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Sustainable Maritime Trade & Smart Ports

a Research Paper on Yemen, The Arabian Gulf, & Red Sea

Dr. Mansour Ali Al-Bashiri

Dr. Nabil Abdullah Bin Aifan

This background paper is an output of the OASIS – Onward Alliance for Stability and Inclusive Solutions project, implemented by DeepRoot Consulting with the financial support of the European Union



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Foreign trade constitutes a fundamental pillar of sustainable economic and social development in any country. It contributes significantly to employment generation across various economic sectors, strengthens food security, ensures the availability of a wide range of goods and services, and promotes opportunities for gender equality, particularly in countries overlooking strategically important maritime corridors, such as Red Sea shipping routes and other major sea lanes. Over the past few decades, international trade has experienced remarkable growth and unprecedented expansion, driven by the increasing integration of global supply chains. As a result, the value of global merchandise trade has risen rapidly, reaching approximately US\$35 trillion annually (UNCTAD, 2026). Nevertheless, preliminary projections for global trade performance during the first quarter of 2026 indicate a slowdown in growth owing to the escalating conflict in the Middle East and the Strait of Hormuz, which has disrupted energy flows, driven up global shipping costs, and triggered a worldwide inflationary wave affecting all sectors of the economy.

Alongside the economic and social significance of foreign trade, maritime transport remains the backbone of international commerce, carrying approximately 90% of global trade by volume (IMO, 2024). Containerized shipping alone accounts for more than 35% of total global trade volume and approximately 60% of its total value (World Bank, 2023). Within this global context, Red Sea and the Arabian Gulf constitute a strategic hub for international trade. Together with their ports, they possess immense economic significance, serving as a principal maritime corridor for more than 15% of global seaborne trade and as a critical transit route for nearly 20% of the world's oil and liquefied natural gas (LNG) supplies, equivalent to approximately 6–7 million barrels of oil per day, in addition to facilitating the annual movement of more than 50 million tonnes of agricultural products (Arab Report, 2024).

Commercial seaports have now become a vital economic asset at the global level and a principal driver of economic development, particularly in light of the growing trends toward economic liberalization and trade openness that have characterized economies worldwide over recent decades, alongside the rapid advancement of digitalization and the smart economy. Consequently, the maritime transport industry in many developed countries—including several states in the Arabian Gulf and Red Sea region—has undergone profound transformation through the adoption of smart port concepts based on intelligent applications and advanced information and communication technologies (ICT), while simultaneously embracing the principles of economic, social, and environmental sustainability. This transformation encompasses policies and practices aimed at environmental protection, the promotion of corporate social responsibility, the meaningful participation of women and youth, the enhancement of maritime security, and the advancement of the blue economy as a strategic pathway to sustainable development.

In Yemen, despite being one of the least developed countries in the Middle East, its seaports—including the Ports of Aden, Al Hudaydah, Mukalla, and other smaller ports—have historically played a pivotal role in facilitating the country's foreign trade with international markets. These ports have constituted the primary gateway for the importation of goods and commodities into Yemen, handling approximately 81% of the country's total imported goods in 2016 (Economic Updates Bulletin, 2021). Beyond their national significance, Yemeni ports possess considerable economic and strategic importance for Red Sea and the Arabian Gulf region, as well as for global maritime trade, owing to their strategic location along major

international shipping lanes and Yemen's oversight of one of the world's most critical maritime chokepoints—the Bab al-Mandab Strait.

Despite their strategic significance, ports in the southern Red Sea region (Yemen, Sudan, and Djibouti) face a range of structural challenges, including limited operational efficiency, governance deficiencies, constrained digital transformation, and declining competitiveness compared with regional ports. While ports in the Arabian Gulf are primarily confronted with modern challenges such as digital transformation, cybersecurity, carbon neutrality, and intensifying competition, ports in the northern and southern Red Sea remain particularly vulnerable to security and geopolitical risks arising from tensions along strategic maritime corridors, most notably the Bab al-Mandab Strait and the Suez Canal, both of which exert a direct influence on international trade flows and global supply chains.

This paper examines the performance of commercial ports and sustainable maritime trade in Red Sea and Arabian Gulf region and identifies a number of key issues and challenges facing these ports. While highlighting the importance of the maritime transport industry in general, as well as the technological advancements currently reshaping the sector and its role in promoting economic development, the paper places particular emphasis on the status of Yemen's maritime transport sector. It further underscores the role of seaports in advancing the Sustainable Development Goals (SDGs) in Yemen during the coming period, considering Yemeni ports as a catalyst for development and a strategic instrument for enhancing competitiveness and attracting investment.

The paper also emphasizes the importance of aligning port management and operations with contemporary international trends in sustainability, digital transformation, and maritime security, in accordance with globally recognized port performance indicators and benchmarks. Such alignment supports the transition toward a development model founded on the economic, social, and environmental dimensions of sustainability through: the protection of the marine and coastal environment; the promotion of social responsibility; the advancement of the blue economy; the strengthening of coastal community resilience; and the active inclusion of youth and women in the port and maritime sectors. It further advocates the provision of training, employment, and entrepreneurial opportunities for these groups in the fields of sustainability, digital transformation, and maritime security, thereby fostering social equity and maximizing the utilization of human capital.

Scope and Objectives of the Paper

In line with the core knowledge pillars of the Third OASIS Platform Forum on Sustainable Maritime Trade and Smart Ports in Yemen, the Arabian Gulf, and Red Sea Region, and in response to the structural and emerging challenges confronting ports and logistics systems across the region—particularly in Yemen—including operational inefficiencies, digital transformation gaps, and the evolving challenges arising from political instability and maritime security concerns, this paper primarily analyzes and assesses the performance of Yemeni seaports and compares them with their counterparts in the Arabian Gulf and Red Sea region. The analysis is intended to support the advancement of sustainable maritime trade and contribute to the achievement of its strategic objectives.

