personnel available to work have all lead to high level of stress (both perceived and actual) among engine room personnel. Such a tendency is confirmed by Oldenburg and Jensen (2019) who point out that on board a ship, engine room personnel are the second group after deck ratings that have highest occupational stress. Therefore, work place stress is considered to be an organic part of marine engineering profession. This could be again due to the constraints on-board ship, any challenging demand from environment essentially has to be taken care by personnel working on board. For instance, if any machinery does not work at an expected level in mid sea, personnel working on board ought to come up with immediate solution which can be workable with the spares and equipment that are available on the ship till necessary help is available in the next port. To put it in other words, adaptive response to stress is part of marine engineer profession. It is in this context that this article borrows elements of work place stress from the perspective of Allostasis Load Model of Stress as propounded by McEwen (2005) who introduces a new terminology called allostasis refers to the adaptive bodily responses to stress. He propounds that if the allostasis load is within limits, adaptive response to demands would occur. However, if allostasis "over load" occurs due to sudden unexpected demands from environment, this may lead to negative effects on human health. In marine industry, allostasis overload could be ship in a rough sea, extended contracts during COVID-19, no shore leave and no crew change during COVID-19, etc. Though in marine industry, allostasis leads to adaptive behaviour to stress which is a long terms exercise (Todd, 2019), however, not addressing frequent occurrence of allostasis and particularly allostasis over load may lead to long terms impacts on health of marine engineers. This calls for remedial measures and coping strategies in place to handle such occurrence.

CAUSES OF STRESS AMONG MARINE ENGINEERS

Seafaring job is unique in nature and the factors affecting stress have particular characteristics different from other jobs (Anna Carotenuto *et al*, 2012). Research have shown that stress among seafarers in general is high. Separation from family is seen as affecting factor particularly for young seafarers having children (Oldenberg *et al*, 2009). Also, long hours of working results into increase in level of stress among seafarers (Oldenberg *et al*, 2019). Cultural differences among on-board employees may lead to understanding problem significantly (Simpson & Thompson, 2003) (Lu CS *et al*, 2012). Further, voyage planning (Elif Bal, 2015) and impact of lack of on-board socialisation, recreation, friendship on mental health of seafarers (McVeigh and Malcom, 2019) are also acknowledged as factors increasing stress level of on-board seafarers. In the larger context of human resource management, Oldenberg and Jensen (2019), acknowledge that the stress level among seafarers varies based on policies followed by different companies.

RATIONALE FOR DESIGNING A NEW INSTRUMENT TO MEASURE STRESS

From the above discussion its apparent that spate of factors contribute to stress among marine engineers. In this context, instruments to measure level of stress like 'Perceived Stress Scale' (PSS) developed by Sheldon Cohen in 1983, 'Depression Anxiety Stress Scale' (DASS) developed by Lovibond, S.H., Lovibond, P.F. in 1995 are widely used till date. While the Perceived Stress Scale is designed to measure the level of stress in general and classify them under categories like 'low stress', 'moderate stress' and 'high perceived stress'; the Depression, Anxiety and Stress Scale is designed to measure the levels of 'depression', 'anxiety' and 'stress' and categories them under 'normal', 'mild', 'moderate', 'severe' and 'extremely severe'. The existing instruments to measure stress taking into consideration critical lifetime events and their resulting stress on an individual. Such an analysis leads to a measurement of stress through perceptions based on previous experiences of depression, anxiety and stress. However, when we talk about working professionals, talking about measuring work place stress is of significant importance to prescribe suitable stress coping strategies. Stress emanating out of critical life time incidents and level of work place stress are related. Stress measurement in the workplace is measured using established questionnaires particularly among health professionals. However, such methodologies result in subjective perception and therefore, an integrated approach of using data from various sources would be giving holistic understanding of stress (Guglielmi, *et. al.*, 2013). The above instruments are used for sectors where the jobs are shore based. Thus, the constraints in the work place are not as significant as in case of marine engineering sector where the jobs are on-board ship based with less and timely access to resources, significant constraints and Covid-19 pandemic has further escalated these constraints and challenges. Given the nature of the job in marine engineering sector on ships and specifically during Covid-19, applying the existing stress measurement methodologies in the form of DASS, PSS and questionnaires used among health professionals can't readily be applicable to marine engineering jobs. Applying the existing stress measurement instruments to measure stress among marine engineers would lead to astrayed sense of stressors and levels of stress, and thus their respective coping strategies. In view of this, stress measurement among marine engineers requires a customized sector specific intervention to suitably measure and come up with effective stress coping strategies for marine engineers. In this context, the present paper follows a questionnaire based approach exclusively designed for marine engineers which would account for the work place constraints of the sector and thus suitably measure stress and effectively prescribe stress coping strategies during uncertainties like Covid-19 pandemic. In the line of Guglielmi, et. al., 2013, we acknowledge that the result of such customized questionnaire based survey would be based on the perceptions of the working marine engineers towards various stressors and the resultant stress during Covid-19 pandemic and their individual stress coping strategies for the same. Nevertheless, given the scanty nature of scientific evidence, such an exercise would provide first hand information on stressors and levels of stress among marine engineers and thus would pave path for effective, responsive and adaptive stress coping strategies to uncertainties like Covid-19 pandemic.

In the above context, the present paper makes an attempt to design a questionnaire (as provided in Annexure 1) with a purpose of collecting data from marine engineers among all ranks to identify whether certain stress factors get augmented due to extraordinary situations like Covid-19 pandemic, attack of SARS virus, etc.

METHODOLOGY IN DEVELOPING QUESTIONNAIRE

A five-point Likert scale survey questionnaire has been designed initially consisting of 37 questions to identify stress factors like (i) job itself, (ii) planning, (iii) company policy, (iv) family affairs/away from family, (v) on-board socialization, (vi) on-board cultural diversity. The same was forwarded among working Indian marine engineers who sailed for a significant period during Covid-19 or experienced non-normal situations while sailing, like attack of SARS virus, etc. Out of the marine engineers to whom the questionnaire was forwarded, 100 responded. Based on the responses received, to establish linkages, the data was processed using IBM SPSS 23, Lisrel 8.8 and Microsoft Excel 2019.

Worthy illuminating here is that while developing a questionnaire, reliability and validity of the same should be tested. Only if a questionnaire is found reliable and valid, it may be used for collection of data and the results could be representative of real world scenarios. In this context, reliability of a questionnaire refers to the extent to which the scores of the respondents are not affected by chance factors. A high reliability scored questionnaire doesn't produce significantly different results of one single respondent if the questionnaire is administered several times on him.

Cronbach's Alpha is most commonly used technique to identify reliability of a Likert scale questionnaire. It was developed by Lee Cronbach to measure internal consistency (reliability) of a test or scale. Internal consistency refers to, the extent to which the items/questions of a scale/test measures same construct. It is expressed as a number between 0 to 1. The acceptable values of Cronbach's Alpha are shown in table 1.

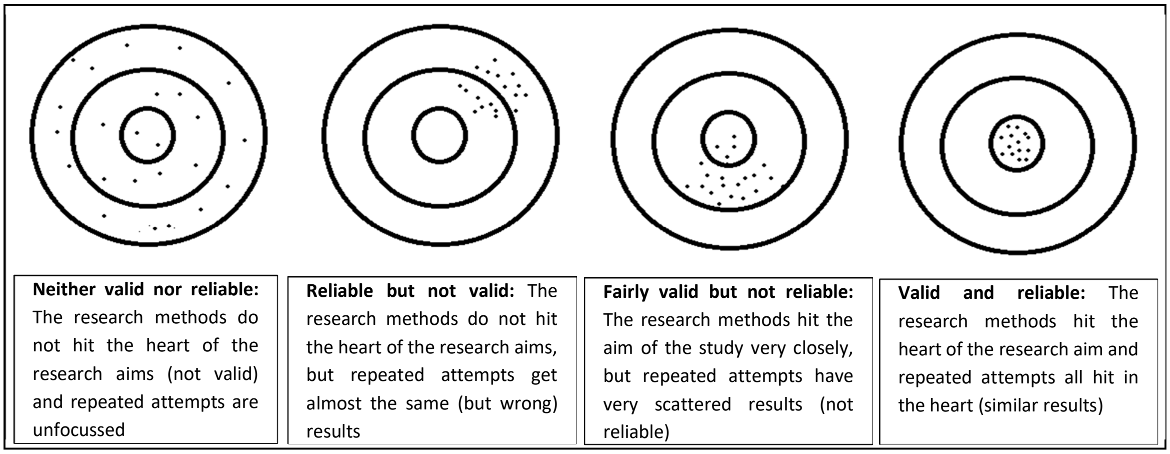
Table 1
Threshold values of Cronbach's Alpha

Cronbach's Alpha	Acceptability
>= 0.90	Excellent
>= 0.8 but <0.9	Good
>= 0.7 but <0.8	Acceptable
>= 0.6 but <0.7	Questionable
>= 0.5 but <0.6	Poor
< 0.5	Unacceptable

Source: George, D., & Mallery, P.(2018)

On the other hand, validity refers to, the extent to which the questionnaire measures what it is supposed to measure. Testing of validity is an essential criterion towards construction of a valid questionnaire. Validity may be measured by (i) face validity, (ii) content validity, (iii) convergent validity and (iv) discriminant validity. The concept and importance of reliability and validity is shown through fig 1.

