Horizon Europe Energy - HORIZON-CL5-2021-D3-02

EUROPEAN CLIMATE, INFRASTRUCTURE AND ENVIRONMENT EXECUTIVE AGENCY (CINEA)

Report of stakeholders' know-how limitations

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This document is the SEANERGY project **"Report of stakeholders' know-how limitations"** (contract no. 101075710) corresponding to **D2.1 (Month 8)** led by **"World Maritime University".**

This project has received funding from the European Union's Horizon Europe research and innovation program under grant agreement number 101075710. This visual support reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

1.1 Discussion of the survey results on barriers and solutions

A survey questionnaire was launched by the World Maritime University (WMU) at the beginning of May until the end of June 2023. The construction of the survey went through rigorous reviews by the project partners. Additionally, a stakeholder identification was held up in WMU, which helped gather data on more than 600 stakeholders spread around the EU. The survey sought to investigate the barriers that ports' stakeholders have with respect to the port energy transition. While the barriers were investigated, the significance of stakeholders to the port energy transition in addition to finding some solutions to identified barriers were also highlighted. The survey reached 1420 stakeholders, 260 responded, and only 104 completed it until the last question. The analysis will reflect the numbers that answered each question considering that 170 stakeholders answered some questions. Figure 5 below shows the proportion of the stakeholders that answered the survey. Please find the full list and details of survey questions in Appendix 1, at the end of this deliverable document.

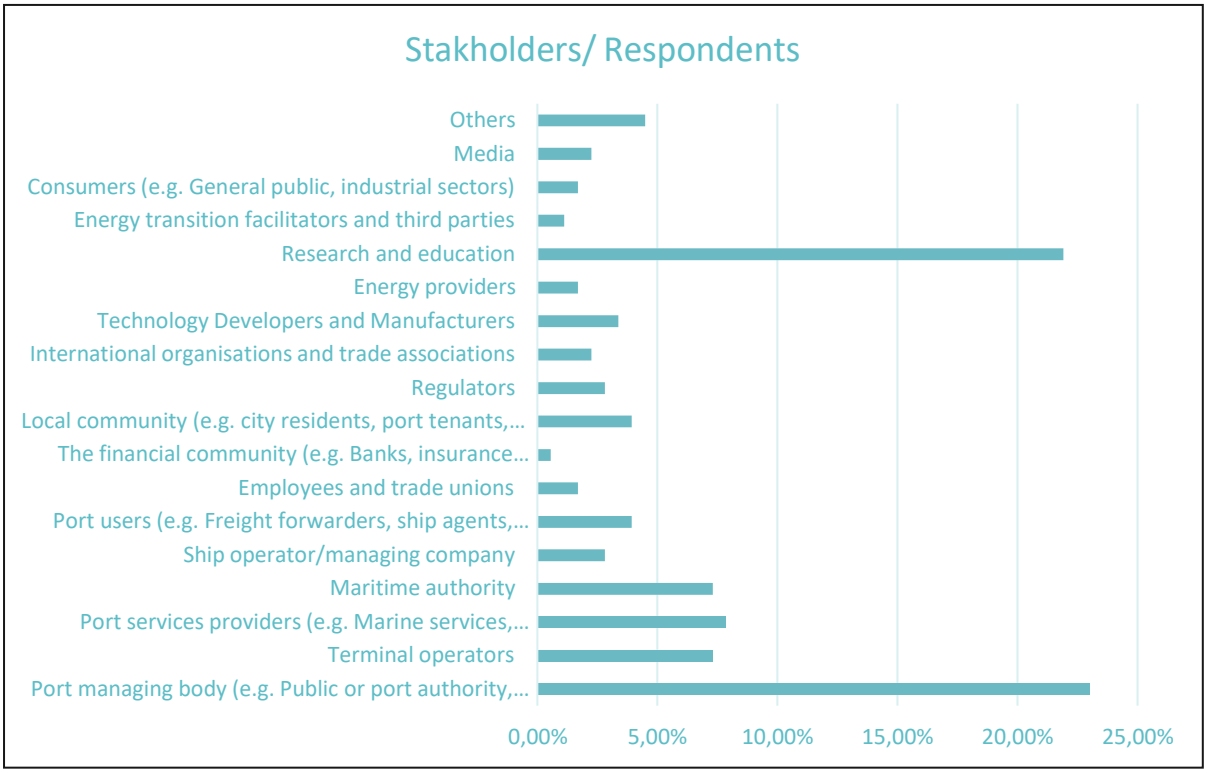

Figure 5: The proportion of the stakeholders that answered the survey

Responses were collected from 19 EU countries. The port managing bodies, academia, port users, service providers, terminal operators, and local communities highly answered the questionnaire than other stakeholders.

1.1.1 Importance of stakeholders to the port energy transition

The survey dedicated one question that asked the respondents about the importance of different stakeholders in the port transition to renewable energy and clean fuels. The respondents were asked to rate the level of significance in such transition using (1-lowest to 5-highest). The result shows that the port managing body (I.e., Public or port authority, port operating companies) is on top as it was rated the highest. On average, 87% of the responding stakeholders believed that the managing body is the most important (4.34) player in the port energy transition, followed by energy providers, ship operators, terminal operators, regulators and the maritime authority. This confirms the role of the port itself as a catalyst in the transition, while also highlighting the energy provider's role. Without cleaner fuels, ports cannot supply their equipment, ships and land transport. The regulators' role is also important as the domestication of climate change mitigation is essential for port authorities to begin the transition and also drive the shipping and port operators to comply. Most of the rating is between medium and intermediate for the rest of the stakeholders. This also confirms that

stakeholders have power and interests in the port energy transition, and they should not be left behind.

Table 2: Results of ranking of the significance of stakeholders to port energy transition

Rating order	Stakeholders' category	Rating mean	Percentage of responses
1	Port managing body (e.g., Public or port authority, port operating companies)	4.34	87%
2	Energy providers	4.12	82.4%
3	Ship operator/managing company	4.10	81.9%
4	Terminal operators	4.05	81%
5	Regulators	4.00	81%
6	Maritime authority	3.99	85%
7	Technology Developers and Manufacturers	3.87	81%
8	Energy transition facilitators and third parties (Designers, Architects, Contractors, Construction workers, port project managers, consultants, and other service providers)	3.63	80.4%
9	The financial community (e.g., Banks, insurance companies, stock exchange, credit institutions, investors, ministry of finance, public funds)	3.59	77.2%
10	Research and education	3.57	77.5%
11	Port services providers (e.g., Marine services, customs, coastguards)	3.53	87%
12	Port users (e.g., Freight forwarders, ship agents, brokers, road hauliers, railway companies, and logistics providers)	3.50	70%
13	Consumers (e.g., General public, industrial sectors)	3.46	81.5%
14	Local community and societal groups of interest (e.g., city residents, port tenants, None Governmental Organisations (NGOs))	3.33	66.5%
15	International organisations and trade associations	3.20	66.5%
16	Employees and trade unions	3.15	62.9%
17	Media	3.15	62.3%

As a takeaway, mapping and understanding the stakeholder and being sensitive and responsive to them minimizes the use of their abusive powers, strengthens cooperation, and facilitates successful energy transition (planning, execution and construction, and operation). As recommended in D1.1., mapping of stakeholders engaged in the ports energy transition is required, and thus needs to be a transparent and dynamic process that verifies and builds understanding of stakeholders. The D1.1., in fact, discussed the applicability of the stakeholder circle method from the port perspective, i.e., the five steps (identify, prioritize, visualize, engage, and monitor). This cycle provides a holistic understanding of the stakeholders' needs, expectations, interests, power, legitimacy, proximity, and how to build a collaborative platform through the communication plans.

1.1.2 Ranking of barriers and solutions

Barriers' ranking

In the survey, respondents were requested to rate the significance of the barriers to energy transition in ports on a scale of 1 to 6, based on the strength of each barrier. Based on the perspective of different stakeholders, Figure 6 shows the overall ranking of barriers to energy transition in ports.

The next step is to investigate and compare the perspective of stakeholders about the strength of barriers. For this reason, stakeholders with the highest participation in the survey are considered, including port managing bodies, research and education professionals, port service providers, maritime authorities, and terminal operators. Table 3 demonstrates a comparison of the strength and priority of barriers in the view of different stakeholders.

Table 3 illustrates how different stakeholders' opinions differ on the ranking of barriers and how they differ from the overall results. As we can see, the viewpoint of port managing bodies is very similar to the overall results with some disorders of the barriers. Although this could be attributed to the high number of respondents from this group, however, the centric role of port managers and their mastery and awareness on general issues related to energy in ports should be acknowledged. As a result of continuous engagement with internal port actors and outside port stakeholders, port managers possess a real perspective of the current and potential barriers to port energy transition.

As expected, research and education professionals have a comprehensive perspective from the outside. While they see the policy and regulatory issues as the main barriers, they do not overlook the port economy and social issues. By emphasizing inertia, training of the workforce, and social admissibility of new technologies, they expressed their concerns about social affairs. However, in the list of the eight highest ranking barriers, they do not highlight technical barriers such as maturity of technologies and availability of technical codes and standards.

By contrast, the main concern of the port service providers is the immaturity of new technologies, followed by information issues and hidden costs. This shows that port service providers are more interested to see disseminated information about new technology performance and readiness. Valid and open sources of information will reduce the hidden cost for all stakeholders.

The priority of the concerns of the maritime authorities is different. They think more about the relationship between stakeholders as their main concern is the lack of communication and split incentives in various forms. However, they do not ignore the technical issues, including the immaturity of new technologies. Interestingly, they do not believe in uncertainties regarding future policies and regulatory implications as main barriers, probably due to their engagement in such issues.

Terminal operators are directly engaged with daily port operations. Therefore, their concerns in dealing with port landlord, regional and national authorities, port workforce, and neighbouring society are realizable. In the next step, they think about technical barriers.

Figure 6: Overall perspective of stakeholders on the ranking of barriers to energy transition in ports

Table 3: Comparison of stakeholders' perspectives on barriers to the energy transition in ports *

Ranking of the barriers each stakeholder						
Overall ranking	**The barriers**	**Port managing body**	**Research and education**	**Port service providers**	**Maritime authorities**	**Terminal operators**
1	Uncertainties regarding future policies	1	1	4	N/A	5
2	Immatureness of technologies	3		1	2	8
3	Limited access to capital by ports' authority	4	2	N/A	N/A	N/A
4	Lack of codes and standards for new technologies	2	N/A	N/A	7	6
5	Regulatory implications	7	4	8	N/A	2

6	Inertia (resistance to change)	8	3	5	N/A	N/A
7	Hidden costs	5	5	3	4	1
8	Inconsistency between port and ships equipment	6	6	6	6	7
Other concerns with higher priorities			7- lack of trained workforce	2- information issues	1- lack of communication	3- social admissibility of some new technologies
			8- social admissibility of some new technologies	7- social admissibility of some new technologies	3- split incentives between port landlord and tenants	4- lack of trained workforce
					5- split incentives between ports, shipowners, and tech. Providers	
					8- lack of space	

* The number in the table indicates the raking of the barrier among other barriers (from 1, the first top barrier, to 8, the lowest barrier level)

Solutions' ranking

In the survey, respondents were requested to rate the significance of the solutions for the energy transition in ports on a scale of 1 to 6, based on the strength and priority of each solution. Based on the perspective of different stakeholders, Figure 7 shows the overall ranking of solutions for the energy transition in ports. Similar to barriers, an investigation and comparison of the stakeholders' viewpoint about the priority of solutions is carried out. Table 4 demonstrates a comparison of the priority of solutions in the view of different stakeholders.