The principal objectives of this paper are to:

1. Assess the performance of ports in Yemen and across Red Sea and Arabian Gulf region;
2. Identify the principal challenges and opportunities associated with the transition toward sustainable maritime trade systems and smart ports;
3. Support policymakers in Yemen and the wider region, as well as international partners, in formulating more effective policies for optimizing the utilization of seaports and maximizing investment in existing maritime assets and infrastructure; and
4. Present practical recommendations and policy proposals for the development of ports in accordance with contemporary international best practices, while promoting regional cooperation in this field.

These objectives are pursued through a comprehensive analysis of the current state of maritime trade and port performance across the region, complemented by an examination of the legal and institutional framework governing Yemen's port sector. The paper also identifies mechanisms for promoting the participation and empowerment of youth and women to enable them to play a leading role in driving this transformation.

To achieve the objectives of this paper, both the descriptive-analytical and participatory field research approaches were employed to provide a comprehensive assessment of the current state of sustainable maritime trade and smart ports in Yemen and Red Sea–Arabian Gulf region, as well as their contribution to sustainable development. The analytical framework integrates four complementary quantitative and qualitative research methods, as follows:

Quantitative Analytical Method: This method involved the collection and analysis of relevant studies, reports, and statistical data to identify the principal challenges and constraints affecting port performance, and to formulate policy recommendations aimed at enhancing operational efficiency and overcoming these challenges.

Qualitative Method: This component was based on Key Informant Interviews (KIIs) conducted individually with 16 experts and professionals specializing in the management and operation of the seaports covered by the study. The participants were selected on the basis of their extensive academic qualifications and long-standing professional experience in the maritime and port sector, with the objective of capturing informed perspectives on the current state of maritime trade and port systems across the region. In addition, one specialist representing the youth and women stakeholder group, with substantial professional engagement in port-related activities, was included to ensure a more inclusive assessment.

Comparative Analysis: A comparative assessment was undertaken of eight seaports located along Red Sea and the Arabian Gulf. The objective was to evaluate their current performance and identify the principal factors underlying the success of some ports and the relatively weak performance of others, using internationally recognized port performance indicators as the analytical benchmark.

Case Study Method: Aden Container Terminal (ACT) was selected as the case study for the applied analysis, as it accounts for approximately 70% of the operational activity of the Port of Aden. The Port of Aden is Yemen's largest seaport, and its container terminal is the country's largest container-handling facility. Moreover, the port occupies a strategic location in close proximity to major international shipping lanes and handles approximately 62% of Yemen's cargo throughput. Despite these strategic advantages, the port continues to experience significant operational shortcomings, placing it at the bottom of the rankings among competing ports in neighboring countries, according to international port performance assessments (Bin Aifan, 2024).

Sustainable trade constitutes one of the principal drivers of economic growth, generating broad-based benefits for society through higher income levels, employment creation across multiple sectors, and the generation of foreign exchange required to finance the import of capital and intermediate goods essential for economic development (Al-Bashiri, 2023). Furthermore, sustainable trade strengthens economic relations among countries and promotes economic integration within regional and international economic blocs.

Nevertheless, international trade has also generated significant environmental, economic, and social challenges. These challenges have contributed to climate change and environmental degradation, including biodiversity loss and marine pollution, as well as violations of labour rights, particularly those associated with cost-cutting practices, child labour, inadequate wages, and excessive working hours. They have also exacerbated inequalities both among countries and within individual nations (UNCTAD, 2023).

1.1 Sustainable Trade

Sustainable trade may be defined as:

"The exchange of goods and services in a manner that delivers balanced economic, social, and environmental benefits while promoting economic growth, preserving resources for future generations, emphasizing ethical supply chains, reducing pollution, supporting social equity, and advancing green technologies as fundamental pillars for achieving the Sustainable Development Goals (SDGs)." (FasterCapital, 2025).

According to the United Nations Forum on Sustainability (2013), sustainable trade refers to:

"A set of standards that producers, traders, manufacturers, retailers, or service providers may be required to meet, including respect for fundamental human rights, workers' health and safety, the environmental impacts of production, community relations, land-use planning, and other relevant requirements." (UNCTAD, 2023).

1.2 Sustainable Trade Practices

Sustainable trade practices refer to the approaches and strategies adopted by businesses and governments to promote trade while minimizing adverse environmental and social impacts. These practices encompass a broad range of initiatives, including the use of renewable energy, Reduction of waste and pollution, the promotion of fair labour practices, the protection of workers' rights, and the advancement of gender equality (FasterCapital, 2025). The importance of sustainable trade policies is reflected in the following:

- Reducing environmental impacts: This is achieved through the implementation of environmentally sustainable measures, including reducing carbon emissions by utilizing renewable energy sources such as solar and wind power, minimizing waste through recycling programs, reducing excessive packaging, and adopting sustainable materials.
- Enhancing positive social impacts: Businesses can improve the health and well-being of their employees by providing safe and healthy working conditions. They can also

contribute to local community development by sourcing local products and services and actively supporting initiatives that address social challenges.

- **Improving operational and productive efficiency:** Sustainable practices enhance operational efficiency and financial performance by reducing waste, optimizing resource utilization, and increasing the use of clean energy, thereby improving overall economic returns.