Fig. 1. Illustration of Reliability and Validity



Source: Oladimeji Akeem Bolarinwa (2015)

Face validity: It denotes clarity, brevity and completeness of the questionnaire items/questions. The respondents have stated that they didn't face a difficulty in understanding the questions and the items/questions are comprehensive in nature.

Content validity: Content validity refers to the degree to which the items of a questionnaire reflect a specific domain and can be measured using Content Validity Index (CVI). CVI can be measured by number of experts rate the items as per relevance to the study. The value of CVI lies between 0 to 1. The present questionnaire has been forwarded to four experts and everybody has rated is very relevant to the study.

Convergent validity: Convergent validity of a questionnaire is derived to determine whether the questions/items of a single construct/variable are associated closely or not. To assess convergent validity, Confirmatory Factor Analysis (CFA) was performed and thereby, Composite Reliability (CR) and Average Variance Extracted (AVE) were obtained and shown in table 4. While CR is intended to determine the consistency of construct validity indicator (Hamdan et al, 2011); AVE indicates how much variations in his items can be explained by the latent variable. Convergent validity is said to be achieved if the CR of a variable is higher than its AVE and the AVE is greater than 0.50 (Hair, 2009).

Discriminant validity: Discriminant validity explains whether the items of one construct diverge from another construct or not. It also measures the degree of differences between the overlapping construct (Hair & Ringle, 2014).

RESULTS AND DISCUSSION

As obtaining reliability of a questionnaire is the preliminary step towards making it useful, the cronbach's Alpha value of the questionnaire is obtained using SPSS 23 and the result is shown in table 2. The reliability of the questionnaire is found to be 'Good'.

Table 2
Overall Reliability Statistics

Cronbach's Alpha	No. of Items
0.882	37

Source: Authors own estimation based on the questionnaire self developed

After establishing reliability of the questionnaire, statistical validity of the same is also required to be established. Face validity and content validity helps to identify items unnecessary and ambiguous. It also indicates if any area of research is not covered through the questionnaire. In the present questionnaire, one item was found to be unnecessary and hence dropped. While calculating Cronbach's Alpha, another item found to be not reliable and therefore dropped. Hence now, the modified questionnaire consists of 35 questions. Cronbach's Alpha of same is once again calculated and is shown in table 3. The reliability of the questionnaire after elimination of 2 item is also found to be 'Good'.

Table 3
Results of the Reliability Test

Latent Variables	Cronbach's Alpha	No of Items	Reliability status
Job itself	0.778	08	Acceptable
Planning	0.773	08	Acceptable
Company policy	0.862	07	Good
Family affairs/ away from family	0.903	04	Excellent
Lack of socialization	0.737	03	Acceptable
On-board cultural diversity	0.741	04	Acceptable
Overall Reliability	0.878	34	Good

Source: Authors own estimation based on the questionnaire self developed

In the present questionnaire, CR of each construct is higher than their respective AVEs. However, three constructs viz., Job itself, Company policies and On-board cultural differences have AVEs less than threshold values i.e., 0.50. According to Fornell and Larcker, the convergent validity is still adequate even if the AVE is less than 0.50 but the CR is more than 0.60. As the CR of those three latent variables are well above 0.60, convergent validity of the questionnaire is established.

Table 4
Composite Reliability and Average Variance Extracted

Variables	CR	AVE
Job itself	0.87	0.47
Company policies	0.84	0.44
Job associated Planning	0.87	0.59
Away from Family	0.99	0.95
On-board Culture differences	0.85	0.40
Lack of Socialisations	0.87	0.70

Source: Authors own estimation based on the questionnaire self developed

Fornell-Larcker criteria as suggested in 1981 used to be a popular way in establishing discriminant validity. In 2015, Henseler while disapproving the same, proposed Heterotrait-Monotrait ratio of correlations (HTMT). HTMT is found to be superior than Fornell-Larcker criteria and is able to achieve higher specificity and sensitivity (Hamid et al. 2017).

According to some authors (Clark and Watson, 1995; Kline, 2011) threshold value of HTMT is 0.85 while some others propose 0.90 (Gold *et al,* 2001; Teo *et al,* 2008). Value of HTMT below threshold establishes discriminant validity for a construct.

HTMT of the questionnaire is undertaken and found that value of each construct is below 0.90 (table 5). Hence, the discriminant validity of the questionnaire is established.

Table 5
Results of Heterotrait – Monotrait ratio of Correlations

Constructs	Job itself	Job Planning	Company policy	Away from family	Lack of socialisation	Cultural difference
Job itself						
Job planning	0.86					
Company policy	-0.01	-0.15				
Away from family	0.29	0.36	-0.15			
Lack of socialisation	0.50	0.62	0.12	0.59		
Culture difference	0.20	0.46	0.08	0.46	0.41	

Source: Authors own estimation based on the questionnaire self developed

The reliability and validity status of the questionnaire is summarised in table 6 which essentially highlights that in terms of reliability test of the questionnaire, the results of the Cronbach's Alpha shows that all the constructs are above threshold value which necessarily qualifies the said questionnaire in the realibity test.

Table 6
Summary of Reliability and Validity Statistics

Statistical procedure	Status	Conclusion
Cronbach's Alpha	All constructs are above threshold value	Questionnaire is reliable
Face validity	The respondents didn't face difficulty in understanding the questions	Questionnaire is valid
Content validity	The subject experts rated very relevant to the study	
Convergent validity	AVE and/or CR is above threshold levels	
Discriminant validity	HTMT values of all constructs are less than 0.90.	

Source: Authors own estimation based on the questionnaire self developed

In terms of validity, table 6 shows that the questionnaire prepared qualifies the test of validity in terms of face validity, Content Validity, Convergent Validity and Discriminant Validity that means the results from the survey thus obtained could be used to measure stress levels among marine engineers.

CONCLUSION

A generalised approach of measuring stress and understand stressors have been followed in literature on stress measurement. Research approaches to measure stress using established methodologies has been snowballing with time. With the on-set of COVID-19, such interventions are in their hay days. Given the nature of environment in which job is taken place on board ship, maritime industry has been adding to research anxieties to understand stressors of this industry. Therefore, a sectoral approach rather than adopting existing methodologies to understand stressors is the need of the hour. In this context, a questionnaire is developed to understand stressors and thus facilitate measuring stress levels among seafarers in maritime sector. The questionnaire thus developed also qualifies the reliability and validity test, thus focus on scientific rigour of such questionnaire which could be used to understand stressors and facilitate measurement of stress in future studies.

ANNEXURE 1

Table 7

Questionnaire to identify level of psychological stress among seafarers

Expectations from the respondents: In this section, the researcher tries to identify the factors responsible during onboard/extraordinary situations in increasing level of stress among the respondents. While going through the statements, please mark your response which comes spontaneously; please don't take much time to think and mark, as by doing that your responses may get biased. Remember, there is neither a right nor wrong response.						
Instructions: Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. Strongly disagree(1), Disagree(2), Neutral(3), Agree(4), Strongly agree(5).						
J1	Do you agree that your job involves a high level of stress?	1	2	3	4	5
J2	Do you agree that due to extraordinary situations, time pressure for completion of work increases resulting into increase in stress level?	1	2	3	4	5
J3	Do you agree that your stress level further increases due to increase in job responsibility during the above-mentioned extraordinary situations?	1	2	3	4	5
J4	Do you agree that you need to work for more hours (than normal working hours) during the above-mentioned extraordinary situations?	1	2	3	4	5
J5	Do you agree that your stress level further increases due to overwork during the above-mentioned extraordinary situations?	1	2	3	4	5
J6	Do you agree that following the guidelines as per different rules/regulations (ISPS, ISM Code, etc.) during extraordinary situations becomes more stressful?	1	2	3	4	5
J7	Do you agree that on-board work environment (mixing/gossiping with others, etc.) becomes depressing during extraordinary situations like COVID-19 pandemic?	1	2	3	4	5
J8	Do you agree that your level of stress increases while working on-board during extraordinary situations like COVID-19 pandemic, outbreak of SARS virus, rough sea, etc.?	1	2	3	4	5
P1	Do you agree that seafarers run shortage of equipment on-board and that have an effect on furthering their stress levels during the above-mentioned extraordinary situation?	1	2	3	4	5
P2	Do you agree that during extraordinary situations, on-board job stress could be reduced by better planning either at company level or at on-board level?	1	2	3	4	5
P3	Do you agree that during extraordinary situations, planning for your on-board activities becomes more critical?	1	2	3	4	5
P4	Do you agree that 'Planning for on-board activities' during extraordinary situations becomes more stressful than normal period?	1	2	3	4	5
P5	Do you agree that being a seafarer you have to perform not only your core job activities (i.e., marine engineering activities) but additional multifarious activities also, which leads to increase in level of stress?	1	2	3	4	5
P6	Do you agree that performing multifarious activities further increases your stress level during extraordinary situations?	1	2	3	4	5
P7	Do agree that you feel more stressed as controlling/inspecting authorities (e.g. MMD in India, port authorities, etc.) of different nations plays more strict role than usual during pandemic/ extraordinary situations?	1	2	3	4	5
P8	Do you agree that lack of manpower on-board have an effect on further increase in stress level of seafarers during the above-mentioned extraordinary situation?	1	2	3	4	5
C1	Do you feel that your company provides adequate support to the on-board employees during extraordinary situations?	1	2	3	4	5
C2	Do you agree that you get adequate recognition from your company for accomplishing some difficult tasks on-board?	1	2	3	4	5
C3	Do you agree that you get adequate recognition (other than financial) from your company for sailing/overstaying on-board due to COVID-19 pandemic situation?	1	2	3	4	5