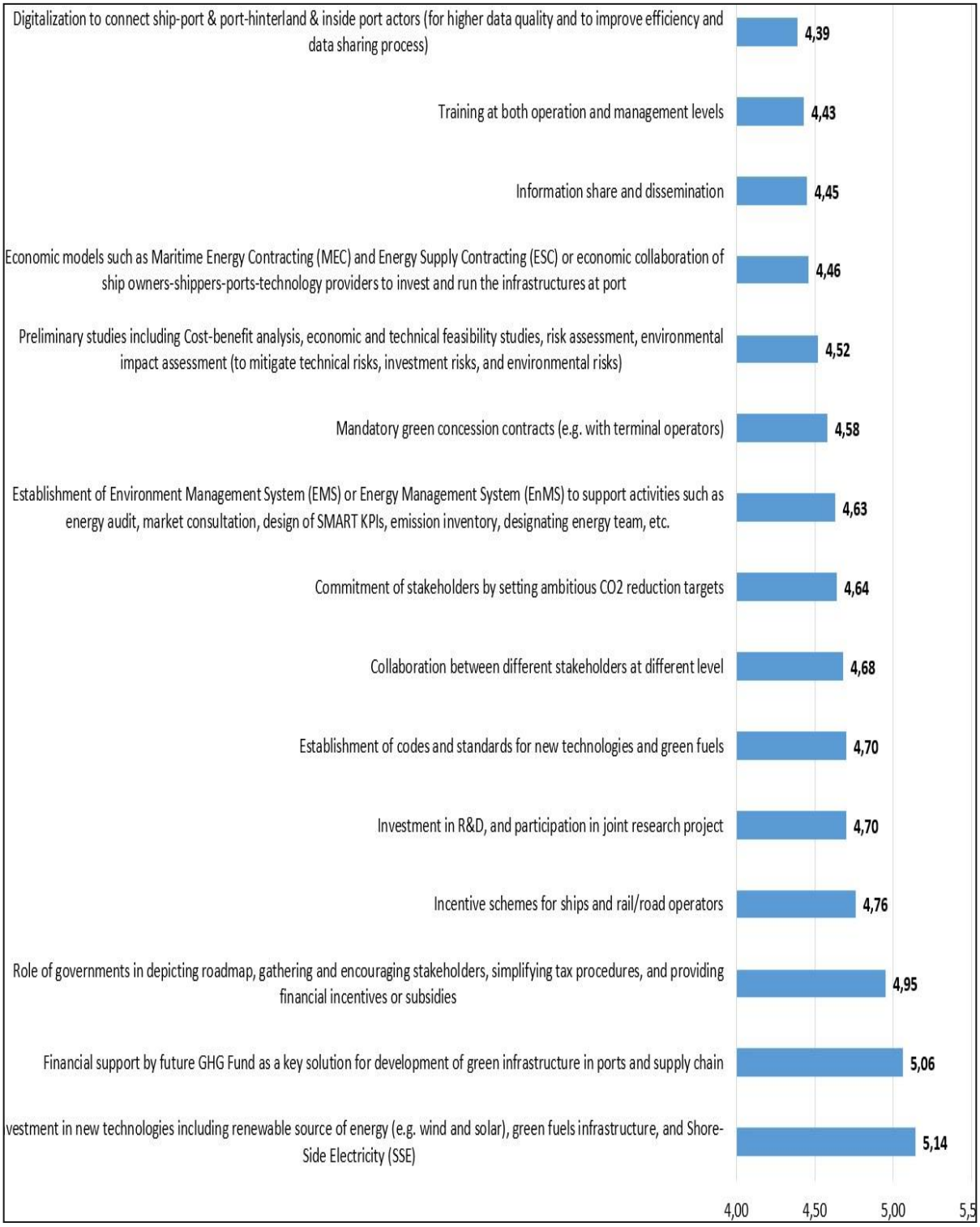

Figure 7: overall ranking of solutions for the energy transition in ports

*Table 4: A comparison of the solutions priority recommended by stakeholders regarding the energy transition in ports**

Ranking of the solutions to each stakeholder						
Overall ranking	**The solutions**	**Port managing bodies**	**Research and education**	**Port service providers**	**Maritime authorities**	**Terminal operators**
1	Investment in new technologies	3	1	1	1	1
2	Financial support by future GHG Fund	1	3	4	2	2
3	Role of governments	2	2	8	7	8
4	Incentive schemes for ships and rail/road operators	6	6			5
5	Investment in R&D, and participation in joint research project	N/A	5	3	4	3
6	Establishment of codes and standards for new technologies and green fuels	8	N/A	5	N/A	N/A
7	Collaboration between different stakeholders at different level	N/A	4	N/A	N/A	7
8	Commitment of stakeholders by setting ambitious CO2 reduction targets	N/A	N/A	N/A	N/A	4
Other solutions with higher priority		4- Mandatory green concession contracts	7- Training	2- Preliminary studies	3- Preliminary studies	6- Mandatory green concession contracts
		5- Economic models	8- Information share and dissemination	6- Digitalisation	5- Establishment of EMS or EnMS	
		7- Digitalisation		7- Mandatory green concession contracts	6- Mandatory green concession contracts	
					8- Digitalisation	

* The number in the table indicates the raking of the barrier among other barriers (from 1, the first top barrier, to 8, the lowest barrier level)

Table 4 shows that almost all stakeholders believe in investment in new technologies as a priority. Similarly, receiving financial support from the future GHG Fund is the desire of most stakeholders. While future MBM can close the price gap between conventional fuels and alternative fuels, at the same time its revenue can facilitate the energy transition by supporting ports in the establishment of bunkering infrastructure and green corridors. Following that, all stakeholders indicate the significant role of governments in facilitating the energy transition in ports through economic instruments, initiating negotiations between stakeholders, and depicting a roadmap.

Based on the results in Table 4, port management is more interested in short- and mid-term practical solutions with tangible results such as mandatory green concession contracts, economic models, and digitalisation. They may suppose that already there are enough commitment and collaboration between stakeholders. By contrast, research and education professionals have a more long-term view by considering collaboration between stakeholders, investment in R&D, and upskilling the workforce in ports.

Port service providers believe that if the investment in new technologies is the first step, it should be immediately followed by preliminary studies, investment in R&D, and the establishment of codes and standards for the adoption of these new technologies. In this direction, they see financial support from GHG Fund and mandatory green concession contracts as drivers of this movement.

Maritime authorities are the only group with less consistency between their desired solutions and their indicated barriers. While their main concerns were about the lack of communication and split incentives between stakeholders, it was expected to see some solutions like collaboration between stakeholders or economic models in response to split incentives. However, their preferences are more based on operational strategies such as the establishment of EMS or EnMS, mandatory green concession contracts, and digitalisation.

The preferences of terminal operators are solutions that improve the relationship between stakeholders, such as port incentive programs for ships and rail/road operators, green contracts, collaboration between stakeholders, and the leading role of governments. It may be due to their central role in port operations, which requires them to interact with a variety of stakeholders.

1.2 Conclusions and recommendations for part one

This part addresses the growing environmental concerns and the pressing need to combat climate change in ports. Specifically, the barriers and solutions to ports' energy transition have emerged as a pivotal area of research and policy implementation. The transition to cleaner and sustainable energy sources in the maritime industry is no longer an option but a necessity to ensure a greener future. Therefore, it is important to understand the impediments that hinder progress in this domain and identify the potential solutions that can drive positive change.

All the stakeholders involved in the maritime sector benefit from the results in this part. Firstly, understanding the barriers to ports' energy transition enables governments, policymakers, and industry leaders to design more effective and targeted strategies to overcome these obstacles. By

addressing these challenges head-on, they can create an environment that fosters the adoption of renewable energy solutions, promoting a significant reduction in greenhouse gas emissions and air pollution associated with traditional port operations. Furthermore, the results shed light on the economic benefits of embracing energy transition in ports. Investing in sustainable technologies and renewable energy sources can lead to long-term cost savings, increased operational efficiency, and enhanced competitiveness for ports. It opens up new avenues for economic growth and job creation, particularly in the renewable energy sector. Additionally, the adoption of cleaner technologies in ports can improve the overall public perception of the maritime industry, attracting more environmentally-conscious customers and investors.

By identifying and addressing these challenges and solutions, ports can unlock immense benefits for the environment, economy, and society at large. Through concerted efforts and strategic planning, ports can become energy hubs that is a pioneer in the adoption of clean energy practices, playing a pivotal role in the global fight against climate change and setting an inspiring example for other industries to follow suit.

Recommendations for Ports:

Based on the insights gained from this part, several recommendations are proposed for ports to facilitate a smoother energy transition:

- Set Ambitious Renewable Energy Targets: Ports should establish ambitious yet achievable renewable energy targets to guide their transition plans. These targets should be aligned with national and international climate goals, fostering a collective commitment to sustainability.
- Foster Public-Private Partnerships: Collaboration between port authorities, private companies, and research institutions is crucial to overcoming the financial and technical barriers to energy transition. Public-private partnerships can accelerate the deployment of renewable energy projects and facilitate knowledge sharing.
- Develop Incentives and Subsidies: Governments and relevant authorities (port authorities) should introduce incentives and subsidies to encourage ports to adopt green technologies and invest in renewable energy infrastructure. Financial support can offset the initial costs and motivate ports to embrace sustainable practices.
- Embrace Technological Innovation: Ports should embrace innovative technologies, such as smart grid systems, energy storage solutions, and shore power facilities, to optimize energy consumption and facilitate the integration of renewable energy sources.
- Engage with stakeholders: Collaboration with stakeholders and local communities is essential to building trust, fostering support, and addressing potential concerns related to ports' energy transition. Transparent communication and community engagement are vital for successful implementation.

2 Part two- Cultural analysis and social inclusion approach: The role of women in the port and port logistics

2.1 Introduction to the Port Industry

The role of women in the port and port logistics industry is an important topic that has received limited attention in the literature. However, some studies have been conducted to evaluate the gender equality criteria related to social sustainability in ports (Sanrı, 2022). These studies have shown that the logistics and transport industry is male-dominated, and the degree of female participation is low. Female employees are said to constitute only 31% of the total workforce in the industry, and female employees occupying technical roles in logistics and transport companies are less than 15% on average (Amushila, 2022). Despite the low representation of women in the industry, there are efforts to increase the women's workforce share in the port industry (Sanrı, 2022).