1.3 Smart Ports

Smart ports are defined as "innovative ports that leverage Information and Communication Technologies (ICT) and other advanced technologies to enhance operational efficiency, improve service delivery and competitiveness, and ensure that the economic, social, and environmental needs of both present and future generations are met" (Habibi, 2023) Compared with conventional ports, smart ports are distinguished by several key characteristics (Paraskevas, 2024), the most important of which include:

- **Automation:** Smart ports rely extensively on automated systems to operate port activities around the clock with minimal human intervention. This increases operational efficiency while reducing labour costs and minimizing human error.
- **Internet of Things (IoT):** IoT technologies enable interconnected devices to collect, exchange, and process data in real time, facilitating timely, accurate, and data-driven decision-making and enhancing both operational and administrative efficiency within ports.
- **Fifth-Generation (5G) Technology:** Fifth-generation (5G) communications provide higher data accuracy, greater network capacity, and high-speed real-time data transmission, thereby improving the responsiveness and efficiency of port operations.
- **Environmental Sustainability:** Smart ports seek to reduce their carbon footprint and ship-generated emissions by deploying advanced technologies that shorten vessel waiting times, optimize fuel consumption, and protect the marine environment through the increased use of renewable energy sources.
- **Connectivity:** Smart ports possess advanced connectivity capabilities that integrate maritime, logistics, industrial, and supply chain ecosystems, facilitating the seamless flow of cargo, information, and operational data among vessels, terminals, and other stakeholders.
- **Continuous Improvement:** Smart ports are characterized by their ability to continuously optimize their operations through the adoption of emerging technologies, innovative solutions, and best practices, thereby enhancing operational efficiency and adapting to the evolving demands of the maritime transport industry.

Table (1): Key Differences Between a Conventional Port and a Smart Port	
Conventional Port	Smart Port
Relies primarily on manual operations.	Relies on automation and intelligent systems.
Characterized by slower operational processes.	Characterized by high-speed, efficient operations.
More susceptible to human error.	Significantly reduces human error.
Operates with limited data availability.	Utilizes accurate, real-time data to support decision-making.

The adoption of digital technologies in ports offers a wide range of strategic benefits. Table (2) presents the principal advantages of port digitalization, including enhanced operational efficiency, reduced operating costs, strengthened security, and improved resource utilization.

Table (2): Principal Benefits/Advantages of Seaport Digitalization

Category	Benefits / Advantages
Enhancing Port Operational Efficiency	Automated cargo handling, navigation, and vessel management.
	Increased productivity, reduced congestion, and faster vessel turnaround times.
	Improved port call scheduling through the implementation of the Just-In-Time Arrival (JIT Arrival) system.
Cost Reduction and Environmental Sustainability	Data-driven decision-making through the use of predictive analytics.
	Improved fuel consumption, cargo-handling operations, and equipment management.
Optimal Resource Utilization	Real-time monitoring of vessels, cranes, and port facilities using Internet of Things (IoT) sensors.
	Predictive maintenance and enhanced safety protocols.
	Automated tracking of personnel and assets.
Knowledge Management	Streamlined customs and logistics procedures through digital documentation.
	Reduced administrative burdens and enhanced trade-flow traceability.
Connectivity and Communication	Real-time tracking and coordination between vessels and shore-based operations.
	Advanced satellite communications enabling seamless data exchange.
Enhanced Security	Access control, digital permit management, and continuous 24/7 port surveillance.
	Smart gateways to strengthen port security.

Source: (World Bank, 2025a)

1.4 Digital Transformation

Digital transformation refers to the adoption or expanded use of digital and computing technologies by an organization, government, or industry as a strategic component of its operational model. It is a dynamic process that reshapes the factors of production and productivity through the rapid advancement of big data, cloud computing, Artificial Intelligence (AI), and other next-generation information technologies (Sun, 2021).

Digital transformation in the maritime and port sector encompasses several key digital systems, including the following:

Port Community System (PCS)

The Port Community System (PCS) is a digital platform designed to facilitate and optimize the exchange of information and data among a broad range of port stakeholders. Its primary objective is to enhance the efficiency, security, and reliability of maritime trade and logistics operations, reduce administrative burdens, minimize vessel and cargo delays, and improve end-to-end visibility and transparency throughout the supply chain.

A PCS typically provides a comprehensive range of functionalities, including cargo tracking and monitoring, vessel scheduling and berth planning, customs clearance and inspection procedures, invoicing and electronic payment services, as well as numerous other port-related operational services (World Bank, 2024).

Maritime Single Window (MSW)

The Maritime Single Window (MSW) is a centralized digital platform for the collection and exchange of information submitted by ships upon their arrival at ports. It is designed to streamline and optimize operational procedures among all entities involved during the vessel's arrival, port stay, and departure.

The platform enables participating stakeholders to submit standardized information only once through a single electronic interface, thereby eliminating duplication, reducing operational inefficiencies, and improving coordination among all stakeholders (World Bank, 2025a).

Terminal Operating System (TOS)

The Terminal Operating System (TOS) is the core software platform used to manage container terminal operations. Its principal functions include planning, coordinating, and monitoring all terminal activities, including cargo loading and unloading, cargo transportation and storage, vessel and truck scheduling, and gate operations management (Peralta et al., 2019).

Port Management Information System (PMIS)

The Port Management Information System (PMIS) comprises an integrated suite of information systems designed to monitor and manage vessel movements, cargo manifests, truck arrivals and departures, cargo-handling equipment utilization, and other operational activities within the port environment (EPA, 2021). In addition, the Vessel Traffic Services (VTS) is a shore-based maritime traffic management service operating in coastal waters and port areas to assist in monitoring, organizing, and regulating vessel traffic within designated maritime zones, thereby enhancing navigational safety and operational efficiency (Serrano et al., 2024).

Sustainable maritime trade has become a governing framework for reshaping global supply chains under the combined influence of geopolitical shocks, the energy transition, digital transformation, and the evolving role of ports within the broader maritime economy. Consequently, global trends in sustainable maritime trade increasingly emphasize the alignment of fleet and trade growth with emission reduction objectives, the strengthening of resilience, and the empowerment of developing countries—particularly those located along strategic maritime corridors such as Red Sea—to maximize their participation in the global maritime economy within a more equitable and sustainable governance framework (OECD, 2025; World Bank, 2025a; UNCTAD, 2025; IAPH, 2022).