C4	Do you agree that your company's view/policy regarding employee recognition is satisfactory?	1	2	3	4	5
C5	Do you agree that your company took adequate steps/measures to reduce level of depression among on-board employees?	1	2	3	4	5
C6	Do you agree that your company took adequate steps/measures to reduce level of stress among on-board employees?	1	2	3	4	5
C7	Do you agree that your company's stand towards supporting on-board employees during extraordinary situations is depressive?	1	2	3	4	5
F1	Do you agree that during extraordinary situations, like COVID-19 pandemic, while on-board, you get depressed by thinking about your family/friends/close relatives?	1	2	3	4	5
F2	Do you agree that during extraordinary situations like COVID-19 pandemic, while on-board, you get stressed by thinking about your family/friends/close relatives?	1	2	3	4	5
F3	Do you agree that during extraordinary situations like COVID-19, if you get stuck on-board, being away from family and friends for longer period results into increase in level of your depression?	1	2	3	4	5
F4	Do you agree that during extraordinary situations like COVID-19, if you get stuck on-board, being away from family and friends for longer period results into increase in level of your stress?	1	2	3	4	5
CD1	Do you agree that your colleagues adequately recognize your accomplishment of some difficult task on-board?	1	2	3	4	5
CD2	Do you agree that on-board cultural differences increase your stress level?	1	2	3	4	5
CD3	Do you agree that due to cultural differences, working on-board with people of different nationality during extraordinary situations, becomes more stressful?	1	2	3	4	5
CD4	Do you agree that due to cultural differences, working on-board with people of different nationality during extraordinary situations, is more depressing?	1	2	3	4	5
S1.	Do you agree that due to inadequate level of on-board socialization among colleagues you feel more depressed than usual during COVID-19 pandemic situation?	1	2	3	4	5
S2	Do you agree that lack of shore leave during extraordinary situations like COVID-19 pandemic is having a major role with increase in level of depression among on-board employees?	1	2	3	4	5
S3	Do you agree that lack of shore leave during extraordinary situations like COVID-19 pandemic you feel more stressed?	1	2	3	4	5

Source: Authors self developed questionnaire

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THE ROLE OF SOLID PLASTIC WASTE RECYCLING OPERATIONS IN ACHIEVING SUSTAINABLE EVELOPMENT

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1. ABSTRACT:

Environmental issues have become at the forefront of international concern. Therefore, this concern has been reflected in most of the world's policies through activating rational environmental policies to achieve sustainable development between the requirements of economic and social development, and the preservation of natural resources and ensuring their survival and preserving the right of future generations. The problem of the accumulation of solid plastic waste is one of the most difficult and complex problems in Egypt, because plastic materials are widely used as they are characterized by being of light weight, multi-purpose, water-resistant. This research aims to measure the impact of the recycling operations of solid plastic waste on the economy SWOT analysis for the year 2021.

Keywords: Solid plastic waste, Recycling, Sustainability, Blue economy.

2. INTRODUCTION:

Recycling provides the opportunity to use recovered plastic to manufacture a new product, thus achieving sustainable manufacturing, known as circular economy. Generally speaking, circular economy converts waste materials into economic value as a result of the flow of major waste quantities. Thus, it reduces the quantities of waste to be collected, disposed of, buried, or incinerated. Plastic recycling process represents an aspect of sustainable manufacturing; where the recovered plastic waste is utilized to manufacture new products and preserve the natural resources used in the production of new plastics (Mwanza et al., 2016).

Studies on plastic waste have shown that the accumulation of plastic waste in open landfills emits greenhouse gases and carbon dioxide, caused by the occurrence of the problem of global warming. Plastic is an organic material produced from petroleum petrochemical derivatives found everywhere in the global economy. Plastic is characterized by many advantages, including lightness, durability, formability, water resistance, and low production costs. In fact, plastic particles are able to survive for thousands of years and do not degrade biologically. Therefore, plastic is utilized in many industries, such as cars and other vehicles and machinery, as well as the preservation and distribution of food, goods, medical products and the like. Subsequently, this results in accumulating large quantities of solid plastic waste. In other words, the huge volume in production of plastic leads to large amounts of plastic waste. Hence, this poses a real environmental threat, as this plastic waste mostly ends up in the oceans, and it was estimated that about 150 million tons of plastic waste was dumped into the oceans in 2017 (Bishop et al., 2020).

Plastic production has been used since 1950 and has become an important part of our daily living. Plastic is generally applied in various categories such as industry, medicine, transportation, automobiles, food packaging and other materials that carry goods from spoilage, packaging, and distribution of drinking water. In addition, it is utilized in the manufacture of clothing and medical devices. It is produced in large quantities and disposed in waste streams and often end up as ocean debris in oceans and seas. Several studies have indicated that about 40% of plastic products have an average life of less than a month; therefore, plastic waste produced in huge quantities is considered a major challenge to environmental management and sustainable development and constitutes a major threat.

Solid waste management and plastic waste is considered as a complex system. It includes environmental, social, and economic issues that must be taken into consideration to improve waste life cycle, reduce water; soil and air pollution, reduce open burning of waste and open dumps scattered all over the world. Thus, solid plastic waste recycling aims to reduce the rate of waste flow to its final disposal sites in the developing countries due to the low technological requirements and economic investments in these countries. In fact, mismanagement of solid plastic waste has many negative effects which are:

1. Local negative effects such as (pollution of soil, surface, and ground water).
2. Regional effects (pollution of water bodies used in agriculture and domestic purposes).
3. Global effects such as (global warming and marine litter) and the damage, they cause to marine organisms in oceans.

Recycling is the most environmentally useful strategy that deals with solid waste in order to reuse it. Recycling solid plastic waste leads to the reduction in oil and carbon dioxide emissions and decreases the quantities of waste that require disposal or burial, thus saving the costs of landfills for waste savings (Khoo, 2019).

Plastic production began dramatically in the fifties of the last century and reached about 359 million tons in 2018. The significant increase in tons of plastic has led to the deterioration of waste management, misbehaviour, and neglect of the consuming population, which eventually caused the accumulation of plastic waste and its abundant presence in waterways, ecosystems and in landfills waste. In the past decades, large quantities of plastic were produced until 2015; however, only 9% of them were recycled, 12% was burned and 79% accumulated in the environment, landfills or waterways, seas and oceans.

Therefore, recycling has environmental benefits compared to other options such as burial or incineration to reduce the environmental damage and threats of plastic. Actually, this places a great responsibility on the manufacturing companies and they may fail to efficiently manage the plastic materials that have expired and take advantage of the financial and social benefits of manufacturing more circular and sustainable application of the principle of Extended Product Responsibility (EPR) (Plakas et al., 2021)

In this content, environmental sustainability requires recycling plastic waste and eliminating random disposal, burning and burial of it to avoid the environmental damages of plastic waste, especially global warming and climate change which are to be reviewed below. The main objective of managing and recycling plastic waste is to reduce greenhouse gas emissions and to measure the environmental impact of these gases such as carbon dioxide and methane which increase the temperature of the earth causing the problem of melting water from the poles due to climate change as a result of burning plastic waste, whether to generate energy or use it in industry. Consequently, countries should adopt a sustainable policy to increase factories that working recycling plastic waste (Khoo, 2019).

3. RESEARCH AIMS AND OBJECTIVES

Research aims

This research aims to define methods for reduce production and utilization of new plastics. This is in addition to recycling solid plastic waste, which has a positive impact on the environment to reduce emissions to transfer research area into a green city and solving all waste supply chain problems and achieving economic savings that would increase job opportunities.

Research objectives

1. To reduce the production of new plastics according to study cases over the world.
2. To study the processes of supply chain for recycling the plastic solid waste and solve its problems to approach environmental efficiency through recycling, re-manufacturing, reusing, and reducing the amount of plastic, which contributes to achieving a circular economy, preserving natural resources, and achieving sustainable development.
3. To determine the impact of recycling solid plastic waste; in addition, reducing the dumping of solid plastic waste in Egypt based on the blue economy concept.

4. LITEREATURE REVIEW:

The following studies discussed the three dimensions of environmentally, economically, and socially sustainable development; drivers of sustainable plastic waste recycling, and strategies for recycling solid plastic waste. Due to the huge amount of solid plastic waste, many countries use traditional landfills for burial and final disposal of the waste produced in them. Because plastic does not decompose biologically, plastic waste remains for a long time. Some countries may also resort to using incineration to get rid of plastic waste. In fact, this method leads to the transformation of plastic waste into ash that results in many pollutants of air, such as carbon dioxide, nitrogen dioxide and many other toxic gases, which negatively affect the viability of air and human health, as well as the impact of plastic waste on soil, surface, and ground water. All of this clarifies and confirms the option of recycling plastic waste which is the most sustainable option for dealing with solid plastic waste (He et al., 2015).