This part will study the sociocultural and behavioural aspects (along with the SSH disciplines stated in the previous sections) that directly impact the successful clean energy and fuel transition. This will be approached in two segments. First, desk research has been conducted by searching and summarising how the port industry has progressed in the following issues according to previous public and private reports: economics, politics, sociology, demography and ethnology (all with a gender-based lens to understand why men have traditionally predominated the port industry)[1]. As a result, an overall human-dimension picture will be obtained, from which further strategies for technology integration can be drawn as recommendations for stakeholders to allow for an easier and smoother transformation of activities and inclusion of women and underrepresented communities. IHE Delft has developed the content of the survey/questionnaire, using the GDPR-compliant software “Netigate”, in collaboration with the other task participants and the survey questionnaire will be sent out to potential respondents in the last week of July 2023[2].

2.1.1 Progression of the Port Industry: Economics, Politics, Sociology, Ethnology

The port industry has been an essential component of global trade and commerce for centuries, serving as a crucial link between producers and consumers across the world. The industry has undergone significant development and progression over time, evolving from simple docks for ships to modern, sophisticated facilities adapting to changing market dynamics, technological

[1] Then, through online surveys, will be sent to stakeholders to get a grasp of the community's perception of the same concepts
[2] Results of the survey will be analysed at later stage

advancements, and geopolitical shifts. Today, ports around the world handle large volumes of cargo, and continue to play a pivotal role in facilitating international trade and economic growth. The port industry has played a critical role in global trade and commerce for centuries (Wang et al., 2018). During the early stages of development, ports operated in areas with ample and secure space, allowing for safe and cost-effective operations (Liu et al., 2020). However, as society evolved and the global economy expanded, ports had to adapt and progress alongside them (Xu et al., 2019). In the last few decades, the port industry has seen a substantial transformation as it responded to increasing demands from international trade and technological advancements (Tu, 2022). Today, the port industry continues to evolve, driven by technological advancements and changing global trade patterns. Many ports have expanded their infrastructure to accommodate larger ships, with some capable of handling vessels of over 20,000 TEUs (Twenty-foot equivalent units). The development of automated and semi-automated container terminals has also led to more efficient cargo handling, reducing turnaround times and improving productivity.

One of the most significant developments in the port industry has been containerisation, which gained rapid popularity over several decades. Containerisation revolutionised the industry by facilitating a more efficient and cost-effective transport method. The use of standardised containers meant that goods could be loaded and unloaded faster, enabling ships to spend less time docked at port (Akbayirli et al., 2016). Over the past 40 years, world seaborne trade has increased by almost 40%, with containerised cargo showing the most dynamic growth. Containerisation has become a crucial element of maritime activity, world trade and global industrial structure, reflecting changes in manufacturing and production. Container lines have gone through various organisational phases in their pursuit of profitability, with most container ship advancements being focused on increasing vessel size to cater to trade expansion and provide economies of scale (Peters, 2001). Terminal productivity and port efficiency drove market development. Automation and other port technology solutions increased terminal productivity. Such solutions were able to boost outputs but adoption was hindered by high fixed costs, managerial obstacles, and differing laws. Few studies examined how handling technologies and external factors such as port location affected terminal efficiency (Ghiara and Tei, 2021). Furthermore, the adoption of automated cargo handling systems and technology has allowed ports to increase their efficiency while reducing costs significantly (Markkula, 2021). Numerous innovations have been introduced in the maritime port industry over the past few decades, demonstrating that innovation is essential in this intensely competitive and evolving industry. These initiatives, including container terminal optimisation (Gharehgozli et al. 2016) and port-centric logistics (Kramberger et al. 2018) have been fundamental transformations in port labour. This included changes in the types of

tasks required, skills needed, professional profiles, employment relationships, work organisation, training methods, and the overall number of jobs available. As a result of these advancements, port infrastructures have undergone significant changes as shown in Figure 8, with modern ports featuring larger and deeper berths to accommodate the increasing size of vessels. Moreover, with the emergence of global supply chains and hub-and-spoke networks, ports have become a crucial link between producers and consumers across different regions (Šekularac-Ivošević et al., 2013), Port development has been a continuous process, and modern ports now offer far more than just cargo handling services. They also provide logistics and warehousing services, administrative management, insurance, consolidation, and delivery (Chen, 2022; Xu et al., 2019).

One of the most significant trends in the port industry today is the emphasis on sustainability and reducing the carbon footprint. Many ports have implemented eco-friendly initiatives, such as the use of renewable energy sources and reducing emissions from ships and cargo handling equipment. Some ports have also developed green initiatives, such as the use of electric vehicles and the installation of solar panels.

Another trend in the port industry is the growing importance of digitalisation and data analytics. Many ports have implemented advanced technology systems, such as Internet of Things (IoT) devices, artificial intelligence (AI), and blockchain, to optimise operations, enhance security, and improve supply chain visibility. These technologies have enabled ports to track cargo movements, predict demand, and optimise resources, improving efficiency and reducing costs.

The COVID-19 pandemic has also significantly impacted the port industry, with disruptions to global trade and supply chain operations. The pandemic highlighted the importance of resilient and adaptable port systems that respond quickly to changing market conditions and disruptions.

The port industry has seen significant progression over the years, from developing natural harbours to implementing containerisation, digitalisation, and sustainability initiatives. The industry continues to evolve, driven by technological advancements, changing trade patterns, and global economic trends. As the world becomes increasingly interconnected, the role of ports in facilitating global trade and commerce is set to become even more critical in the years ahead.

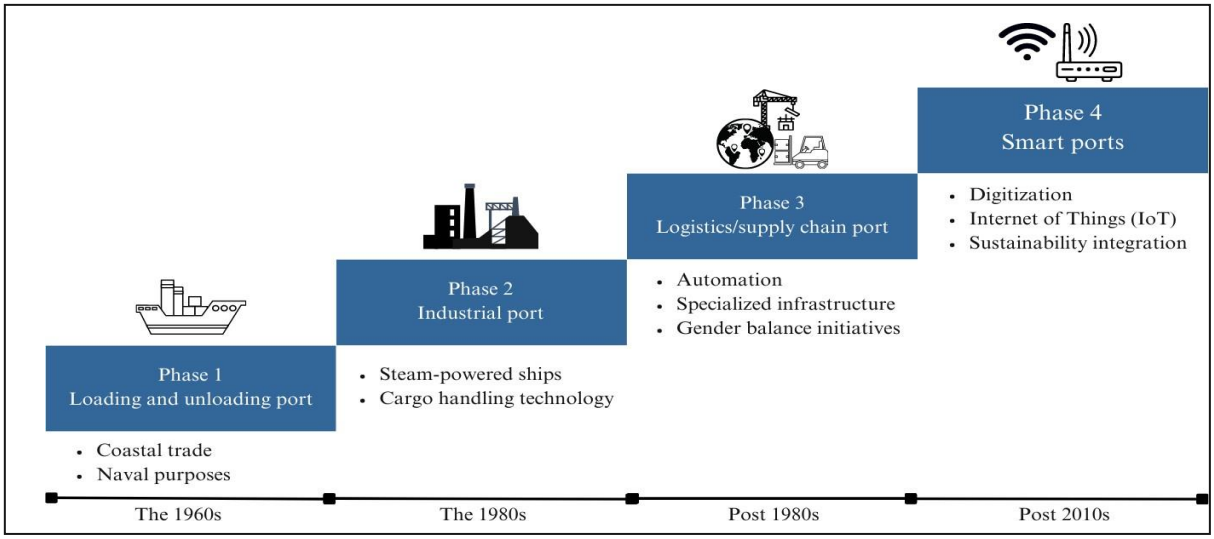

Figure 8: Evolution of the port system

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Economics

The port industry plays a crucial role in the global economy by facilitating the movement of goods and people. Over the years, the industry has undergone significant changes in response to evolving trade patterns, technological advancements, and environmental concerns. As a result, the economic development and progression of the port industry have been shaped by a complex interplay of factors that vary across regions and countries. The port industry is an integral part of the global economy, serving as a hub for the movement of goods and connecting businesses to markets worldwide (Ma et al., 2021). The industry has played a significant role in the economic development of nations, particularly those with coastal regions. In this article, we will discuss the economic development of the port industry in the world, its growth, and the challenges it faces.

Historically, ports have been the gateways for trade, connecting different regions and facilitating the exchange of goods. The development of port infrastructure and technology has played a vital role in the growth of the global economy (Hua et al., 2020). The industrial revolution in the 18th and 19th centuries led to an increase in demand for goods, and ports became crucial in the movement of goods across the world. The growth of the shipping industry and advancements in technology, such as containerisation, have further contributed to the development of the port industry (Haralambides, 2021). Today, the port industry is a major contributor to the global economy, with ports serving as critical nodes in global supply chains. The World Bank estimates that around 80% of global trade by volume and 70% by value is transported by sea, and ports play a crucial role in this movement. The port industry has grown significantly over the years, with ports becoming larger and more complex, and handling greater volumes of cargo (Munim and Schramm, 2018). The port industry's economic development has significantly impacted national and regional economies. Ports are major employers, with thousands of people working in various roles such as stevedores, terminal operators, truck drivers, and customs officials. The development of ports has also led to the growth of ancillary industries, such as logistics and transportation, and has attracted foreign investment (Wu and Fu, 2020). Countries with well-developed port infrastructure have a competitive advantage in global trade, and ports have played a significant role in the growth of many economies. For example, the Port of Singapore, one of the world's busiest ports, has been a key factor in the economic growth of Singapore, contributing to the country's status as a global financial and trading hub. Similarly, the development of the Port of Rotterdam in the Netherlands has played a significant role in the country's economic growth, with the port handling around 450 million tons of cargo annually and serving as a major gateway for trade with Europe (Trujillo and Tovar, 2007). As part of a city's transportation infrastructure, a port contributes to the city's economic growth from various angles. Due to its geographical advantages, shipping has become the primary mode of transportation in many European

regions, and port logistics services have been found to play a crucial role in the economy of the hinterland, as evidenced by numerous studies (Notteboom, 2009; Essoh, 2013). The interaction between the port and city development impacts GDP and other key factors such as population, area, and intellectual properties (Bottasso et al., 2014). Furthermore, ports have been found to impact world trade, as the shipping industry is fundamental to global import and export trade, as exemplified by the causal relationship between world trade and port throughput in Rotterdam (Heijman et al., 2017). Port throughput, as the most critical indicator of port service production, is frequently used to analyse the interaction mechanism between the port and the city's economy, and how it affects the port city, ports located in Rouen, for example contribute more than 21% of regional Gross Domestic Products (GDP) in 2007 (Cong et al., 2020). Ports can be viewed as facilitators of economic growth since they encourage development in particular economic sectors and locations near ports or corridors. The economic advantages of ports are typically divided into direct, indirect, and induced categories, shown in Figure 9. Indirect and induced benefits are challenging to identify explicitly, as it is difficult to prove that the economic activity and usage of related resources would have occurred only due to the port investment.

When an investment in a port leads to increased economic activity, the benefit is assessed by determining the net value of the additional output. The direct benefits for the port are financial and would be factored into any financial appraisal and economic appraisals. However, the financial benefits would be evaluated somewhat differently, with economic appraisals utilising a social discount rate and, for certain inputs, potentially valuing them at shadow prices (Notteboom et al., 2022).