Studies confirm that maritime transport remains the backbone of global trade, placing ports at the center of the maritime economy as critical nodes for the movement of goods, services, and value creation. This has led to a qualitative transformation in the role of port authorities, which has evolved from the traditional service operator model to that of landlord, regulator, and developer, and ultimately to that of a logistics developer and port community builder responsible for governance, sustainability, and urban integration (OECD, 2025; World Bank, 2025a).

At the macro level, the Review of Maritime Transport 2025, published by the United Nations Conference on Trade and Development (UNCTAD), indicates that maritime transport markets are operating in "troubled waters" as a result of the interaction of geopolitical disruptions, new tariffs and trade restrictions, energy policies, and changing patterns of demand for goods. The closure of, or threats to, certain maritime routes led to a significant increase in ocean freight rates during 2024, particularly in the container shipping sector. Freight rates subsequently experienced fluctuations during 2025 as fleet capacity expanded and shipping capacity was more effectively managed. The report further emphasizes that efficient ports are those capable of reducing delays and costs while facilitating the seamless movement of goods across borders. It also highlights the growing prominence of ports that provide alternative fuel bunkering services, such as Liquefied Natural Gas (LNG), as part of a green port infrastructure that supports emissions reduction.

Digitalization has become a decisive factor in achieving both operational and environmental sustainability. There is a strong correlation between improved port performance and the implementation of trade facilitation measures and digitalization. International reports recommend the regular measurement of port performance using internationally recognized indicators to identify performance gaps and enhance governance and transparency, particularly in developing and least developed countries. Furthermore, the adoption of electronic systems such as the Port Community System (PCS) and the Maritime Single Window (MSW) is associated with shorter cargo clearance times and improved maritime connectivity indicators. Data from 85 developing countries confirm that countries implementing these systems achieve better performance than those that do not (UNCTAD, 2025).

From the broader perspective of the maritime economy, the OECD report *The Ocean Economy to 2050* indicates that the global ocean economy accounted for approximately 3–4% of global economic output between 1995 and 2020, while employment generated by the global ocean economy represented 3.5–4.7% of total global employment over the same period. At the same time, the report warns that the ocean economy is under increasing pressure as a result of

climate change, biodiversity loss, pollution, and the declining productivity of many marine-based economic activities.

At the regional level, security and military developments in recent years—including the conflict in Yemen, tensions related to the Bab al-Mandab Strait, the escalation associated with the war in Gaza, and regional tensions involving Iran—have resulted in higher marine insurance premiums and ocean freight costs, as well as the diversion of some international shipping routes to alternative, more costly routes. These developments have had a direct impact on global commodity and energy prices. They have also prompted a number of countries to reassess their strategies concerning port security, supply chain resilience, and the acceleration of the transition toward smart ports and maritime digitalization in order to strengthen crisis management capabilities and adapt to growing geopolitical risks (Joint Arab Report, 2025).

In Yemen, its location overlooking the Bab al-Mandab Strait, Red Sea, the Gulf of Aden, and the Indian Ocean constitutes a strategic asset that can support economic recovery, provided that the role of ports is reactivated as hubs for trade and logistics services. However, the war and institutional fragmentation have resulted in extensive damage to infrastructure, disruptions to supply chains, increased transportation costs, and the imposition of restrictions and complex procedures on imports. This situation has, in turn, increased the cost of food and fuel and further deepened the humanitarian crisis.

To address these challenges, it is essential to place port and transport infrastructure development among the priorities of public investment, while simultaneously reforming governance structures, reducing institutional fragmentation among port authorities and security and customs agencies, and leveraging Yemen's maritime advantages to integrate the country into regional and global supply chains as part of a broader strategy for building sustainable economic resilience (OECD, 2024).

2.1 Foreign Trade: Macroeconomic Indicators

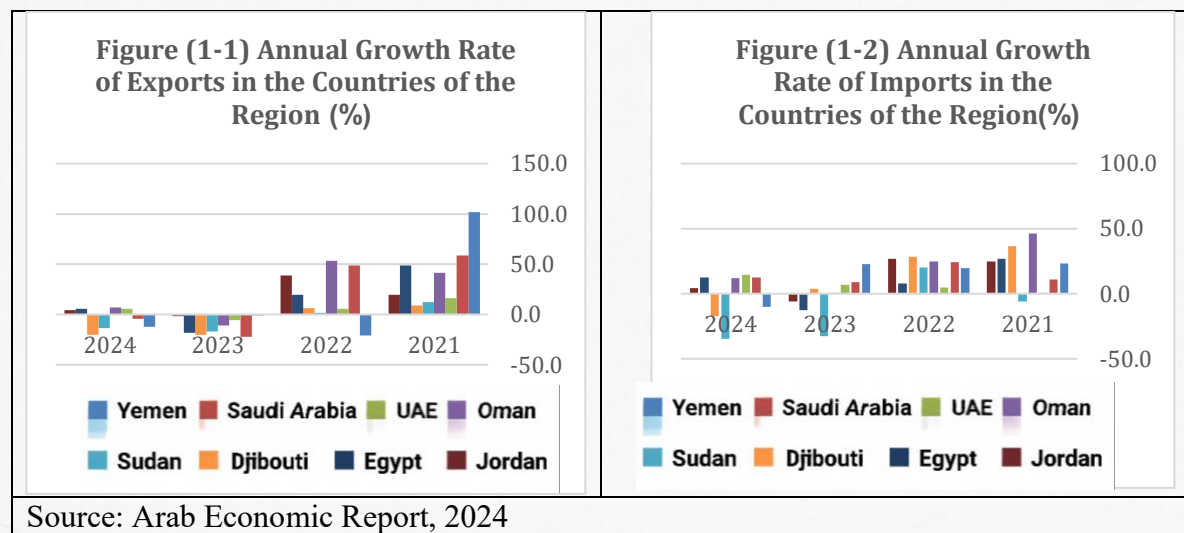
The Arabian Gulf and Red Sea region, as well as the Arab region in general, constitutes an important source of energy products, including oil, natural gas, and petrochemical derivatives. Arab exports of oil and gas account for a substantial share of total Arab exports, averaging approximately 60% of the region's total exports (ESCWA, 2023). Given the sensitivity of these exports to political, economic, and security developments within the region and beyond, as well as to global political and economic alliances, Arab exports experience fluctuations in their volumes, revenues, and international trade patterns.