Recycling is deemed as one of the best options in the hierarchy of solid waste management, including plastic, to reduce the effects of end-of-life and end-of-use of post-consumer plastic waste. This option is chosen with the aim of reducing plastic waste that is disposed of in random ways, whether in the streets, in open landfills or in landfills not subject to environmental supervision. This is performed with the aim of reducing the greenhouse gases emitted from these wastes such as methane and carbon dioxide, maintaining environmental sustainability, and ensuring that plastic waste is not dumped into waterways such as oceans and seas to maintain the marine environment free of pollution (Mwanza et al., 2016).

The accumulation of solid plastic waste has harmful effects on the environment and the human being, the quality of air, soil, surface and ground water, marine environment, marine organisms and fish. Consequently, the accumulation of waste has a detrimental effect on societies in the developing countries such as Egypt, where there are no clearly defined strategies for effective management of solid waste that poses danger to the Egyptian society and drains it (Ibrahim, and Mohamed, 2016).

In this context, Mwanza et al., (2018**)** stated that many African countries face challenges in managing plastic waste, although most of these countries have policies and legislation on solid plastic waste management, but there is a gap between legislation and waste management policies. All these countries aim to recycle their solid plastic waste in order to achieve sustainable industrialization, contribute to achieving sustainable development and environmental sustainability, and mitigate environmental damage resulting from the accumulation of waste.

Solid plastic waste results from homes, markets and companies and is heterogeneous and has different physical and chemical properties. Therefore, the heterogeneity of solid plastic waste is the main problem that hinders and makes the process of sorting and separating this waste tiring and time consuming. Therefore, companies resort to traditional methods in managing solid plastic waste; this means that the process of sorting wastes, as well as the disposal of solid waste generated from rural and urban areas represents a major problem facing many developing countries.

Therefore, Abdel-Shafy and Mansour (2018) aimed to determine the role and behaviour of stakeholders, starting with consumers or companies, as well as plastic solid waste collectors, wholesalers, retailers, recycling factories, and governments, whether the public sector or the private sector. This is in terms of solid waste management, analysing the various factors that affect the waste management system, and encouraging stakeholders to adopt sustainable management systems. This is in addition to defining the economic schedule for each type of solid plastic waste to achieve economic savings that contribute to the countries' domestic product. Many countries, including Singapore, have tried to adopt a policy for recycling plastic waste to achieve certain benefits from it and its derivatives.

Their target is to achieve a circular economy and preserve natural resources, by doing some activities that add economic value to plastic waste and which enables it to be reused again instead. In fact, most countries, such as Egypt, convert waste into energy, as happens in the incinerators of cement factories. These systems are environmentally unsustainable and result in the emission of carbon dioxide, which negatively affects the earth's temperature in what is known as the problem of global warming. Thus, this policy contradicts with the goals of sustainable development that try to maintain environment and reduce global warming (Khoo, 2019).

Solid plastic waste causes environmental pollution, which has become a global issue, where open landfill and open incinerators are considered one of the most important methods of waste treatment and final disposal, especially in low-income countries. the study aims to review the pollutants resulting from the dumping of solid plastic waste in the oceans and seas and the resulting damage to fisheries and high rates of marine pollution that affected the blue economy negatively (Ferronato and Torretta, 2019).

Oceans have a pivotal role in the global economy as they contribute a large percentage to the global economic returns, amounting to about one and a half trillion dollars in 2010 and are expected to reach three trillion dollars in 2030. With climate-related changes and the pressures resulting from climate change on all countries the world is clear that paying attention to sustainable development and achieving its goals may help to make some progress in addressing the problem of climate change. Actually, this can be made possible by adopting sustainable development strategies in all its aspects and developing processes to recycle waste, especially plastic ones, which often end up as waste and debris thrown into the oceans affecting fish, marine wealth and the marine organisms living in it. Thus, giving priority to waste recycling strategies, especially plastic, helps to preserve the marine environment and achieve the goals of the blue economy by paying attention to the safety of the oceans and marine life and achieving marine growth with strategies that support environmental sustainability and help solve the problems resulting of climate change (Bennett et al., 2019).

Many studies have been conducted in the developing economies such as Zambia, India and Nigeria, and these studies have considered recycling solid plastic waste as an important component of sustainable manufacturing in developing economies. These studies indicated that the majority of recovery and recycling operations are carried out by informal waste collectors and pickers.

Actually, they have contributions to the significant reduction in the cost of waste management in addition to the positive environmental effects as well as achieving a kind of social justice by providing income for the poor through informal recycling activities. Because of the big amount of solid plastic waste; we need to develop legal legislation to involve them in plastic waste recycling system and to help collect the largest possible amount of plastic waste present in the environment and recycle it sustainably (Mwanza et al., 2019).

Blue economy aims to separate social and economic activities and development from environmental degradation. Moreover, it opts to maximize the use and return of marine resources and the resources of the seas and oceans, such as fish, oil, natural gas, minerals, and others. Blue economy in the seas and oceans is considered a source of livelihood for many residents of the countries bordering these seas and oceans. Therefore, all countries of the world strive to achieve environmental sustainability, sustainable development and reduce marine pollution to achieve the goals of the blue economy.

To achieve this mission; a commitment of all countries in recycling of waste plastic instead of dumping it into waterways, oceans and seas to ensure that marine pollution does not occur and damage to fish stocks that may become entangled with this plastic waste or may die as a result of ingestion of this plastic waste all of these strategies aim to achieve the goals of the blue economy and increase the return from it for all countries bordering seas and oceans (Abdullahel Bari, 2019). Oceans, seas, and rivers are the final destination for poorly managed plastic waste and are considered a problem in ocean debris and the accumulation of waste in oceans, seas and rivers is a major problem affecting the blue economy (Bishop et al., 2020).

Recycling and reusing solid plastic waste is very important to ease material restrictions in several countries, including China, and to promote sustainable economic development for the country. This has resulted in an increase in the amount of plastic waste generated daily, especially in countries with a high population, and it has become an environmental problem that threatens many countries. Therefore, the population must also be involved in the recycling of solid plastic waste by participating in the activity of collecting plastic waste. This is in addition to the activity of sorting home plastic waste to reduce the cost and time of sorting this waste in factories. Subsequently, this would achieve economic savings to encourage companies working in the field of recycling plastic waste (Huang et al., 2020).

Recently, the plastic sector has witnessed a unique growth due to the numerous advantages of plastic. However, about 91% of the total plastic produced is not recycled which is considered as a major environmental disaster, as it has been found that plastic will emit 1.78 gigatons of carbon dioxide equivalent in 2050. To recycle the types of plastic used in the world, such as high and low density polyethylene, polyethylene terephthalate, polypropylene and polystyrene, with the aim of stopping the production of new plastics and achieving a circular economy by recycling as much plastic waste as possible. In fact, among the European commission's goals is to recycle 55% of plastic waste by 2030, while not restoring to use the traditional methods of waste disposal, whether by burning or burial, to avoid the resulting damage and greenhouse gases that affect environmental sustainability (Meys et al., 2020).

Solid plastic waste supply chain includes a number of logistical activities such as collecting, sorting, transporting, treating, and finally disposing of solid plastic waste. The applications of the Fourth Industrial Revolution have been used such as Internet of Thing (IoT) to raise the performance efficiency of these activities and reduce the resulting environmental pollution. It also aims to design strategies to solve waste management problems using a sustainable, intelligent, and multi-dimensional waste management system to reach environmental sustainability.

The growing economy in South Korea has led to an increase in production and consumption, which in turn has led to an increase in the amount of waste generated. Thus, new waste treatment facilities and new landfills are resorted to for waste disposal due to the generation of large quantities of solid plastic waste, especially in urban areas due to the high level of income. Korea aims to implement a system based on the participation of citizens in waste collection services as well as in local governance in order to achieve and collect the largest possible amount of plastic waste and recycle it. Waste is converted into ash and then disposed of in marine dumps (Sungmin et al, 2020).

In 2015, these types of waste plastic containers amounted to 141 million tons annually in Germany and it is expected to increase more. It has also been found that plastic production will emit 1.78 carbon dioxide equivalents in the year 2050. Therefore, the proper handling of plastic waste represents a major challenge to evolving into an environment-friendly future, by governments and official institutions in many countries adopting the goals of transition to a circular economy to achieve global economic prosperity. For example, the European Commission imposed a plan to recycle about 55% of plastic waste in 2030, as well as China and the United States which imposed the same percentage by stopping the production of new plastic to achieve a circular economy and to benefit from recycling plastic waste and to preserve the environment (Meys et al., 2020).

Recycling is the most environmentally sound strategy for dealing with solid waste in order to reduce the source and reuse. Recycling solid plastic waste is an opportunity to reduce the use of oil and carbon dioxide emissions and the quantities of waste that require disposal or burial, thus saving the costs of landfills for this waste and the achievement of a circular economy and significant economic savings (Khoo, 2019). The most important goals of sustainable development are climate action, and this can be achieved by improving the collection of plastic waste, separating waste at the source, and applying appropriate treatment technology. This is in addition to reducing the quantities of plastic waste directed to landfill through controlling and monitoring this waste using information and communication technology. Climate change and increase of carbon dioxide emissions are caused by the accumulation and burning of this waste in open landfills or from burning this waste in cement factories to generate energy (Fatimah et al., 2020).