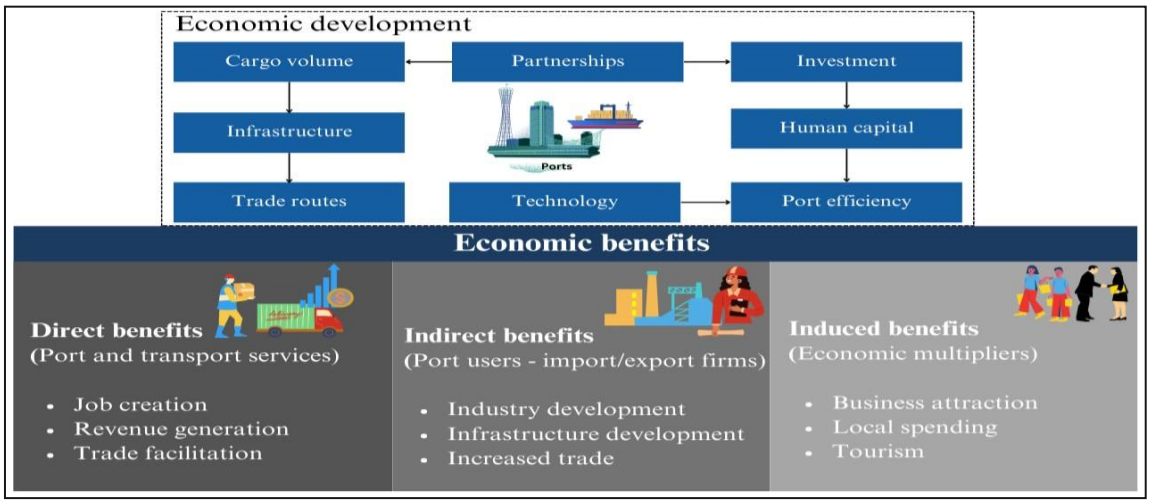

Figure 9: The economic development of ports

As shown in Figure 9, the economic development of ports is driven by several key aspects. Cargo volume plays a crucial role in port growth as ports strive to increase their capacity to handle larger volumes of cargo, both in terms of import and export. This requires continuous infrastructure

development, such as expanding container terminals and improving storage facilities. Higher cargo volumes lead to increased revenue, job creation, and overall economic growth in the port's surrounding areas. Partnerships and investments are vital for the economic development of ports. Collaboration between port authorities, private sector stakeholders, and governments can lead to significant investments in port infrastructure and services.

Politics

The port industry is an essential part of global trade and commerce, with ports serving as the gateway for the movement of goods and services between countries. As a result, the port industry is highly regulated, and political developments significantly impact its operations. In recent years, there have been several political developments in the port industry that have shaped its operations and governance. Various factors have influenced these developments, including globalisation, technological advancements, and changing geopolitical landscapes. The global port industry has thus experienced significant political developments throughout its history. From the early days of port activities to modern times, there have been numerous instances where political decisions have significantly impacted the growth and nature of port industry operations (Pintossi et al., 2021).

As global trade expanded over time, the development of port infrastructure became increasingly significant, and many governments started investing heavily in building modern seaports to support international trade (Vasilyeva et al., 2018). One of the most significant political developments in the port industry has been the increasing privatisation of ports. In the past, many ports were state-owned and operated, but in recent years, many governments have turned to private sector involvement in the port industry. This shift has been driven by the belief that private operators can bring greater efficiency and innovation to port operations, leading to increased competitiveness and economic growth.

Another significant political development in the history of the port industry was the shift towards privatisation in the late 20th century (Hein and van de Laar, 2020). Governments across the world began to recognise that privately operated ports can be more efficient, cost-effective and adaptable compared to government-owned facilities. This shift towards privatisation was often driven by political pressures, such as reducing public spending or attracting private investment into the country's infrastructure (Juhel, 2001). Additionally, there have been several instances where geopolitical conflicts and tensions impacted port industry operations. For example, the ongoing trade tensions between the U.S. and China have resulted in significant disruptions to global shipping patterns and changes to port infrastructure investment priorities, as countries look to redirect their trade flows

(Munim and Schramm, 2018). In recent years, the political development of the port industry has also been influenced by environmental concerns. Environmental concerns have emerged as a significant political issue in the port industry. Ports are major air and water pollution sources, with ships and cargo-handling equipment emitting significant amounts of greenhouse gases, particulate matter, and other pollutants. Thus, various governments are increasingly recognising the need to reduce the environmental impact of port operations, limiting carbon emissions and increasing sustainability. These political developments in the port industry reflect changing global priorities and objectives over time, from expanding trade power to reducing public spending to addressing environmental concerns (Christodoulou and Cullinane, 2019). Furthermore, political decisions have also impacted the legal and regulatory frameworks of port industry operations. For example, changes in trade policies and regulations at the national or international level can have significant effects on port operations, including tariffs and quotas affecting the import and export of goods, as well as changes to labour laws that impact the workforce (Bucher et al., 2021).

Sociology

The development of the port industry has been an important aspect of sociological study due to its impact on global trade and economic growth (Vukić et al., 2018). From a sociological perspective, the development of the port industry reflects society's changing attitudes towards commerce and globalisation (Janardhan, 2019). Historically, ports were centres of power for coastal cities and nations. As societies became more interconnected through trade and transportation, ports became gateways to the global economy (Kim et al., 2016).

The sociological development of the port industry has also been shaped by technological advances, such as containerisation and automated systems, which have led to increased efficiency and productivity (Durán et al., 2021). Furthermore, the concept of port cities as cultural melting pots has facilitated the development of a globalised society by fostering cross-cultural interaction and exchange (Scholars Strategy Network, 2018). This has also significantly impacted port cities' and surrounding communities' social and economic development. The sociological impacts of port development can be seen in the social and economic changes within port communities. As ports have grown in size and importance, they have often attracted migrants seeking employment, creating diverse communities with unique social dynamics (Natteboom, 2009). The port industry is undergoing significant sociological developments that reflect the changing nature of global trade and economic development. While these changes present opportunities for innovation and growth, they also pose challenges in terms of labour relations, urban planning, and social and environmental sustainability.

Demography

The demographic developments in the port industry reflect the changing trends in global trade and the dynamics of the workforce. The demographic developments in the port industry have played a significant role in shaping the history of global trade and economic growth. The port industry has seen significant demographic changes in recent years due to several factors, including globalisation, technological advancements and changing consumer behaviours (Wu et al., 2022). The port industry has experienced significant growth in trade and shipping activities, particularly in emerging economies (Lam and Yap, 2019), due to changes in (i) **gender diversity** is an important demographic development in the port industry. Historically, the port industry has been male-dominated, but this is slowly changing as more women enter the industry. Many ports are actively promoting gender diversity, with initiatives such as training programs, mentoring, and leadership development opportunities for women, (ii) the **globalisation of the port industry** has led to increased cultural diversity in the workforce. Ports are now home to workers from diverse backgrounds with different languages, customs, and traditions. This diversity has created new challenges for port operators, such as ensuring effective communication and creating a culture of inclusion and respect, and (iii) **increasing labour force diversity**, including changes in workforce demographics such as age, gender and skill level, has led to a need for more flexible and inclusive management practices.

Ethnology

The port industry has played a crucial role in the development of trade and commerce worldwide. Throughout history, ports have served as key entry and exit points for goods, people, and cultures. In contrast to historical ports, which were often integrated with the surrounding communities and served as cultural melting pots, modern mega ports have been conceived as gated industrial complexes designed to facilitate the efficient movement of goods. However, the development of ports is not solely a technological or economic process; it is also grounded in cultural and social factors (De Martino, 2020). For example, the ethnological development of ports in different parts of the world has been impacted by factors such as regional cultural practices and beliefs about work and commerce and national and international policies shaping port development (Chang and Chang, 2012). Understanding the cultural and social factors that have influenced the development of ports is critical for policymakers and port managers seeking to foster sustainable development in their communities (Boza et al., 2017).

Workforce diversity is also an important ethnological development in the port industry. Historically, the port industry has been male-dominated, with few opportunities for women and minorities. However, there has been a concerted effort to promote diversity and inclusivity in the industry in

recent years. They have implemented various programmes and initiatives aimed at encouraging women and minorities to pursue careers in the port sector. These efforts include training programs, mentorship opportunities, and scholarships to support individuals from underrepresented groups. By providing access to education, skills development, and mentorship, ports aim to create a more inclusive and diverse workforce. Promoting workforce diversity in the port industry brings numerous benefits. Firstly, it expands the talent pool and increases the potential for innovation and creativity. Diverse perspectives and experiences foster new ideas and approaches, leading to improved problem-solving and decision-making within port operations. Additionally, diverse workforces enhance cultural sensitivity and understanding, allowing ports to better serve their diverse clientele and international partners.

Moreover, fostering diversity in the port industry contributes to economic growth and social development. By breaking down barriers and creating equal opportunities, ports can tap into a broader pool of talent, resulting in increased productivity and competitiveness. Additionally, providing women and minorities with meaningful employment in the port industry helps to reduce socio-economic disparities and promotes social inclusion.

2.1.2 Gender-based lens in understanding male predominance in the port industry

The port industry is predominantly male-dominated, with men occupying most of the positions in the industry, including top management roles, dockworkers, and sailors. Understanding this phenomenon through a gender-based lens provides a useful framework for understanding the underlying factors that contribute to male predominance in the port industry. The gender-based lens recognises that gender roles and stereotypes play a significant role in shaping the dynamics of different industries and workplaces. In the case of the port industry, gender stereotypes may have contributed to the marginalisation of women in this field.

Given the historically male-dominated nature of labour-intensive industries, including the port industry, gender norms and expectations may play a role in perpetuating this imbalance (MacNeil and Ghosh, 2017). Feminist economists have identified several factors that contribute to the gender wage gap and occupational segregation in male-dominated industries. One key factor is the universal tendency towards gendered job segregation, as noted by (Anker et al., 2003). This tendency towards gendered job segregation is further reinforced by the societal norms and expectations regarding men's and women's roles in the workplace (Michel, 2020). One major factor contributing to the gender imbalance in the port industry is gender stereotypes and societal expectations. Gender stereotypes are deeply ingrained in many societies and often dictate what is considered appropriate behaviour and

roles for men and women. In the case of the port industry, the perception that physical strength and toughness are essential traits for the job has led to the exclusion of women from the industry. The stereotype that women were physically weaker than men was used to justify the idea that women were not fit for physically demanding jobs like those in the port industry (MacNeil and Ghosh, 2017).

Gender bias in recruitment and promotion practices can also contribute to male predominance in the port industry. Hiring managers and recruiters may unconsciously favour male candidates over female candidates due to gender bias, leading to fewer women being hired for jobs in the industry. Similarly, promotion practices in the industry may favour male employees over female employees, leading to fewer women in management positions. This also contributes to the lack of diversity in the industry's recruitment and retention policies. Many port employers tend to rely on word-of-mouth recruitment or hire based on personal connections, which can lead to a lack of diversity in the workforce (Pastra and Swoboda, 2021).