On the other hand, maritime trade accounts for a significant proportion of total trade in Yemen and the countries of Red Sea and Arabian Gulf region. Seaports constitute the primary gateways for the movement of a large share of imported and exported goods and commodities, particularly petroleum and gas products, which represent a major component of the trade of these countries. In this context, available data (Economic Updates Bulletin, 2021) indicate that Yemen's maritime gateways handled approximately 85.5% of the country's total trade prior to 2014. This share subsequently declined to around 66.7% in the following years due to conflict, war, and restrictions imposed on a number of Yemeni ports, particularly those located along Red Sea coast.

Overall, trade activity across the region experienced varying developments. Available data (Arab Economic Report, 2024) indicate that the total value of exports for the countries covered

by this study⁽¹⁾ increased from approximately US\$524 billion in 2020 to approximately US\$888 billion in 2022. This value declined modestly during 2023 and 2024 as a result of the security developments witnessed across the region, particularly those affecting the southern Red Sea, reaching approximately US\$769 billion in 2024. Consequently, the countries covered by this study recorded an average annual export growth rate of 11.8% over the 2020–2024 period.

Despite this overall growth, the average annual growth rate of exports varied considerably from one country to another (Figure 1-1). During the 2021–2024 period, the Sultanate of Oman recorded the highest average annual export growth rate in the region, at approximately 22.7%, followed by Saudi Arabia (20.3%), Yemen (17.0%), Jordan (15.2%), Egypt (13.8%), and the United Arab Emirates (5.6%). By contrast, both Sudan and Djibouti recorded negative average annual export growth rates of –4.0% and –6.2%, respectively.



With respect to imports, available data indicate that the total imports of the countries covered by the study recorded sustained annual growth averaging 9.6%, increasing from US\$502 billion in 2020 to approximately US\$722 billion in 2024. In terms of average annual import growth within the region, the Sultanate of Oman ranked first (Figure 1-2) with approximately 21%, followed by Saudi Arabia (14.1%), Yemen (13.7%), Djibouti (12.9%), Jordan (12.7%), Egypt (8.6%), and the United Arab Emirates (6.6%). By contrast, Sudan recorded negative import growth during the same period, amounting to –13.2%.

Table (3): External Trade as a Percentage of Gross Domestic Product (GDP) (2024), %

	exports	imports
Yemen	7%	72%
KSA	25%	19%

⁽¹⁾ The study covers the following countries: Yemen, Oman, Saudi Arabia, the United Arab Emirates, Egypt, Jordan, Sudan, and Djibouti.

Foreign trade is of considerable economic importance to the countries of Red Sea and Arabian Gulf region in general, and to the countries covered by this study in particular, as it constitutes a substantial share of their Gross Domestic Product (GDP). In some countries, the value of foreign trade even exceeds the value of GDP. The data presented in Table (3) indicate that the value of foreign trade in Djibouti, the Sultanate of Oman, and the United Arab Emirates exceeds the value of their respective GDPs. This reflects the high level of commercial activity in these countries and their transformation into regional trade hubs serving numerous countries within the region and beyond.

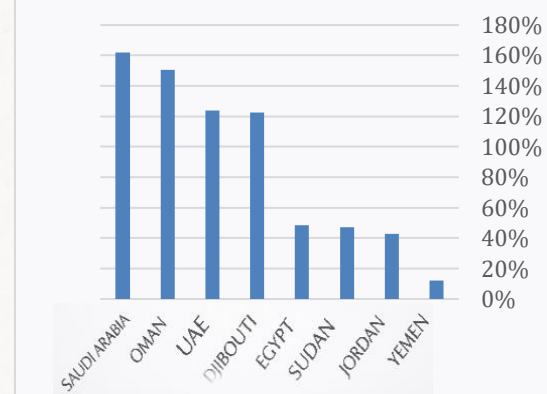
United Arab Emirates	61%	54%
Oman	59%	41%
Sudan	12%	19%
Djibouti	87%	100%
Egypt	12%	25%
Jordan	23%	50%
Source: Arab Economic Report 2024		

In countries such as Yemen and Jordan, total foreign trade—comprising both exports and imports—accounts for more than 70% of GDP, particularly on the import side, where imports represent approximately 72% of GDP in Yemen and 50% of GDP in Jordan. This clearly demonstrates the extent to which both Yemen and Jordan depend on external markets to meet a significant portion of consumer demand and the investment requirements of producers.

The data also indicate a relatively strong degree of economic diversification in countries such as Saudi Arabia and Egypt. As shown in Table (3), although Saudi Arabia is among the world's leading oil exporters, its total exports accounted for no more than 25% of GDP, while imports represented approximately 19% of GDP. A similar pattern can be observed in Egypt, where total exports and imports in 2024 represented approximately 12% and 25% of GDP, respectively.

On the other hand, the data indicate considerable variation among the countries covered by this study with respect to trade sustainability, as measured by the export-to-import coverage ratio. The data show that Saudi Arabia, the Sultanate of Oman, the United Arab Emirates, and Djibouti exhibit a very high level of trade sustainability. Saudi Arabia recorded the highest export-to-import ratio at approximately 162%, followed by the Sultanate of Oman (150%), the United Arab Emirates (124%), and Djibouti (123%). By contrast, Egypt, Jordan, Sudan, and Yemen experience relatively low levels of trade sustainability in terms of export coverage of imports, particularly Yemen, where the ratio did not exceed 12%. Meanwhile, the trade sustainability ratios of Egypt, Jordan, and Sudan ranged between 43% and 49%.