Plastic has many economic benefits that can be achieved by including the recycling process in the concept of a circular economy, which aims to change the current linear economy model by extracting maximum values from resources during use and recovering and renewing materials at the end of their service life. The principles of a circular economy are integrated with the sustainable supply chain. This management provides many advantages from an economic perspective and contributes to achieving sustainable development. Furthermore, major companies that have a large capital must build centers or factories to recycle their waste, within the framework of the closed-loop supply chain. Through this, economic savings can be achieved reducing the number of times of re-ordering materials used in the manufacture of plastic products from suppliers. It also reduces the lead time for the production of new products and reduces the waiting time for supply from suppliers, and thus reduces the total costs for companies. Consequently, through recycling waste, raw materials can be obtained again and utilized in the manufacture of plastic products. This is new, and this, in general, achieves financial and economic savings for companies (Ren et al.,2020).

Plastic pollution resulting from the accumulation of solid plastic waste in the environment is considered a serious problem that threatens the climate, and many statistics have indicated that about 500 billion plastic bags are used worldwide annually, as 50% of this percentage is single-use plastic products, and about one million are purchased A plastic bottle every minute in the world, and about 8 million tons of plastic are thrown into the oceans every year, and the percentage of plastic that is generated from the total waste destined annually in the world is about 10% From the last century due to the increase in population and increased consumption in the world.

The population increase and the high rates of daily consumption have resulted in the accumulation of large amounts of plastic waste in the environment, emitting large amounts of greenhouse gases. Plastic ranges from 7% of nitrous oxide, 3% of fluorinated gases, and 10% of methane, in addition to 80% of carbon emissions, which negatively affect temperature and weather, affect climate stability, and are a major cause of the global warming problem. Plastics in the marine environment is one of the major concerns because of their persistence at sea, and adverse consequences to marine life and potentially human health. Rivers annually emit between 1.15 and 2.41 million metric tons of plastic to the oceans.

The international environmental association has just published a report about plastic pollution. This report is ringing the alarm again because nothing gets better despite a generalized awareness. Indeed, the plastic pollution is uncontrollable. By the year 2030, the plastic pollution of our oceans could double, threatening marine life and our own health. China and Indonesia are the main sources of plastic pollution for single use: bottles, packaging, main bags polluting the oceans (The countries polluting the oceans the most with plastic waste - Plastic Ethics, 2019).

China and Indonesia alone are responsible for around 5 million tons of plastic waste ending up at sea each year. As the Statista chart shows, they are coastal countries crossed by the largest rivers such as Yangtze, Nile, Amazon, etc. or located on islands that drain the most plastic in marine environments, annual metric tons of mismanaged plastic waste and total ending up in global water at the most countries polluting oceans; shown in the next figure (1):

Figure (1) The countries polluting the oceans the most with plastic waste.

3.1 INTERNATIONAL EXPERIENCES IN PLASTIC WASTES

The European Union aims to achieve recycling rates of solid plastic waste at a rate of 50% in 2025 and 55% in 2030. Hence, many European Union countries such as Austria, Germany and Netherlands are trying to achieve the highest rates of recycling their plastic waste by following an integrated system for the collection, treatment, and final disposal of solid plastic waste in environmentally sustainable ways. Recycling rates of plastic waste in these three countries are 23%, 43% and 30%, respectively. Plastic waste is expected to reach billion tons by 2050, resulting in significant environmental damage. indeed, these wastes have become a threat to the environment, human beings, water and soil, and this problem has recently attracted the world's attention and trends because it is an essential element and a major cause of climate change and aggravation of the global warming problem (Picuno et al., 2021).

There are several methods for treating solid plastic waste which have been implemented in many countries such as the United States of America, Japan, Germany, and Denmark in order to reduce the accumulation of plastic waste in our environment. Synthetic crude oil or refined fuel produced using pyrolysis technology Plastic to Fuel (PTF) to obtain a high-calorie fuel can be used to operate machinery and cars, where plastic waste is converted into fuel through pyrolysis and thermal catalysis. In fact, there are two companies in the United States of America that have the capacity to process 25.000 tons of plastic waste annually. In Japan, there is a factory called Sapporo, which has been operating since 2000, with a production capacity of 15.000 tons annually. It is the largest factory of its kind in Japan in treating plastic waste turning it into high-calorie fuel (Khoo, 2019).

Plastic recycling can reduce environmental pollution and carbon dioxide emissions by reducing the accumulation of waste in the environment, whether in the streets, in open landfills or in water resources, seas and oceans. This research aims to achieve a green supply chain for solid plastic waste free from any emissions or environmental damage. These may result from any logistical activity in the solid plastic waste supply chain, starting from the places of plastic waste production, whether in homes or companies, to the recycling centers and passing through other activities of collection, transportation, sorting and classification of plastic waste along the supply chain.

This is performed so as to reduce or mitigate the problem of global warming and change the economic model of the current line to a circular economy in order to achieve sustainable development. Furthermore, this would contribute to the companies that have large capital to establish their own collection centers and recycling centers to recycle plastic waste to achieve the so-called model of the supply chain with a link closed to reduce the consumption of raw materials and the cost associated with it. Thus, the end of this is to achieve a circular economy, so the production companies will be more environmentally sustainable; as shown in the next figure number 2 (Ren et al., 2020).

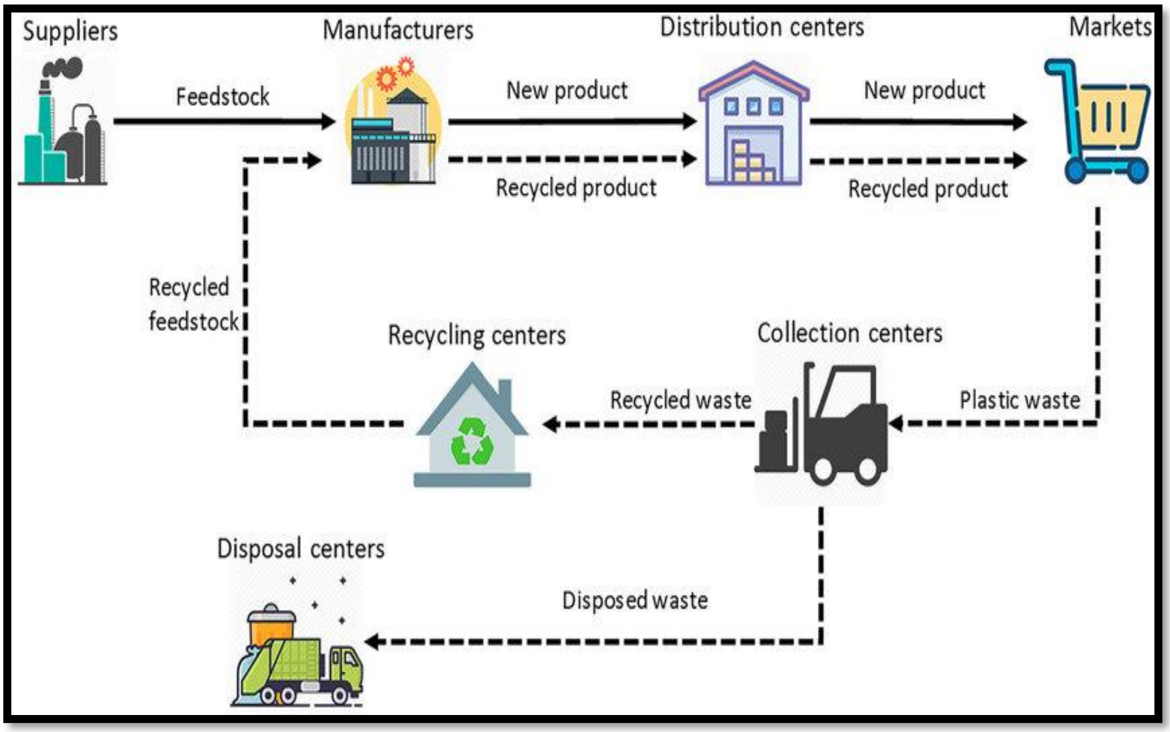

Figure: (2) Diagram of the proposed CLSC network.
Source: Ren, et al., (2020).

3.2 GAP ANALYSIS AND CONTRIBUTION

Figure (3) Gap analysis and research contribution.
Source: By authors.

5. RESEACH PROBLEM

Massive quantities of solid plastic waste are produced daily in major cities in Egypt; Cairo and Alexandria, which have a harmful impact on our health and on the environment as a result of carbon dioxide and methane emissions, which causes the rise in global temperature and leads to ice melting at the poles, as well as the spread of diseases and epidemics. Moreover, what aggravates this problem also is the absence of mechanisms and integrated factories with high technologies that can deal with the huge recycling capacity due to the daily consumption that produces these amounts of waste, which poses a threat to the environment, man, animals, marine organisms, and the blue economy.