Moreover, the port industry has historically been male-dominated, which means that the existing culture and norms may not be welcoming or inclusive of women. This can create a hostile or unwelcoming work environment that discourages women from pursuing careers in the industry. Additionally, the lack of female role models and mentors in leadership positions can make it difficult for women to envision themselves in leadership roles within the industry (Sanrı, 2022).

The gender-based lens provides a valuable perspective for understanding the male predominance in the port industry. By recognising the role of gender stereotypes and discrimination, and implementing policies and programmes that promote diversity and inclusivity, it is possible to create a more equitable and inclusive workplace that benefits everyone.

2.2 Perception of the community in topics related to port industry progression

The perception of the community plays a crucial role in the port industry's progression. The industry's impact on the local economy, environment, safety, and community relations can shape the community's perception of its progress. Therefore, the industry's efforts to prioritise sustainability, safety, and community engagement can help build trust and support among the community and promote positive perceptions of its progression.

Communities are critical stakeholders in the port industry. They are directly affected by the industry's activities, and their perception of the industry can influence government policies, regulations, and investment decisions. In recent years, there has been increasing attention to the role of communities in shaping the future of the port industry. Several factors influence communities' perceptions

regarding the industry's progression, including environmental impacts, economic benefits, employment opportunities, and social impacts (Felício et al., 2022).

One of the key factors influencing the community's perception of the port industry's progression is its impact on the local economy. Ports are major economic drivers, providing jobs and supporting local businesses. The community's perception of the industry's progress is often linked to its perception of the local economy's health. If the community perceives the port industry as thriving and contributing to the local economy's growth, it is likely to view the industry positively. The port industry provides direct and indirect employment opportunities for communities. Direct employment opportunities are in cargo handling, shipping, logistics, and maintenance, while indirect employment opportunities are in transportation, retail, and hospitality. The perception of communities regarding the industry's employment opportunities can be positive or negative, depending on the level of skill required, job security, and the impact on the local labour market. The industry has responded by investing in training and education programmes to develop a skilled workforce, creating stable job opportunities, and collaborating with local communities to support workforce development.

One of the most significant concerns of communities related to the port industry is the potential environmental impacts of the industry's activities. The industry's operations, such as cargo handling, dredging, and ship emissions, can negatively affect air and water quality, noise pollution, and the natural environment. Communities are increasingly concerned about the impact of the industry on their health, safety, and quality of life (Mthembu and Chasomeris, 2022). The perception of communities regarding the industry's environmental impact can be positive or negative, depending on the measures taken to mitigate these impacts (Stan, 2022).

The study of communities in maritime traffic, particularly in the context of port industry progression, has drawn increasing attention from researchers in recent years (Lloyd's Register, n.d.). One topic of interest in this area is communities' perception of the changes brought about by the port industry progression. This area of research seeks to understand how communities perceive the benefits and drawbacks of port industry progression, such as increased traffic volume, pollution regulations, and technological advancements. The port industry's safety record is another crucial factor that can shape the community's perception of its progression. Safety incidents such as spills, fires, and accidents can significantly impact the industry's reputation and public perception. Therefore, the industry's efforts to prioritise safety and implement best practices can help build trust and support in the community. The port industry's relationship with the local community is also vital in shaping perception. Community engagement, open communication, and transparency can help build trust and promote

positive perceptions of the industry's progression. Additionally, the industry's efforts to address community concerns and prioritise social responsibility can help enhance its reputation and public perception.

5. Women's roles in energy transition and innovation

The global energy environment is experiencing fundamental change, with the need to transition to sustainable and renewable energy sources becoming more pressing than ever. As the globe moves towards cleaner energy solutions, women are increasingly taking the lead in pushing innovation and adopting sustainable practices in the port sector, with a rising acknowledgement of the contributions that women can make.

Women can play a broad range of roles in port innovation and energy transition, including coordinating and facilitating the adoption of novel technologies. By establishing an innovation network in which women are essential players and decision-makers, port authorities may play a critical role in the development of a regional innovation system.

Governments and public policy, according to a study on speeding a clean energy transition in Southeast Asia (Aleluia et al., 2022), play a critical role in the transition to renewable energy. This shows that women in administration and policy roles may have an impact on port energy transitions.

Furthermore, in a study on green transition and gender prejudice, Arias et al. (2023) examined the participation of women in renewable energy generation firms in Latin America and the Caribbean. According to the study, renewable energy enterprises with the largest female participation had the highest relative efficiency in the labour-capital ratio.

Another study looked at the role of women in guaranteeing justice during the energy transition in ASEAN and G7 countries (Sumarno et al., 2023). According to the study, women's engagement in just energy transition is critical, yet they are underrepresented in the energy industry. The study encourages women's participation in a just energy transition and seeks to reconcile justice and inclusivity in the energy transition from upstream and downstream ASEAN beneficiaries with G7 examples. Women may play important roles in energy transition and port innovation, including leadership and management, training and education, and technology and engineering.

Leadership and management: Women's leadership in energy transition and innovation in ports is crucial for driving positive change, fostering sustainability, and creating a more inclusive and forward-thinking industry.

Breaking stereotypes and entering technical professions: The port industry's technical sector is fast evolving as more women break stereotypes and enter historically male-dominated professions such as engineering, environmental sciences, and renewable energy technologies. Their presence contributes a variety of viewpoints, inventiveness, and problem-solving talents, which eventually benefits the development of sustainable practices within ports.

STEM education promotion and mentorship: It is critical to inspire and empower the next generation of women to continue the momentum of their participation in the energy transition and port innovation. Women in the sector are actively committed to encouraging young girls to seek professions in energy and port-related fields by supporting STEM (Science, Technology, Engineering, and Mathematics) education. Guenaga et al. (2022) examined the effects of a group mentorship programme directed by a female STEM role model on the young people who took part in the programme, as well as whether or not these effects varied depending on the participants' gender. The authors demonstrated how the mentorship sessions changed their perspectives on technology, self-efficacy in mathematics, gender stereotypes, allusions to science and technology, and professional choices. According to a report by the International Labour Organisation (ILO) titled Women in STEM Workforce Readiness and Development Programme in Indonesia (ILO, 2021), a programme has been implemented to increase productivity and prevent women from losing their employment as a result of automation in various sectors. This programme aims to strengthen ties between private-sector businesses, social partner institutions, and vocational training facilities to increase women's access to STEM-related jobs and their retention and advancement. Furthermore, mentorship programmes headed by women provide important assistance and direction to ambitious professionals, establishing a nurturing environment in which talent can blossom.

Engineering and Design: Women can work as engineers and designers to develop and optimise energy-efficient port infrastructure and processes. This includes creating eco-friendly port facilities, green buildings, and sustainable transportation systems within the port.

Research and Development (R&D): Women can make important contributions to R&D efforts in developing sustainable and renewable energy solutions for port operations. They may be involved in designing and implementing technologies such as solar, wind, or wave energy systems and investigating new energy storage methods.

Policy and Advocacy: Women can help shape energy policy and advocate for environmentally friendly practices in the port and maritime industries. They can get involved in organisations and activities that promote cleaner energy and lower pollution.

2.3 Inclusion of women and underrepresented communities

2.3.1 Challenges and Opportunities

In recent years, there has been a growing recognition of the importance of diversity and inclusion in the workplace, and the port industry is no exception, given that historically, the industry has been male-dominated, with a limited representation of women and underrepresented communities. One of the main challenges in the inclusion of women and underrepresented communities in the port industry is the perception that it is a male-dominated industry. This perception can discourage women and underrepresented communities from pursuing careers in the industry. The industry's lack of role models and mentors can also be a barrier to entry for these groups. Additionally, the physical demands of some jobs in the industry, such as loading and unloading cargo, can be a deterrent for women.

This lack of diversity and inclusion can have a negative impact on the industry's growth, innovation, and overall success. As such, there has been a growing push towards the inclusion of women and underrepresented communities in the port industry, recognising the valuable contributions they can make and the benefits of a diverse workforce (Barreiro-Gen et al., 2021). Women's participation in the maritime industry has been reported to be fairly limited in many parts of the world and both horizontal and vertical segregations can still be observed even today (Kitada, 2009; Kitada and Bhirugnath-Bhookhun, 2019).

This topic encompasses various issues, such as increasing the number of women and minorities in port-related jobs, providing equal opportunities and fair treatment, promoting diversity and inclusivity in leadership roles, and addressing the unique challenges faced by these groups in the industry. In this context, it is important to understand the current state of the industry and the various initiatives aimed at promoting inclusion and diversity, as well as the challenges that still need to be addressed.

The inclusion of women and underrepresented communities in the port industry has become a critical issue. Women constitute a significant portion of the global population, and their contributions to the workforce cannot be ignored. Similarly, underrepresented communities bring unique perspectives and experiences to the table, which can help businesses to grow and thrive (Hoobler et al., 2018).

The benefits of diversity in the port industry are numerous. First and foremost, a diverse workforce can bring a range of perspectives and experiences to the table, which can help businesses to understand their customers better and adapt to changing market conditions. Additionally, diversity can lead to increased creativity and innovation, as individuals with different backgrounds and experiences are more likely to approach problems from unique angles (Turnbull, 2013).

Various governmental initiatives, including laws promoting gender equality, have been implemented to initiate the process of reducing gender segregation and enhancing the existing work environments. However, there is a need for more comprehensive measures to break down access barriers to jobs and facilitate the retention of underrepresented genders. It is crucial to integrate such efforts since ad hoc initiatives are usually not effective in decreasing gender segregation (Dragomir, 2018). Despite the benefits of diversity, however, women and underrepresented communities continue to face barriers to entry into the port industry. One of the main challenges is the lack of female role models in leadership positions. Without visible female leaders, women may struggle to see a path forward in the industry and may be less likely to pursue careers in port-related fields (Kim et al., 2019).

This research shows that European ports have engaged in measures aimed at reducing gender segregation, and the research found that men and women tend to do different jobs in ports due to traditions and culture (Barreiro-Gen et al., 2021). This was in good agreement with other reports published in the literature (Struthers and Strachan, 2019).

Gender segregation, compliance, gender equity, and gender equality play significant roles in the sustainability of ports, Figure 3. Historically, the port industry has been characterised by gender segregation, with certain roles predominantly filled by men and others by women. This segregation limits opportunities for women to access higher-level positions and contributes to gender disparities in the industry. Addressing gender segregation is crucial for promoting sustainability in ports. Breaking down these barriers allows for the utilisation of the full potential of the workforce, leading to increased productivity and innovation.

Compliance with gender equality regulations and international frameworks is essential for fostering sustainability in ports. Governments and port authorities need to implement and enforce legislation and policies that promote gender equality and prohibit discrimination. This includes addressing issues such as pay gaps, workplace harassment, and unequal opportunities for career advancement. Compliance with gender equality standards ensures that ports create a fair and inclusive environment that supports the well-being and professional growth of all employees.

Gender equity involves providing fair and impartial opportunities, resources, and support to individuals regardless of their gender. Promoting gender equity in the port industry entails addressing the underlying factors that contribute to gender disparities, such as bias and stereotypes. This can be achieved through targeted initiatives, including mentorship programs, training opportunities, and career development support for women in traditionally male-dominated roles. By striving for gender equity, ports create a sustainable, inclusive work environment that attracts and retains diverse talent.