Figure 2 : Exports/Imports Ratio for the Period (%) 2024–2020



In Yemen, a combination of factors and developments resulting from a decade of conflict and war has been the principal cause of the decline in exports to this exceptionally low level. Prior to 2015, exports accounted for approximately 20% of Gross Domestic Product (GDP) and around 45% of total imports (Annual Statistical Yearbook, 2014). The principal factors include:

1. The near-complete cessation of production and operations across most oil and gas sectors following the departure of foreign oil companies operating in Yemen, followed by the complete suspension of crude oil exports since October 2022.
2. The destruction and shutdown of a large number of critical infrastructure facilities supporting the trade sector, particularly those related to exports. In addition, many of these facilities have been converted into military installations, as is the case with the Balhaf Liquefied Natural Gas (LNG) Export Terminal and the Al-Dhabbah Oil Terminal.
3. The blockade imposed on Yemeni ports, particularly those located along Red Sea coast, including the Port of Al Hudaydah, the Port of Ras Isa, and the Port of Al-Salif.

Furthermore, the experts and technical specialists who participated in the field study consider that maritime trade in Yemen is currently unsustainable from the economic, environmental, and social perspectives. The principal manifestations of this lack of sustainability are reflected in the following characteristics:

1. Political and security instability, which adversely affects the operational efficiency of Yemeni ports and undermines their operational capacity.
2. Limited financial resources available for investment in appropriate infrastructure, coupled with the low financial returns generated by current port activities.
3. Inadequate legislative and regulatory frameworks that fail to keep pace with current requirements, together with the ineffective enforcement of existing laws and regulations, as well as weak coastal surveillance and control.
4. High shipping and marine insurance costs associated with Yemeni ports as a result of increased marine insurance premiums, leading to a decline in their competitiveness.
5. Weak infrastructure, resulting in reduced port efficiency, delays and slow cargo-handling operations, poor occupational safety for port workers, and limited employment opportunities.
6. Persistent environmental risks along Yemen's coastline, particularly those related to pollution and the limited capacity to respond to maritime emergencies.
7. Failure of Yemeni ports to keep pace with developments in the application and utilization of Artificial Intelligence (AI) technologies relevant to port operations.
8. Worsening food insecurity and the deterioration of the livelihoods of coastal communities and those engaged in fisheries and port-related services, owing to dependence on imports through ports affected by conflict and instability.

Based on the analysis of economic, trade, and logistics indicators, the level of maritime infrastructure development, port efficiency, and the prevailing political and security conditions, together with the findings of the field interviews conducted by the study team, the countries covered by this study can be classified into three main groups (Table 4). These groups differ in their economic and trade characteristics, the level of preparedness of their ports for the transition toward sustainable trade systems and smart ports, and the supporting logistics associated with their economic activities.

Table (4): Countries Covered by the Study Classified According to Their Trade Characteristics

Group	Countries	Key Characteristics
I	Saudi Arabia, United Arab Emirates,	• Dominance of the oil and petroleum derivatives sector.

	Qatar, Kuwait, Bahrain, and the Sultanate of Oman	• High economic performance and high-income levels. • Active to highly active maritime trade, with high-performing and highly competitive ports. • Very well-developed infrastructure that supports investment and economic activity.
II	Egypt and Jordan	• A relatively diversified economy. • Moderate economic performance and middle- to low-income levels. • Active to moderately active maritime trade, with average port performance requiring targeted improvements. • Good infrastructure conducive to investment and economic activity.
III	Yemen, Sudan, and Djibouti	• A relatively diversified economy, with the oil sector dominating under conditions of stability in both Yemen and Sudan. • Weak economic performance and very low-income levels, particularly in Yemen and Sudan. • Diverse and substantial, yet underutilized, economic resources. • Weak maritime trade, coupled with low port performance and significant structural challenges. • Weak infrastructure that is not conducive to investment or economic activity.
Source: Prepared by the Study Team		

2.2 Main Characteristics of Trade in the Countries of the Region

The countries of Red Sea and Arabian Gulf region have experienced significant developments in their foreign trade performance, particularly in light of their increasing economic openness to the global economy and the achievement of annual growth rates in this vital sector that exceeded the growth rates of their Gross Domestic Product (GDP). Since foreign trade serves as a reflection of the economic and living conditions prevailing in the region—capturing changes in production, consumption, and investment through the performance and composition of exports and imports—the principal trade characteristics of the region may be summarized as follows:

(a) Commodity Concentration of Exports

Table (5): Export Competitiveness of the Countries in the Region (Export Concentration and Product Diversification Indices, 2023)

Exports in most countries of the region continue to suffer from structural imbalances and deeply rooted challenges arising from their concentration in a limited number of commodities and the limited diversification of their export base. The majority of exports from the countries of the region consist of crude oil, petroleum derivatives, or industrial products associated with the petroleum industry, thereby reducing the international competitiveness of their export structures. Table (5) illustrates the competitiveness of the goods and products exported by the countries of the region by presenting the export concentration and export diversification indices for the countries covered by the study. The relatively high values of these indices indicate that exports are concentrated in a limited number of commodities. Saudi Arabia recorded the highest export concentration index at 0.58, followed by Sudan (0.32), the Sultanate of Oman (0.31), Jordan (0.19), and Egypt (0.10). By contrast, Djibouti, Yemen, and the United Arab Emirates recorded lower export concentration indices. In the cases of the United Arab Emirates and Djibouti, this is attributable to their roles as major regional re-export hubs, receiving substantial volumes of manufactured and primary products from various countries before re-exporting them to other destinations, thereby reducing the concentration of their exports.