6. RESEARCH AREA

Alexandria is one of the main cities in Egypt; therefore, large quantities of solid plastic waste are produced daily. Researcher found that Alexandria produces daily from 3500 to 4500 tons of waste. The governorate wastes 65% of the waste and goes to sanitary landfills without benefiting from it due to the low capacity of the three factories, which ranges between 350 to 750 tons per day. There are three factories engaged in solid waste recycling operations: APIS One, APIS Two and Elzayateen. Their field is dealing with organic materials such as food waste from solid waste to be used in the production of organic fertilizers or as an alternative fuel to generate energy in the incinerators of cement factories. Alexandria has international ports such as Alexandria port which is considered the main port in Egypt, and it has large areas of land on which investment projects of recycling plastic waste can be established, which can achieve an economic return and provides job opportunities and reduces its harmful effects.

7. RESEACH METHODOLOGY

This research follows an analytical approach as the researcher has had interviews with managers of plastic recycling factories. Researcher made interviews with six managers in plastic recycling factories in Alexandria; in different sectors in these factories; using structured questions in order to define strengths, weaknesses, opportunities, and threats to achieve research aims and objectives. In addition, the SWOT analysis is applied to determine strengths, weaknesses, opportunities, and threats facing recycling solid plastics waste generated from factories in Alexandria.

Strength points

1. Increasing interest in studying the supply chain and studying logistics activities by specialists who can find solutions to all the problems facing the efficient performance of logistics activities in Egypt such as transport activity by choosing the optimal methods of transport to reduce transport costs and reduce carbon dioxide emissions from transport as well as solving the problem of waste collection through the container system application to collect waste and the inability of the diggers to tamper with it.
2. Study area presented in Alexandria is devoid of factories with a highly competitive ability in this field.

Weak points

1. Lack of strategies and mechanisms that bring together all stakeholders, starting from the consumer, waste collectors, retailers, wholesalers, and recycling plants with each other, which may lead to a conflict of interests and failure to perform logistics activities efficiently.
2. Weak community participation in adopting more sustainable behaviour in disposal of their waste.

3. Inability of citizens to rationalize consumption and cooperate with municipalities in waste collection operations by disposing of them in roadside collection systems set by localities, which leads to random accumulation of waste in narrow streets that municipalities may not reach, which means the accumulation of large quantities on the long run.
4. Absence of binding laws for the community to sort their waste at home, which reduces time and cost of sorting plastic waste in recycling factories.

Opportunities

1. Recycled products can be exported to Europe and North African countries, and they can also be distributed locally to achieve a good return on the Egyptian economy.
2. Increase of job opportunities.

Threats

The main threat is posed by the limitation of Stakeholders who control plastic waste produced daily from the study area and the surrounding governorates, as it is used to generate energy after burning in cement factories, due to the low cost of a ton of waste compared to other expensive alternatives to fuel.

8. CONCLUSION AND RECOMMENDATIONS

Blue economy is closely related to sustainable development and recycling of solid plastic waste, as many studies have shown that most plastic waste ends up as ocean debris thrown into the oceans and seas. Definitely, this affects the fish population that may become entangled with this waste or swallow it, and eventually leads to its death. It negatively affects particular economic activities such as fishing, which is a source of livelihood for many residents of coastal cities overlooking the seas and oceans. Several studies have recently shown that there is an entire continent near the United States of America that has plastic waste floating on the surface of the ocean. Therefore, the application of sustainable development strategies techniques of recycling solid plastic waste to recover plastic instead of dumping it in the oceans greatly contribute and have a pivotal role in achieving sustainable development and maintaining the blue economy based on the wealth that these oceans contain such as fisheries, gas, oil, etc.

Recycling solid plastic waste is very important to achieve sustainable development and reduce emissions of greenhouse gases such as methane and carbon dioxide, which have caused the problem of global warming. This is in addition to the damage caused by plastic waste accumulated in areas of random accumulation and in open landfills on human health, air quality, surface, and ground water. Moreover, it increases the salinity of the soil, and therefore recycling of solid plastic waste and the reuse of plastic can protect the environment from all these damages through applying the techniques of plastic recovery and recycling to preserve natural resources such as gas and oil. This is in order to stop the production of new plastic and attain economic savings, which contributes to achieving a circular economy instead of a front linear economy.

The interest in reverse logistics and supply chains has recently increased, and it has become necessary to study solid plastic waste supply chain from the consumer, who must rationalize consumption and adopt more sustainable behaviour as well as sorting and classifying his plastic waste. Next comes a collector or waste collector, through retailers and wholesalers, to recycling factories, solving all the problems facing the logistical activities in the supply chain of solid plastic waste, especially the collection and transportation activity. The purpose is to perform these activities at the highest rates of efficiency and effectiveness, and collecting the largest possible amount of plastic waste from cities and rural areas. This is followed by transferring these quantities in the most optimal ways that depend on Internet of things technology, tracking technologies and choosing the best transportation paths to reduce time and cost as well as decrease carbon dioxide emissions resulting from transportation. Accordingly, this contributes to achieving sustainable development and reducing global warming.

Researchers have concluded to some recommendations through which the concept of the blue economy will be applied, which will help to increase the national income of the Arab Republic of Egypt as follows:

1. The necessity of paying attention to studying the solid plastic waste of supply chain, starting from the consumer to the recycling plant. This is in order to solve all problems facing the logistical activities that occur in this chain, whether these are transportation, collection, sorting, treatment, or final disposal activities to achieve the highest performance rates of these activities efficiently and effectively.
2. Developing a strategy that aims to implement plastic waste recycling operations to achieve sustainable development.
3. Applying Extended Producer Responsibility (EPR) method, which means that the role of companies is not limited to distributing their products to the consumer and making profits; rather, these companies have a societal role in order to preserve the environment. This can be achieved through the companies’ responsibility to collect their waste from the consumer to their own collection centres especially in the state to recycle this waste to achieve sustainable development, circular economy and the preservation of natural resources. This can only be performed in the presence of a legal framework binding on productive companies with this role towards the environment.
4. Establishing collecting centres, whether affiliated to the state or the private sector, with the aim of collecting, classifying, and recycling waste again in advanced factories that have effective treatment techniques which serve to recycle the largest possible amount of plastic waste.
5. Enforcing the law at the national level regarding recycling plastic waste and setting penalties for those who dispose of plastic waste indiscriminately, whether in open dumps or in waterways such as seas and oceans.
6. Legalizing the informal collection carried out by waste pickers from homes, open dumps, and areas of random accumulation of waste with the participation of retailers, wholesalers, etc., and linking all stakeholders, starting from the consumer, then a collector or waste picker, wholesalers, retailers, and recycling factories in an integrated system aiming at recycling as much as possible of the plastic waste generated on a daily basis.
7. Enforcement of environmental awareness programs about the importance of plastic and recycling of waste and the damages resulting from the accumulation of plastics in the environment and the damage resulting from throwing plastics into waterways and the weakness it causes to the blue economy and the revenues of the oceans and seas.
8. The need to involve the Community to participate in sorting waste at the household level to facilitate and reduce the time and cost of sorting it in recycling plants.
9. Applying quality standards for plastic recyclers in order to obtain recycled and high-quality plastic that has a high respiratory capacity in the local and international markets.
10. Forming final markets for recycled products and encouraging citizens to buy and reuse them to encourage companies working in this field.

Due to the limitation of data, the researcher could not collect the official data required from the Egyptian Environmental Protection Affairs Agency for solid plastics waste, their quantity, and other vital data. More studies need to be done for Egypt in this topic because this project has a great impact on the national income.

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TOWARDS A SUSTAINABLE BLUE ECONOMY: HOW TO MAKE AN INDUSTRIAL ZONE MORE ENVIRONMENTALLY FRIENDLY? THE CASE OF ROTTERDAM HARBOR.

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Keywords: Sustainable energy production, industrial zone, balancing interests.

1. ABSTRACT: Since the world-leaders decided to reduce the emission of Carbon to stay below the threshold of 1.5 °C warming-up of the atmosphere (Paris agreement, Dec. 2015), the large-scale industrial areas have to find ways to become more environmental-friendly. Especially areas developed in the 1960's – 1970's are often polluting the environment (air, water and soil) with high emission rates., due to their old fashioned modes of operation. One of the major sources of pollution is the use of fossil-fuel energy . Replacing this by more environmentally friendly alternatives is an effective step in the reduction of emissions.

Several approaches look promising. In regions with frequent winds the exploitation of windmills is profitable. In sunny regions the exploitation of solar-farms is profitable. Although still in an experimental stage, the use of green hydrogen-gas might become promising in the next years.

This paper is about the preparations for the construction of a large-scale windfarm in the new, highly industrialized part of the Rotterdam harbor, where winds are all year round. It describes the different interests of the various stakeholders, and how these can be harmonized in a solid solution. Managing the differences in interest is important, because it can be the key to succession or to failure.. Which elements create a positive business case, so that it becomes profitable for investors to step in?

Creating a business case with a positive outcome can take much time, especially with many stakeholders with conflicting interests. In this case the area is not only industrial zone, also protection against flooding is a main topic and it is also an area for multiple types of recreation, including bathing, swimming, wave-surfing, wind-surfing, kite-surfing and board surfing. And this all is situated next to a protected nature reserve. The paper describes this process for the Rotterdam harbor. Once the business case is closed it will take a couple of years to select a qualified supplier/builder and to get electricity delivered.

The smart combination or else the exclusion of functions is the key to get the windfarm fitted into the spatial plans and functions. This is detailed in this paper.