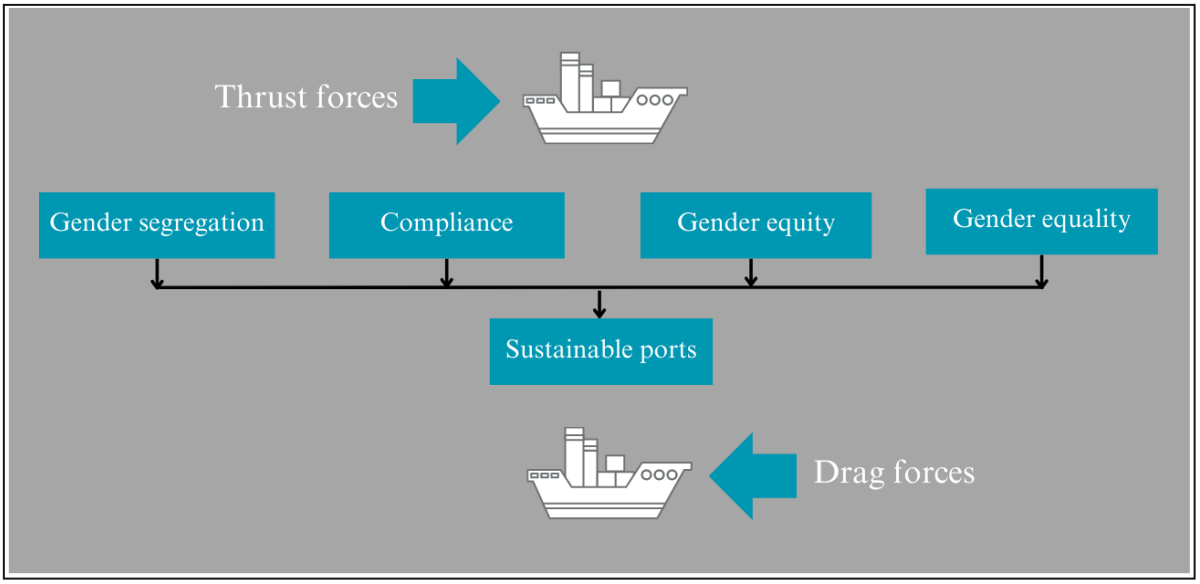

Figure 10: Gender equality for sustainability in ports
Adapted from (Barreiro-Gen et al., 2021)

Gender equality goes beyond gender equity and aims for equal rights, opportunities, and treatment for individuals of all genders. Achieving gender equality in the port industry is fundamental to its sustainability. This involves eliminating discriminatory practices, ensuring equal pay for equal work, and providing equal opportunities for career advancement. Ports can work towards gender equality by fostering a culture of inclusivity, actively challenging gender biases, and promoting diversity at all levels of the organisation.

By addressing gender segregation, ensuring compliance with gender equality regulations, promoting gender equity, and striving for gender equality, ports can create a more sustainable and thriving industry. Gender diversity and inclusivity foster innovation, enhance decision-making processes, and improve organisational performance. Furthermore, promoting sustainability in ports through a gender lens contributes to the broader goals of social responsibility and economic development within the industry and the communities they serve.

Despite the overall progress reported in customary gender equality indicators, women's empowerment and contribution to economic growth are still limited in reality (Kitada and Bhirugnath-Bhookhun, 2019).

In this vein, how can we operationalise women's contribution to economic growth? In the maritime sector, which is known as a traditionally male-dominated industry, research on women's empowerment to support the maritime economy is scarce. Bhirugnath-Bhookhun and Kitada (2017) recognise women managers' important role in boosting the maritime economy in Southern and Eastern Africa.

Advancement of technology through innovation is expected to increase the mobility of people, assets and information across traditional borders and boundaries. Consequently, the contribution of these technological advancements in breaching the reported gender disparity or unreported gender parity can only be underscored. As such, future maritime clusters, which integrate gender-based components, will potentially grow further and add value to this age-old concept in its contribution to economic growth. However, its ultimate growth will depend on the capacity of maritime industries to accept diversity and innovative ideas, particularly in embracing the potential of women professionals and going beyond business as usual (Kitada and Bhirugnath-Bhookhun, 2019).

The maritime industry requires a workforce with advanced technical skills. To encourage more women to pursue careers in this field, the industry and regulatory bodies must take a comprehensive and proactive approach to address gender role bias issues and create physical working conditions that are suitable for both genders. This includes providing women with the necessary skills for the future and fostering their self-efficacy and interest in pursuing maritime careers (Kim et al., 2019).

Despite these challenges, there are also opportunities for the inclusion of women and underrepresented communities in the port industry. The industry is facing a labor shortage, and there is a growing need for skilled workers. This presents an opportunity for the industry to tap into a broader pool of talent by recruiting and retaining women and underrepresented communities. By doing so, the industry can benefit from a wider range of skills and perspectives, which can lead to greater innovation and success.

Furthermore, there is increasing recognition of the benefits of diversity and inclusion in the workplace. Companies that prioritise diversity and inclusion are more likely to attract and retain top talent, have higher employee engagement, and be more innovative and successful. Inclusion can also lead to better decision-making by bringing together diverse perspectives and experiences.

To promote the inclusion of women and underrepresented communities in the port industry, there are several strategies that can be employed. Firstly, companies can prioritise diversity and inclusion in their recruitment and hiring practices. This can include reaching out to underrepresented groups and providing training and development programmes to support their career advancement. Secondly, companies can implement policies and practices that support work-life balance, such as flexible working arrangements and parental leave. Thirdly, companies can establish mentorship and networking programmes that provide women and underrepresented communities with the support and guidance they need to succeed in the industry. Finally, companies can prioritise diversity and

inclusion in their leadership development programs, ensuring that women and underrepresented communities are given equal opportunities to advance into leadership positions.

The inclusion of women and underrepresented communities in the port industry is essential for the industry's success and growth. While there are challenges to achieving this goal, there are also significant opportunities for the industry to benefit from a more diverse and inclusive workforce. Companies can promote inclusion by prioritising diversity in their recruitment and hiring practices, implementing policies that support work-life balance, establishing mentorship and networking programs, and prioritising diversity and inclusion in their leadership development programs. By doing so, the industry can tap into a broader pool of talent and improve its competitiveness in the global economy.

2.3.2 Women in the port of the global supply chain

Over the years, the roles of women in the global supply chain have evolved significantly. The port industry, which is a crucial component of the global supply chain, has seen an increase in the number of women employed in various roles. Traditionally, the port industry has been dominated by men, and women's participation was limited to administrative and clerical roles. However, in recent years, women have increasingly taken up roles in operational and technical areas, such as crane operators, stevedores, port engineers, and logistics coordinators.

The global supply chain is a complex system of networks, processes, and people that ensure that goods are produced, transported, and delivered to consumers worldwide. It involves numerous industries, including shipping, logistics, manufacturing, and retail. Women have always been integral to this system, working in various roles across different industries (Koberg and Longoni, 2019). However, women's participation in the global supply chain is still relatively low, particularly in the maritime industry. According to the International Maritime Organisation, women represent only 1.2% of the maritime seafarer workforce worldwide. This lack of female representation is particularly striking given the sector's increasing demand for skilled labour.

The importance of diversity and the roles of women in maritime shipping is huge. Despina Panayiotou Theodosiou, President of WISTA International, commented: “The recognition of the vital roles women play in the maritime world has been thrown into even greater perspective by the global pandemic. The importance of the contribution everyone plays in the shipping world, the ports sector and the wider maritime industry cannot be undervalued – and women are an integral part of the solutions that the

global economy needs as the slow recovery continues" (https://grrip.eu/the-importance-of-women-in-maritime/).

Women are also making significant contributions in the management and leadership roles in the port industry. They are breaking down barriers and challenging gender stereotypes, leading to increased diversity in decision-making positions. In addition to the benefits of diversity and inclusivity, having more women in the port industry has economic advantages. A study by the International Transport Forum found that increasing women's employment in the transport sector could lead to a $30 trillion increase in global GDP by 2025.

Women play a crucial role in the port of the global supply chain, but they face various challenges that limit their employment and career advancement opportunities. These challenges include discrimination, harassment, and lack of representation. To overcome these challenges, it is important to provide women with access to training and educational opportunities and to create a supportive and inclusive work environment. By doing so, we can create a more diverse and inclusive workforce in the port of the global supply chain. UNCTAD (2021) (United Nations Conference on Trade and Development) studied the business case for diversity in the Indian maritime industry. It was reported that, while companies often viewed diversity as a moral obligation, they tended to overlook its potential positive impact on business outcomes. Besides, after interviews with HR heads, CEOs, and experts, the study found that companies generally lacked data connecting diversity to financial performance.

Gender equality is an important aspect of the global supply chain, which refers to the network of companies, organisations, and individuals involved in the production and distribution of goods and services around the world. Despite progress in recent years, gender inequality remains a significant challenge in many parts of the supply chain, particularly in manufacturing, agriculture, textiles, and the port industry. A gender perspective is vital to fully understanding and conceptualising global value chains, their power structures, division of labour, welfare effects and empowerment (Schumacher, 2014). Gender equality is a fundamental human right that is critical for the growth and development of every society. Despite the progress made over the years, there are still significant gender gaps in various industries, including the global supply chain (Gonzalez et al., 2015). The supply chain is an interconnected network of companies involved in producing, transporting, and distributing goods and services. This complex system spans multiple industries and geographies, with numerous players involved in each stage of the process (Barrientos et al., 2019). Global networks are socially located and involve men and women embedded in their social networks with individual opportunities and

restrictions or exclusions from particular fields of productive activities (Schumacher, 2014). The dimension of gender equality in the global supply chain is a complex issue requiring a multifaceted approach. Historically, women's participation in the supply chain workforce has been limited to low-paying and low-skilled jobs (Vijeyarasa, 2020). However, recent years have shifted towards more significant female representation in higher-skilled roles such as engineering, management, and technology (Prieto-Carrón, 2008).

One of the key dimensions of gender equality in the global supply chain is access to employment opportunities. Women are often excluded from certain jobs or industries due to cultural, social, or economic factors, which can limit their ability to earn a living wage and contribute to the overall economic growth of their communities. Moreover, women with access to employment opportunities in the supply chain may face discrimination in hiring, promotion, or pay, further exacerbating gender disparities.

Figure 11 highlights the significant disparity between men and women in the maritime industry, as reported by (Sandvick, 2019), specifically in supporting line positions and operative line positions. The data reveals that women are underrepresented in these roles compared to men. In supporting line positions, where roles involve functions such as administrative support, logistics coordination, and customer service, women represent only 13% of the workforce, while men make up 49%.

This gender disparity may stem from various factors, including social norms, cultural biases, and historical gender stereotypes that have associated certain roles within the industry as more suitable for men. Addressing this disparity requires concerted efforts to challenge these stereotypes and promote equal opportunities for women to pursue and succeed in supporting line positions. Similarly, in operative line positions, which encompass tasks related to cargo handling, vessel operations, and maintenance, women comprise a mere 5% of the workforce, while men account for 39%. The low representation of women in these roles can be attributed to physical demands, perceived occupational hazards, and the prevalence of male-dominated work environments. Achieving gender balance in operative line positions necessitates creating an inclusive and supportive atmosphere that encourages women's participation, addresses safety concerns, and provides equal access to training and career advancement opportunities.