Jordan	Concentration Index ⁽²⁾	Divers. Index ⁽³⁾
(UAE)	0.194	0.681
Djibouti	0.26	0.538
KSA	0.13	0.576
Sudan	0.583	0.758
Oman	0.324	0.826
Egypt	0.311	0.684
Yemen	0.105	0.562
Jordan	0.21	0.662

Source: UNCTAD, based on the SITC Revision 3 (SITC Rev. 3) classification.

In the case of Yemen, however, the lower concentration index reflects the sharp decline in oil and gas exports—which accounted for more than 90% of the country's total exports prior to 2015—followed by their complete cessation in 2022. Consequently, the export concentration index declined significantly in 2023, as Yemeni exports during that year comprised a broader basket of domestic agricultural and industrial products.

With regard to the export diversification index, all countries in the region recorded limited performance in terms of export diversification. Sudan recorded the weakest performance with an index of approximately 0.83, followed by Saudi Arabia (0.76), the Sultanate of Oman and Jordan (0.68 each), and Yemen (0.66), with the remaining countries recording comparable levels. In this context, available data (GCC-Stat, 2024) indicate that exports of crude oil and petroleum products accounted for approximately 72.6% of the total exports of the Gulf Cooperation Council (GCC) member states.

B) Geographic Concentration of Trade

Table (6), based on data from the United Nations Economic and Social Commission for Western Asia (ESCWA), illustrates the degree of geographic concentration and identifies the

- ⁽²⁾ **Concentration Index:** Also known as the Herfindahl–Hirschman Index (HHI), it measures the degree of market concentration of a country's share of global exports/imports of a specific commodity or commodity group, or the extent to which its trade is diversified across multiple commodities and commodity groups. The value of the Concentration Index ranges from 0 to 1. Lower values indicate a lower degree of concentration in both exports and imports, whereas higher values indicate a greater degree of concentration.

⁽³⁾ **Diversification Index:** Measures the deviation of a country's share of major commodity exports in its total exports from the share of those commodities in total world exports. The value of the Diversification Index ranges from 0 to 1. The closer the index is to 0, the greater the degree of export diversification. A value of 0 indicates that the country's export structure is identical to the structure of world exports.

principal trading partners of Red Sea and Arabian Gulf countries covered by this study. The data indicate the following:

1. Exports are considerably more geographically concentrated than imports in most of the countries covered by the study, particularly the lower-income and lower-trade economies, namely Yemen, Sudan, and Djibouti, where exports to the three largest trading partners account for 70%–97% of total exports. These are followed by the Sultanate of Oman, Jordan, and Saudi Arabia, with export concentration ratios exceeding 34%, while the United Arab Emirates and Egypt recorded lower concentration ratios of less than 26%.

Table (6): Geographic Concentration of Trade in Red Sea and Arabian Gulf Region				
Country	Exports		Imports	
	Top 3 Trading Partners	Share of Total Exports	Top 3 Trading Partners	Share of Total Imports
Jordan	United States, Saudi Arabia, India	47.0%	China, Saudi Arabia, United States	34.7%
Egypt	Saudi Arabia, Italy, Türkiye	22.4%	China, Saudi Arabia, United States	32.8%
United Arab Emirates	India, Saudi Arabia, Japan	26.0%	China, India, United States	31.5%
Saudi Arabia	China, South Korea, Japan	34.0%	China, United States, India	35.0%
Sultanate of Oman	China, South Korea, United Arab Emirates	56.0%	China, United Arab Emirates, Saudi Arabia	32.4%
Yemen	Saudi Arabia, Malaysia, Oman	70.2%	China, Saudi Arabia, United States	32.5%
Djibouti	Ethiopia, Saudi Arabia, United States	96.6%	China, Saudi Arabia, United States	33.3%
Sudan	United Arab Emirates, Saudi Arabia, China	69.8%	China, Saudi Arabia, United States	32.9%
Source: United Nations (ESCWA), External Trade Data Platform for the Arab Region https://etdp.unescwa.org/index-ar.html				

The high degree of export concentration in Djibouti can be attributed to its role as a maritime gateway for its landlocked African neighboring countries, particularly Ethiopia, which accounts for more than 90% of Djibouti's exports (re-exports). In the case of Sudan, the concentration reflects the export of gold—which constitutes a substantial share of Sudanese exports—to the United Arab Emirates. As for Yemen, the concentration of exports toward Saudi Arabia is primarily attributable to the fact that most Yemeni exports during this period consisted of agricultural and fishery products, in addition to the close geographical proximity between the two countries.

2. The high degree of geographic concentration observed in the Arabian Gulf countries reflects the strong interdependence between the region's economies and Asian markets, particularly China and India, which are among the world's largest energy importers. However, this pattern of concentration simultaneously creates a high degree of trade vulnerability, making the region's economies more susceptible to economic, political, and logistics-related fluctuations in these markets.
3. In the case of Jordan, the United States is its leading trading partner as a result of the Free Trade Agreement (FTA) concluded between the two countries, which has enabled Jordanian products to access the U.S. market under preferential trade arrangements.
4. Egyptian exports exhibit a positive degree of diversification, attributable to the diversity of the country's export commodities.

5. With regard to imports, Table (6) shows that the countries covered by the study display relatively similar levels of geographic diversification of imports. This is primarily due to the similarity in the composition of imported goods across most of these countries, which include commodities that meet the population's food and non-food needs, producers' requirements for machinery and equipment, as well as technology products and renewable energy products.

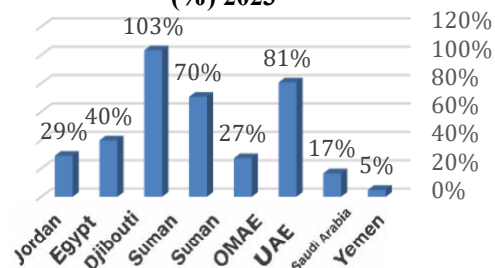
C) Excessive Dependence on Food Imports

Food security represents the most significant challenge currently facing most countries around the world. This challenge also extends to the countries of Red Sea and Arabian Gulf region, as they depend on imports to meet a substantial share of their food requirements, with the associated economic, social, political, and security implications affecting their economic and political independence. In this context, available data indicate that the food import bill for agricultural products in the countries covered by the study increased to approximately US\$89.5 billion in 2023, compared with approximately US\$65.5 billion in 2015, representing an increase of 37% (FAO, 2025).