2. INTRODUCTION

The port of Rotterdam (fig.1) is the largest port of Europe. Ports are economic drivers. Large ports create much activity including emissions. Since the world-leaders decided to reduce the emission of

Carbon to stay below the threshold of 1.5 °C warming-up of the atmosphere (Paris agreement, December 2015), the large-scale industrial areas have to find ways to operate more environmental-friendly. Especially areas developed in the 1960's – 1970's are often polluting the environment (air, water and soil) with high emission rates, due to their old fashioned modes of operation. Although more recent techniques might have reduced the emissions, they still remain fairly high. That is why energy-options that don't use fossil-fuel become more important. To become CO_2-neutral or to reduce other emissions significant renewable energy becomes more important.

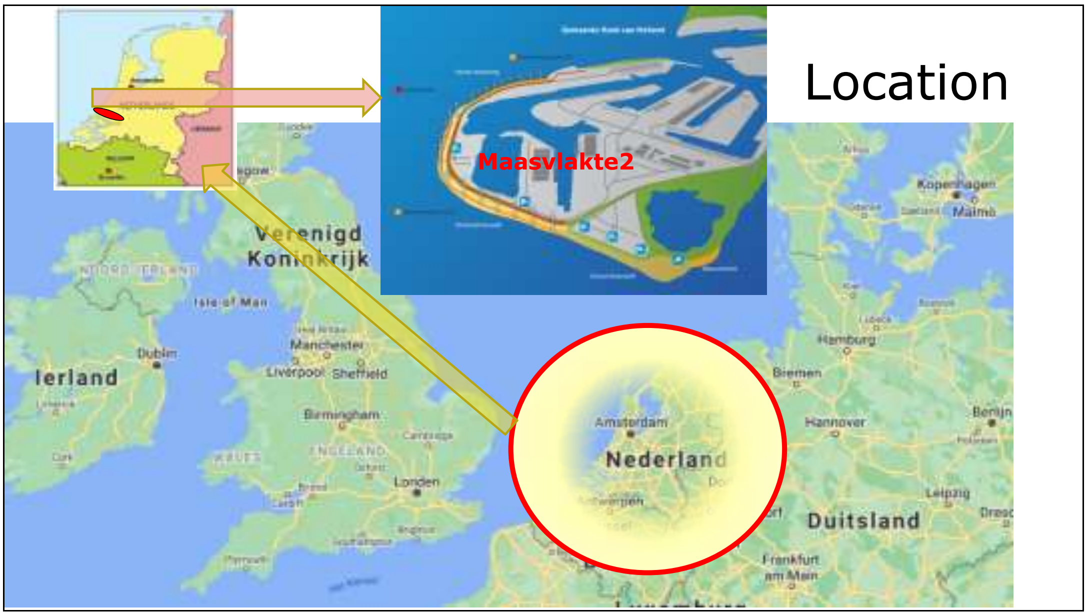

Figure 1, location of the wind farm on Maasvlakte2, the Netherlands.

The Ministry of Infrastructure and Water in the Netherlands has decided in 2018 to become energy-neutral on all the networks they manage (main waterways and roads in the country) by 2030. To reach this goal a location needs to be found where renewable energy can be produced in high volumes. The energy-consumption of the Ministry is around 200 GWh/year and is increasing, due to the shift to electric vehicles and increasing use of smart-traffic options and reduction of gas-fueled installations.

Looking to the meteorological conditions we see that the northern countries in Europe in general have good opportunities for water as energy-source, the height differences allow for this. In the moderate zones wind force is the dominant source and more towards the southern European countries solar-plants are favorite (Segreto et. Al., 2020). In the Netherlands wind-born energy is coming in large volumes from the large wind farms on the North Sea. Onshore this production is in smaller volumes, due to restrictive conditions like spatial planning and nature-impacts that prohibit real large scale wind production farms. In the stretch along the coast not much windfarms have been erected, since many other functions are already operational there and interfere with new wind farms. Therefore it is not easy to find suited locations for extra energy production in large volumes. In many industrial zones windfarms have been installed, but not on a very large scale. Mainly because the available area is relative small. Industrial zones are developed to organize economic activities in a smooth way, and not to optimize the energy-production of that area. The energy-production is a new loot on the stem and has to conquer with the existing functions, who also claim to have priority and reduce the options for new wind farms. And on those locations where some space is left the wind farm has to fit into the existing spatial plans, including the restrictions they have formulated in the different environmental issues, such as noise production, vertical building limits and safety for the surrounding buildings and people. This altogether creates opposition to locations situated near cities, villages and neighborhoods, and lengthy procedures. The impact of these objections on the business case may be large, sometimes too large to finalize the procedures.

3. A WINDFARM ON MAASVLAKTE2

Already during the phase of design and construct of the recently constructed Maasvlakte2 many functions were thought to have a place in the sea-defense (fig 2) (Bestemmingsplan Maasvlakte2, 2008). Note that in this figure a windmill is positioned in the infra-bundle, which was seen as the most logical location at that time. We see that within the area of protection against storm surges and flooding also recreation, nature, industry and infrastructure conquer for space. Each of these functions can be subdivided into more specific aspects. When we look into recreation we can find beach-leisure, bathing, swimming, wave-surfing, board-surfing, kite-surfing and horse-riding. This is done on different stretches of the sea wall. The same holds for infrastructure. Roads, railroads and cables and pipes use different alignments. Also for nature we can subdivide into nature in the shallow sea, on the beach and in the dunes. From industrial perspective each square meter is used for either containers, distribution or chemical purposes, as decided during the phase of planning and design of Maasvlakte2 (Environmental Impact Assessment Maasvlakte2).

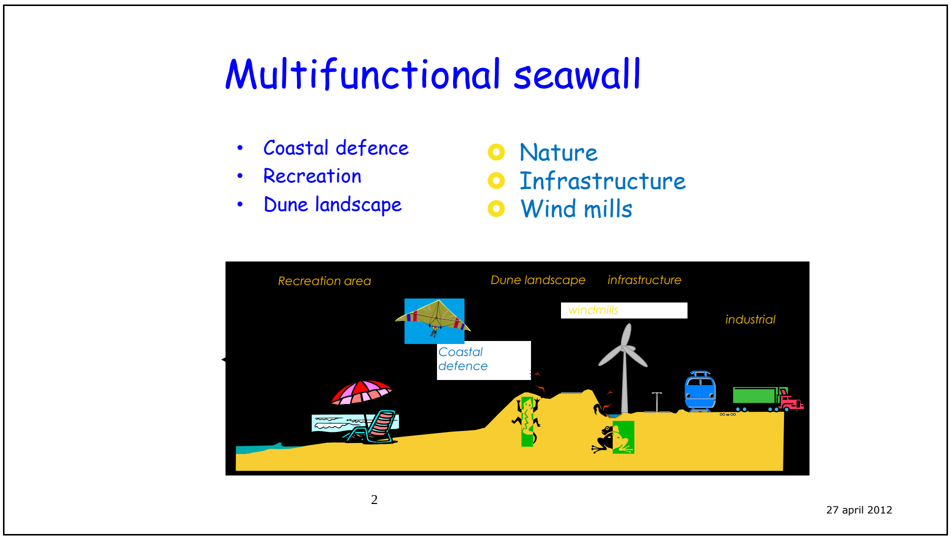

Figure 2: different functions located in the cross-section of the seawall.

Looking in more detail we see that there is no square meter that has no function. So, if we want to bring in a new function, or change an existing one into a higher impact or volume, we have to weigh the pros and cons of the options. We also need to take into account that next to the industrial zone a nature protected area is situated, the so called Voordelta. A shallow zone with undeep water and changing salinity concentrations. This is never done before and will be elaborated in the next paragraph.

4. THE FUNCTIONS AND CONFLICTING INTERESTS.

In the original design of Maasvlakte2 there was room created for wind energy, but only with high extra costs (E.I.A. Maasvlakte2) . To build a wind farm an extra banquet of sand was needed along the whole stretch (ca. 6.5 km) of the sandy coast, to fulfill the boundary conditions for safety. The costs for this extra sand were so high that no positive business case for a wind farm was possible. The location of the windmills in the cross section is also a source for debate. From a social point a framework is developed by Gamboa (2007). This takes the impact on various landowners into account, where on Maasvlakte2 the Port of Rotterdam Authority is the only organizations to lease land for any purpose. From an strict economic point of view, where all aspects are deduced to an amount of money a comparison is made for a Scottish case (Moran, 2007). Here we need to balance between ecological and economic aspects. Differing from most inland locations we don't have citizens near the proposed location, with the complaints coming from the local residents (Langbroek, 20212) and differing from most offshore locations we can see the result also when you are remote from the location, since the size of the windmills fits more with offshore sizes than with onshore sizes.

-From an industrial point of view they should be put as far as possible to the seaside, to have the maximum options for industrial use without limitations.

-From infrastructural point of view it is important to avoid blockade of the road, railway and cables and pipes-zone. If something goes wrong with a wind mill and a wick comes down it has to be assured that this will not hinder the traffic and cannot interrupt the transport via the pipes and cables. The so called high-impact zone has to be free of parts of the windmills at all times. This forces the possible locations of the mills to move seawards, more remote from the infra-bundle.