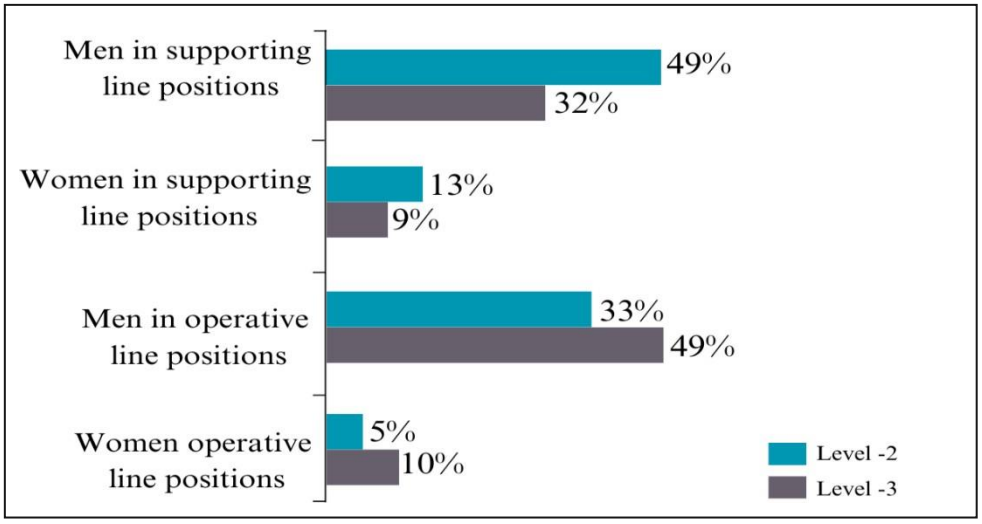

Figure 11: Management employees in the maritime industry
Source: (Sandvik, 2019)

To bridge these gender gaps, various strategies can be employed. Increasing awareness about the diversity of roles and career paths available within the maritime industry can help challenge stereotypes and attract more women to these traditionally male-dominated positions. Implementing proactive recruitment and mentorship programmes can provide support and guidance to women seeking careers in supporting and operative line positions. Additionally, promoting workplace policies and initiatives that foster gender equality, such as flexible work arrangements, equal pay, and zero-tolerance policies against gender-based discrimination and harassment, are essential for creating an inclusive work environment that values and respects the contributions of all employees.

Another critical challenge facing women in the supply chain is the gender pay gap. Women in the supply chain typically earn less than their male counterparts, even when performing the same job (Islam, 2008). This pay gap is particularly prevalent in developing countries where there are limited regulations to enforce gender pay equity. The gender pay gap has a cascading effect on women's economic empowerment, as it limits their ability to achieve financial independence and economic mobility (Szymczak et al., 2022).

Another critical dimension of gender equality in the global supply chain is access to education and training. A lack of education and training opportunities often limits women's participation in the supply chain (Grønning et al., 2020). In many countries, girls have limited access to education, which limits their ability to acquire the skills needed to participate in higher-skilled supply chain roles. Additionally, women often face cultural barriers that discourage them from pursuing non-traditional roles in male-dominated industries (Rubin and Manfre, 2014).

Addressing gender inequality in the supply chain requires a multi-stakeholder approach (van Zyl and Mans-Kemp, 2022). Governments, NGOs, and the private sector all have a role to play in promoting gender equality in the supply chain. Governments can implement policies and regulations that promote gender equity, such as laws mandating gender pay equity and quotas for female representation on boards (Grosser, 2009). NGOs can work with local communities to provide education and training opportunities for women (Kumi and Elbers, 2022), while the private sector can implement policies and practices that promote gender equity in the workplace (Finley et al., 2022).

One way that the private sector can promote gender equality in the supply chain is by implementing supplier diversity programmes (Miguel and Tonelli, 2023). These programmes aim to increase the number of women-owned businesses in the supply chain by setting procurement targets and providing support and training to women entrepreneurs. Supplier diversity programmes not only promote gender equality but also help to create a more diverse and inclusive supply chain, which is beneficial for business performance (Worthington et al., 2008).

Gender equality is a critical dimension of the global supply chain that requires a multifaceted approach to address. Addressing gender inequality in the supply chain requires the involvement of all stakeholders, including governments, NGOs, and the private sector. Promoting gender equality in the supply chain benefits women and creates a more diverse and inclusive supply chain, which is beneficial for business performance. By working together, we can create a more equitable and sustainable supply chain for all.

Women's rights and the policies supporting empowerment

In recent decades, the global community has made significant strides towards achieving gender equality and promoting women's empowerment. However, despite these efforts, women still face systemic barriers in many areas of life, including access to education, healthcare, employment, and political representation. Realising women's rights and empowerment requires comprehensive policy interventions that address the root causes of gender inequality and provide women with the tools and opportunities they need to thrive. Women's rights and empowerment have been at the forefront of global discussions for decades, and with good reason. Women make up a significant portion of the global workforce, particularly in the manufacturing and supply chain industries. Women often face discrimination and inequality in the workplace, which can limit their economic opportunities and impede their ability to reach their full potential (Prieto-Carolino et al., 2021).

Women's rights and gender equality are crucial issues that need to be addressed in the global supply chain industry. Recently, there has been an increased focus on policies and initiatives supporting women's rights and empowerment in the global supply chain. These policies address the systemic issues hindering women's progress and create a more equitable and inclusive workplace (George et al., 2017).

The United Nations Sustainable Development Goals (UN SDGs) are a set of 17 global goals that aim to address the world's most pressing challenges, including poverty, inequality, and climate change, by 2030. One of these goals, Goal 5, specifically focuses on achieving gender equality and empowering all women and girls. It recognizes gender equality as a fundamental human right but alsoa fundamental human right and a fundamental human right and a foundation for a peaceful, prosperous, and sustainable world. It aims to end all forms of discrimination, violence, and harmful practices against women and girls and ensure their full participation and equal opportunities in all areas of life. One such policy is the UN Women's Empowerment Principles, which provide a framework for businesses to promote gender equality and empower women in the workplace (de Souza Mauro et al., 2019). These principles include measures such as promoting women's leadership and development, ensuring equal pay for equal work, and implementing policies to prevent discrimination and harassment.

Another policy that has gained momentum in recent years is the Women's Empowerment in Agriculture Index (WEAI), which measures the empowerment of women in the agricultural sector (Malapit et al., 2019). The WEAI assesses factors such as access to resources, decision-making power, and control over income and assets. The index has been used to inform policies and programmes that support women's empowerment in agriculture, such as improving access to credit and training. In addition to these policies, there are also numerous initiatives and programmes that support women's empowerment in the global supply chain. For example, the International Finance Corporation (IFC) has launched a programme called "SheWorks" (Datta and Kotikula, 2017) which supports businesses in creating more opportunities for women in their workforce. The programme provides tools and resources for businesses to promote gender equality and support women's career development. In addition to these initiatives, many companies in the global supply chain industry have implemented their initiatives to support women's empowerment. For example, some companies have established women's leadership programmes to help women advance into leadership roles. Others have implemented flexible work arrangements to support working mothers and allow them to balance their work and family responsibilities. Some companies have also implemented initiatives to address the specific challenges faced by women in the industry, such as the gender pay gap and sexual harassment.

For example, some companies have conducted gender pay audits to identify and address any pay disparities between men and women. Others have implemented anti-harassment policies and training programmes to prevent and address sexual harassment in the workplace. Despite the progress that has been made in recent years, much work still needs to be done to ensure women's rights and empowerment in the global supply chain. Some of the key challenges that remain include the lack of access to education and training for women, as well as the persistence of discriminatory attitudes and practices in the workplace (Cornwall, 2016). To address these challenges, it is essential to prioritise policies and initiatives supporting women's empowerment in the supply chain. This includes investing in education and training programmes that provide women with the skills and knowledge they need to succeed in the workforce. It also means addressing the cultural and societal factors that contribute to gender inequality and discrimination, such as unconscious bias and stereotypes (Shackleton et al., 2011). Women's rights and gender equality are crucial issues that need to be addressed in the global supply chain industry. While various policies and initiatives have been implemented to support women's empowerment, there is still much work to be done to achieve gender equality in the industry. It is essential to continue to promote policies and initiatives that address the root causes of gender inequality and provide women with the resources they need to succeed.

2.4 Conclusions to part two

In conclusion, this part (SEANERGY PROJECT Subtask 1.1.2) aimed to comprehensively understand the sociocultural and behavioural aspects influencing the port industry's clean energy and fuel transition. The deliverable shed light on the male predominance in the port industry by examining the industry's progression in economics, politics, sociology, demography, and ethnology through a gender-based lens. The analysis[3] has revealed that the port industry has traditionally been male-dominated, and several factors contribute to this predominance. These factors include gender biases, cultural norms, and a lack of representation in leadership positions. In order to ensure an inclusive, successful transition towards clean energy and fuels, stakeholders must address these issues and promote diversity and inclusivity in the workforce.

Based on the desk research, the following recommendations have been proposed for stakeholders' strategies on technology integration and inclusion:

- Develop and implement gender-responsive policies and practices in the port industry to ensure equal opportunities for all individuals, regardless of their gender.

[3] The forthcoming online surveys will definitely provide valuable insights into the community's perception of the port industry's progression

- Enhance diversity in decision-making processes by ensuring women and underrepresented communities have a seat at the table.
- Invest in education and training programmes that promote skill development and capacity building for women and underrepresented communities, fostering a more diverse talent pool.
- Encourage mentorship and networking opportunities to support women and underrepresented individuals in advancing their careers in the port industry.
- Address any existing gender pay gaps by regularly reviewing compensation and benefits packages to ensure fairness and equity.
- Foster a supportive and inclusive work environment by promoting awareness and addressing unconscious biases and discrimination.

By adopting these recommendations, stakeholders can drive meaningful change towards a more inclusive port industry that effectively integrates clean energy and fuels. This, in turn, will contribute to a more sustainable and socially responsible future for the port and port logistics sectors.

3 Final Conclusion

As we conclude this comprehensive analysis, it is clear that the path towards sustainable and inclusive port operations is multi-faceted. This project has intricately delved into the three crucial aspects that will contribute to this transition: addressing the barriers to and solutions for ports' energy transition, understanding the sociocultural and behavioural aspects affecting the port industry's progression, and identifying key tools and certifications to guide this transition. By interlinking the conclusions and recommendations of each part, the overarching vision of this research begins to take shape.

The first part of this deliverable underscored the pressing need for ports to transition towards cleaner and sustainable energy sources, making it a non-negotiable aspect of the maritime industry's future. Addressing the barriers to this transition, such as market failures, hidden costs, access to capital, and more, is crucial for implementing effective strategies. However, the solution does not solely lie in overcoming these barriers. Ports need to set ambitious renewable energy targets, foster public-private partnerships, develop incentives and subsidies, embrace technological innovation, and engage with

stakeholders. Moreover, these practices will ensure environmental benefits and unlock long-term economic advantages and societal gains.