-Within or on the dunes we face another type of problem. Dunes are not fixed, but moving units, so the shape is not fixed. This creates problems when you need to enter the windmill for maintenance purposes etc. and vehicles have problems to come close to the windmill, because of possible disturbance of nature values. So delivering spare parts e.g. is problematic. The nature values need to be protected as well.

-The front-side of the sea wall is the area for the different types of recreation and leisure. We find the people who want to bath in the sun, or like to walk along the water, or to swim. But also the people who want to be active with all kinds of sports. This area is very suitable for different styles of surfing. Wave surfing is possible here, board surfing and windsurfing as well. And various forms of kiting are popular. From a safety point of view the wind mill should not be placed in an area where people can be in crowds. So on intensive used stretches this cannot be combined, but on extensive used parts this might be combined, with some types of recreation. As long as you don't collide with the mast of the turbine and can avoid to become entangled in the wicks, you can use the area. But high speed activities become problematic. Also kite surfing, where jumping is one of the attractive elements of this type of sport is dangerous. From a safety point of view this cannot be combined.

-From a point of safety against flooding it has to be assured that the construction is capable to withstand a certain storm with a chance of occurrence. In a sandy environment this means that enough sand has to remain after the unwanted event took place. This create very strict boundary conditions for possible locations for wind mills.

-from the point of external influences is has to be avoided to create negative impact on the nature protected Voordelta, with high but fragile nature values.

So we see that form the individual standpoints of each of the functions the driving force is always to avoid negative impacts of the wind mill. Overlooking the cross-section there is no place that is not disputed. So the question is, how to find a place without unacceptable negative impacts.

As described above initially a very costly sand banquet is needed when the mills are put in the zone where safety is required. This is the zone were a certain volume of sand needs to remain after a severe storm which erodes a large volume of sand. These costs for a sand banquet will outrange a positive business case. In a place outside of this safety-buffer it might be easier to get a positive business case, since there is no (or much lesser) need for extra sand. As paragraph 4 explains the functions in the cross-section are multiple and the impact zone of each overlaps with the impact zone of one or more other functions. The solution is created in a combination of boundary conditions and taking up responsibilities. One of the main aspects for a business case is the guarantee for the yield of the produced energy for a certain period. As described in the introduction the Ministry of Infrastructure & Water wants to be energy neutral by 2030. This means that all necessary energy is produced in a renewable production unit. The Ministry has guaranteed to buy all produced electricity for the next coming 25 year. This is a great step for a business developer, since it is not only guaranteed that the electricity can be used, but also for a fixed price for this whole period. On the income-side of the business case there is certainty, which is very important when you want your project to get financed. Then remains the question where the windmills can be incorporated into the cross section.

Looking to the stretch along the coastline of Maasvlakte2 there is a difference is priority along the longshore of the coast. In the southern part the focus is on nature values. These should be protected and remain uninterrupted. In the southwestern part is the more intensive used beach, much beach recreation including sun-bathing due to the good orientation towards the sun. The northwestern part is a much less intensive used beach. This is the extensive used area where sportsmen go for kiting and surfing etc. In the northern part the spotting of the ship that sail in and out of the harbor is the major activity (see fig. 3). It will be clear that the impact of the different types of recreation on the surrounding area differs. When you lay on your towel on the beach, there is no impact on other functions, when you sit or stand to spot the traffic neither. When you are kiting you need a lot of space that cannot be used for other activities at the same moment.

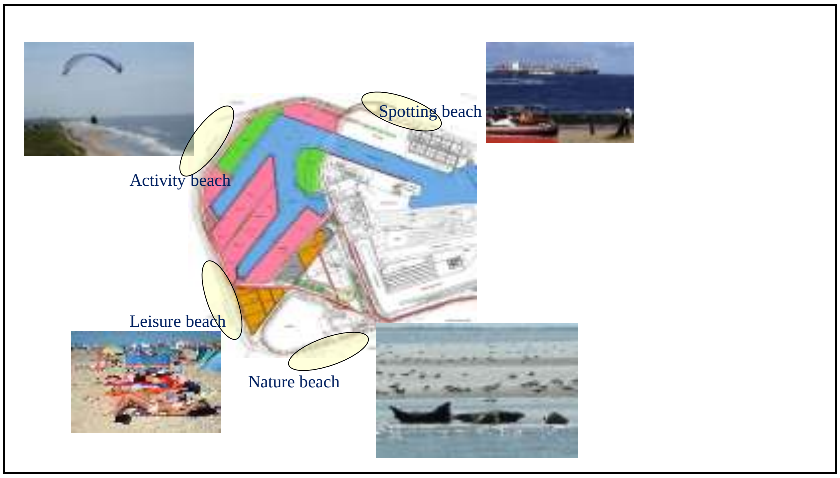

Figure 3: different types of recreation of specified places of the contour.

6. MITIGATING ACTIONS

The conflicting interests in the cross-section cannot be solved without any harm. They are dissimilar and their weight will be judged different by different people. To optimize the choice is made to move the windmills into the tidal-zone. This has one great advantage, that there is no need for an extra sand banquet. Meanwhile it introduces a new challenge, that is to build nearly onshore with mainly off-shore techniques. The impact of the wind farm on the industrial zone is eliminated. The impact on the sea wall with all nature values that it holds is also eliminated or at least sharply reduced. The impact on the recreation on the beach is minimal. The shadow of the wicks is not on the beach. The windmill closest to the recreation zone will get special wicks to reduce the noise with 2 dBa. The impact on swimming is minimal, since you need to go further into the sea when you want to swim, and for those who want to paddle there is no problem. For windsurfing there is also no impact. For board-surfing neither, since the water depth is too low to surf near the pillar of the windmill. For kite-surfers who don't jump there is no problem, but for kite-surfers who jump and make acrobatic turns the situation changes dramatic, since it cannot be allowed to do these exercises in the neighborhood of the windmills. Their ropes may hit a wick with disastrous result. So it is decided to forbid to kite in the area where the windmills will be erected. In the season with few recreation activities on the beach it can be allowed to kite in that area. So zoning in space and in time can create an acceptable outcome, albeit that it is not possible to avoid any negative impact. Being situated on the edge of a nature-protected area (the Voordelta), it is also important to look at possible impacts on this area. The nature values are the shallow water, with salt and brackish water and turbulent bottom. Furthermore additional measures are taken. To minimize the number of birds that will be killed by hitting a wick a very advanced radar-system is developed. This radar identifies large numbers of birds and their tracking. When we combine the atmospheric conditions (wind direction and –speed, twilight or dawn, rain or dry) with the season and the radar-information, gathered at different locations, along the coast and on the North Sea, it is possible to predict at which time migratory birds will go either to the south or the north. That is important because the whole European coast is a major migration-route for many kinds of birds. There is a provision to stop the windmills timely, so that the birds can migrate without disturbance and without being hit by a wick. A comparable system will be used to identify bats. With bat-detectors on some of the wind mills the bats are able to avoid collision with the wind mills, thus reducing the number of victims. The pillars will be built in the intertidal area. This means that sea mammals might be impacted when they come closer towards the construction work. To reduce this impact a hydro-hammer will be used, which reduced the noise under water and also allows for a shorter time per pillar to be drilled into the sea bottom. The possible impact of the windmills on the mammals that travel through the North Sea on their normal routes will be acceptable. They travel on large distance from the location, so there is much damping of the produced noise during the pile driving.

There will be an extensive monitoring program to gather information of the possible impacts. The data that will be collected will be shared with the data that comes from offshore windfarms, in an open source. So everybody who is interested can dive into this information and check the findings or measurements they prefer. This sharing improves the knowledge that will be needed for next generation wind-farms, both offshore and onshore. The combination of cooperative partners on one hand and a business case with a positive outcome on the other hand delivers boundary conditions and a level playing field to come to a solid and robust plan. To project these results on other circumstances both sides, the level playing field, and the business case are equal important. A level playing field can only be reached when all relevant information is shared, so that the parties can make a good judgement of their position. And a business case with too much undefined or open end variables will never convince a bank to invest in this project.

The outcome of this process is that no objection is adopted by the court, so that this plan now is in the phase of realization and that starting from the second half of this year the energy produced by this windfarm will be delivered to the client. The goals for an energy neutral and sustainable production of electricity will be reached in 2023, already 7 year before the deadline.

7. SUMMARY AND CONCLUSIONS

Although an industrial area might seem very suitable for renewable energy-production, it turns out to be challenging to find a location where a production unit can be installed without interference with other functions. For wind-energy the required space is not as large as for a solar-production unit with equal production, but still it is a conquer of space with other functions.

A business case has many variables, including involved parties and their interests, unforeseen costs and varying revenues. Sometimes it is necessary to fix some of these variables in order to come to a solid basis, on which investors are willing to participate.

To find acceptable locations it is necessary to create an atmosphere in which all parties can realize something of their interest. Cooperation and mutual understanding benefits from open discussions, and will be interrupted or disappear when hidden agenda's seem to exist. Also in situations where this open mode of operation is not common use, it is recommended to follow this approach.

Create enough budget and space to realize mitigation and compensation, to alleviate the negative impacts for sectors.

Be pro-active in the setup of monitoring and evaluation programs and share the information with involved parties, to build trust and to decide together on possible (mitigating) steps where necessary.

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