The second part seeks into the sociocultural and behavioural aspects influencing the port industry's clean energy and fuel transition. Despite male predominance being a longstanding issue in the port industry, promoting diversity and inclusivity in the workforce has now become an integral part of the path towards clean energy and fuels. From the gender-based analysis of the industry's progression, it is recommended to develop gender-responsive policies, enhance diversity in decision-making processes, and address pay gaps. The port industry will be better equipped to drive a sustainable and socially responsible future by adopting these recommendations.

The third and final part underlines the crucial role of key tools and certifications in facilitating the green transition. These tools and certifications help to ensure compliance with international regulations and industry best practices. Stakeholders are encouraged to adopt these tools and certifications and share knowledge and best practices. It is also recommended to provide financial and technical assistance to stakeholders, especially small and medium-sized ports, and advocate for the development of international standards and regulations.

In conclusion, it is evident that the transition to a sustainable port and maritime industry is not solely an environmental imperative but also a social and economic necessity. The energy transition in ports, including diverse workforces, and adopting key tools and certifications are all essential components of this transition. By integrating the conclusions and recommendations from this deliverable, the port industry is anticipated to be better equipped to move towards more sustainable operations, fostering a greener, more inclusive, and economically prosperous future.

Appendixes

Appendix 1 Survey questions conducted by WMU for Part One of this deliverable

Title: Port energy transition: Investigation of ports stakeholders' barriers and solutions

Introduction

Dear Sir/Madam,

This questionnaire is developed by the World Maritime University (WMU) in Malmö, Sweden. As you may be aware, WMU was established in 1983 by the International Maritime Organization (IMO) - a specialized agency of the United Nations - as a premier centre of excellence for maritime postgraduate education, research, and capacity building.

This questionnaire is part of the Sustainability Educational Programme for Greener Fuels and Energy on Ports (SEANERGY) project. WMU is a partner in the SEANERGY team along with 12 European partners from 9 countries. SEANERGY has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 101075710. The SEANERGY project sets out to support the transition of ports towards zero-emission, green energy hubs that use hydrogen, integrated electricity systems, and other low-carbon fuels. For further information on SEANERGY, you can kindly refer to the project website: Seanergy Project – Greener Fuels and Energy on Ports. This questionnaire seeks to investigate the barriers that port's stakeholders have with respect to port energy transition. While we aim to understand the barriers. we also intend to highlight the significance of stakeholders and finding some solutions to identified barriers. The questionnaire consists of 4 questions in 3 sections. Section 1 contains two background questions and another question about rating the significance of port's stakeholders to the energy transition, Section 2 contains a question regarding stakeholder's barriers with the scope of port energy transition, and Section 3 contains a question about expected solution for the stakeholder's barriers. We sincerely invite you to support this research project and participate in completing the questionnaire which should take about 10-13 minutes. There is no right or wrong answer. Kindly answer all questions from your organizational experience. Should you have any questions or require any additional clarification, please feel free to contact Anas Alamoush atasa@wmu.se. The accompanying consent form specifies the confidentiality clauses relating to the answers provided by you. Thanking you.

Yours sincerely
Anas Alamoush
Research Assistant/PhD candidate
World Maritime Universityasa@wmu.se

Consent Form

Dear Participant,

The information provided by you in this questionnaire will be used for research purposes and the results will form part of a deliverable and a journal paper, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted. Anonymised research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as the project is complete. Your participation in the questionnaire is highly appreciated. The World Maritime University I consent to my personal data as outlined above, being used for this research. I understand that all personal data will be held and processed in the strict confidence and deleted at the end of this research.

1. Yes, I want to continue
2. No, I want to quit

Section 1: Stakeholders

Please select your country

Please select the port's stakeholder category that you belong to:

1. Port managing body (e.g. Public or port authority, port operating companies)
2. Terminal operators
3. Port services providers (e.g. Marine services, customs, coastguards)
4. Maritime authority
5. Ship operator/managing company
6. Port users (e.g. Freight forwarders, ship agents, brokers, road hauliers, railway companies, and logistics providers)
7. Employees and trade unions
8. The financial community (e.g. Banks, insurance companies, stock exchange, credit institution, and investors, ministry of finance, public funds)
9. Local community and societal groups of interest (e.g. city residents, port tenants, None Governmental Organisations (NGOs))
10. Regulators
11. International organisations and trade associations
12. Technology Developers and Manufacturers
13. Energy providers
14. Research and education
15. Energy transition facilitators and third parties (Designers, Architects, Contractors, Construction workers, port project managers, consultants, other service providers)
16. Consumers (e.g. General public, industrial sectors)
17. Media
18. Other, please specify _____

Question 1: Considering that the following stakeholders play a role in port transition to renewable energy and clean fuels, please rate their level of significance in such transition using (1- lowest to 5- highest)

	1	2	3	4	5
Port managing body (e.g. Public or port authority, port operating companies)	❑	❑	❑	❑	❑
Terminal operators	❑	❑	❑	❑	❑
Port services providers (e.g. Marine services, customs, coastguards)	❑	❑	❑	❑	❑
Maritime authority	❑	❑	❑	❑	❑
Ship operator/managing company	❑	❑	❑	❑	❑
Port users (e.g. Freight forwarders, ship agents, brokers, road hauliers, railway companies, and logistics providers)	❑	❑	❑	❑	❑
Employees and trade unions	❑	❑	❑	❑	❑
The financial community (e.g. Banks, insurance companies, stock exchange, credit institution, and investors, ministry of finance, public funds)	❑	❑	❑	❑	❑
Local community and societal groups of interest (e.g. city residents, port tenants, None Governmental Organisations (NGOs))	❑	❑	❑	❑	❑
Regulators	❑	❑	❑	❑	❑
International organisations and trade associations	❑	❑	❑	❑	❑
Technology Developers and Manufacturers	❑	❑	❑	❑	❑
Energy providers	❑	❑	❑	❑	❑
Research and education	❑	❑	❑	❑	❑
Energy transition facilitators and third parties (Designers, Architects, Contractors, Construction workers, port project managers, consultants, other service providers)	❑	❑	❑	❑	❑
Consumers (e.g. General public, industrial sectors)	❑	❑	❑	❑	❑
Media	❑	❑	❑	❑	❑

Section 2: Stakeholders' barriers

Question 2: Please rate (from 1-lowest to 6-highest) the significance of following stakeholder's barriers that hinder ports' energy transition. Please not that: 1- Not at all a barrier, 2- A very low strength barrier, 3- A low strength barrier, 4- A high strength barrier, 5- A very high strength barrier, 6- An extremely high strength barrier, 7- I don't know:

	1	2	3	4	5	6	I don't know
Hidden costs (e.g. transaction costs, contract associated costs, overhead cost for energy management, cost for training personnel, opportunity cost, etc.)	❑	❑	❑	❑	❑	❑	❑
Limited access to capital by ports' authority (or in other word, high capital cost for establishment of green infrastructures)	❑	❑	❑	❑	❑	❑	❑
Information issues including scarce information, inaccurate information, lack of information disclosure and transparency	❑	❑	❑	❑	❑	❑	❑
Misplaced (split) incentives between Port landlord versus port operator (tenant) and subcontractors	❑	❑	❑	❑	❑	❑	❑
Misplaced (split) incentives between Port management versus ship owners versus technology/energy providers	❑	❑	❑	❑	❑	❑	❑
Difficulties in implementing energy (environmental) management system	❑	❑	❑	❑	❑	❑	❑
Inertia (resistance to change) in port management and other stakeholders	❑	❑	❑	❑	❑	❑	❑
Social admissibility for some new technologies at ports in the vicinity of cities is in doubt (e.g. production of Ammonia at ports)	❑	❑	❑	❑	❑	❑	❑
Lack of trained and competent operators at ports	❑	❑	❑	❑	❑	❑	❑
The lack of communication that may result in a failure to identify stakeholders (Interested parties) and their interests	❑	❑	❑	❑	❑	❑	❑
Uncertainties regarding future policies	❑	❑	❑	❑	❑	❑	❑
Regulatory implications, as a result of interaction between different levels of legislation (local, national, regional, and international)	❑	❑	❑	❑	❑	❑	❑
Lack of codes and standards for new burgeoning technologies like	❑	❑	❑	❑	❑	❑	❑

alternative fuels							
Immatureness of technologies (in terms of safety, operation disruption, and doubt in performance)	❑	❑	❑	❑	❑	❑	❑
Inconsistency between port and ships equipment	❑	❑	❑	❑	❑	❑	❑
Lack of physical space in ports	❑	❑	❑	❑	❑	❑	❑

Section 3: Stakeholders' Solutions

Question 3: Up to what extent the following solutions can be helpful for ports and relevant stakeholders to overcome the barriers mentioned in the last question? 1- Not at all an effective solution, 2- A very low effect solution, 3- A low effect solution, 4- A high effect solution, 5- A very high effect solution, 6- An extremely effective solution, 7- I Don't know:

	1	2	3	4	5	6	I don't know
Digitalization to connect ship-port & port-hinterland & inside port actors (for higher data quality and to improve efficiency and data sharing process)	❑	❑	❑	❑	❑	❑	❑
Preliminary studies including Cost-benefit analysis, economic and technical feasibility studies, risk assessment, environmental impact assessment (to mitigate technical risks, investment risks, and environmental risks)	❑	❑	❑	❑	❑	❑	❑
Investment in R&D, and participation in joint research project	❑	❑	❑	❑	❑	❑	❑
Investment in new technologies including renewable source of energy (e.g. wind and solar), green fuels infrastructure, and Shore-Side Electricity (SSE)	❑	❑	❑	❑	❑	❑	❑
Establishment of Environment Management System (EMS) or Energy Management System (EnMS) to support activities such as energy audit, market consultation, design of SMART KPIs, emission inventory, designating energy team, etc.	❑	❑	❑	❑	❑	❑	❑
Financial support by future GHG Fund	❑	❑	❑	❑	❑	❑	❑

as a key solution for development of green infrastructure in ports and supply chain							
Economic models such as Maritime Energy Contracting (MEC) and Energy Supply Contracting (ESC) or economic collaboration of ship owners-shippers-ports-technology providers to invest and run the infrastructures at port	❑	❑	❑	❑	❑	❑	❑
Mandatory green concession contracts (e.g. with terminal operators)	❑	❑	❑	❑	❑	❑	❑
Establishment of codes and standards for new technologies and green fuels	❑	❑	❑	❑	❑	❑	❑
Incentive schemes for ships and rail/road operators	❑	❑	❑	❑	❑	❑	❑
Collaboration between different stakeholders at different level	❑	❑	❑	❑	❑	❑	❑
Role of governments in depicting roadmap, gathering and encouraging stakeholders, simplifying tax procedures, and providing financial incentives or subsidies	❑	❑	❑	❑	❑	❑	❑
Information share and dissemination	❑	❑	❑	❑	❑	❑	❑
Training at both operation and management levels	❑	❑	❑	❑	❑	❑	❑
Commitment of stakeholders by setting ambitious CO2 reduction targets	❑	❑	❑	❑	❑	❑	❑