Figure (3) illustrates the ratio of agricultural exports to agricultural imports, which constitutes a key indicator of the degree of self-sufficiency or, conversely, the agricultural trade deficit experienced by all countries in the region without exception, including the United Arab Emirates and Djibouti, whose data do not accurately reflect their actual situation. The figure gives rise to the following observations:

- Although the United Arab Emirates and Djibouti appear to exhibit a high degree of self-sufficiency in agricultural products, this indicator does not reflect the actual situation in either country. The high self-sufficiency ratio is attributable to the pivotal role both countries play in the re-export and import of agricultural and food products on behalf of other countries in the region. In other words, they perform a major logistics function through their ports. This can be observed by examining historical data for the two countries, where the ratio of agricultural exports to agricultural imports in 2015 was only approximately 5% for Djibouti and 44% for the United Arab Emirates.
- The data for Yemen and Saudi Arabia indicate a high degree of dependence on food imports. In Yemen, this ratio remains at a very low level of approximately 5%, primarily as a consequence of the conflict and war, which have devastated the country's productive infrastructure in general and its agricultural infrastructure in particular. This has been compounded by the substantial restrictions imposed on Yemeni agricultural products in accessing international export markets. In the case of Saudi Arabia, despite major agricultural initiatives, strong domestic demand and the country's desert climate have made imports the principal source of food supply, while the government has increasingly pursued overseas agricultural investments instead of expanding domestic production, which places significant pressure on water resources.

Figure 3 : Average Agricultural Exports/Agricultural Imports, ~2020 (%) 2023



Source: (FAO), Database, .2025

- Despite Sudan's considerable agricultural potential, the country has experienced sharp fluctuations in the ratio of agricultural exports to agricultural imports over recent years. While Sudan was approaching food self-sufficiency in 2015, meeting approximately 93% of its food requirements (Food and Agriculture Organization (FAO)), the political instability and subsequent armed conflict witnessed in recent years led to a decline in the ratio of agricultural exports to agricultural imports, which averaged approximately 70% during the 2020–2023 period. Consequently, Sudan increasingly relied on imports to satisfy domestic demand for agricultural and food products, placing additional pressure on both the balance of payments and the value of the national currency.
- Sultanate of Oman and Jordan have experienced an increase in imports at a rate exceeding the growth of exports during recent years. This is primarily attributable to population growth and increasing pressure on water resources, which have, in turn, led to greater dependence on external markets to meet the population's food requirements. Egypt, on the other hand, has shown an improvement in the ratio of agricultural exports to agricultural imports over recent years. This ratio increased from 25% in 2010 to 42% in 2021 (Food and Agriculture Organization (FAO)). During the 2020–2023 period, it averaged approximately 40%, despite substantial population growth, which continues to increase the food import bill, particularly for wheat.

Based on the foregoing, it may be concluded that achieving full food security in the countries covered by this study remains a distant objective. These countries continue to experience a food gap that is met through food imports, underscoring the need to reassess existing trade policies and transition toward a sustainable trade model that strikes a balance between openness to global markets and the development of domestic production.

The systematic pursuit of port performance measurement constitutes a central issue in port management, as it is an essential prerequisite for organizing port operations efficiently and effectively. Port performance is understood as the manner in which a port carries out its activities to achieve its defined objectives and meet the expectations of its users within a given economic context, while remaining consistent with the broader institutional and organizational structures of the port system (Notteboom et al., 2022).

The measurement of port performance has assumed a central role in contemporary port management. Intensifying competition and the increasing integration of ports into global supply chains have made it an indispensable strategic tool for benchmarking a port against its competitors, optimizing the utilization of available resources and planning for their expansion, and improving interaction between the port and its users, thereby enhancing service quality and strengthening the port's ability to achieve its stated objectives (Vaggelas, 2019; Notteboom et al., 2022).

In line with the objective of this paper—to analyze the performance of Arab ports in Red Sea and Arabian Gulf region and assess their alignment with contemporary global trade trends—the study adopts a comparative analytical framework that integrates a range of quantitative and qualitative dimensions related to port performance and competitiveness. This framework focuses on measuring the efficiency of container and cargo handling, the quality of port infrastructure, the level of digital transformation and adoption of smart technologies, the efficiency of logistics connectivity, and vessel and container dwell times, in addition to indicators of environmental sustainability, governance, and maritime security. This multidimensional comparison of Arab ports in Red Sea and Arabian Gulf region makes it possible to assess the extent to which each port satisfies the requirements of contemporary global trade, identify their respective strengths, weaknesses, and performance gaps, and thereby derive lessons learned, determine priority areas for intervention, and formulate practical recommendations to strengthen the alignment of these ports with the ongoing transformations in global supply chains and international trade.

3.1 Port Performance Indicators

Port efficiency constitutes a central dimension of business management across all types of organizations, as the overall efficiency of a country's port system depends on the performance efficiency of each individual port. A number of internationally recognized indicators, developed by organizations such as the World Bank, the Organisation for Economic Co-operation and Development (OECD), the European Commission, and the United Nations Conference on Trade and Development (UNCTAD), are used to measure various aspects of port performance at both the global and regional levels. These initiatives are intended to provide policymakers with a better understanding of the factors involved in enhancing the competitiveness of the maritime transport industry in general, and ports in particular, through monitoring and analyzing port performance trends worldwide. The principal indicators include the following:

- **Liner Shipping Connectivity Index (LSCI)**

The Liner Shipping Connectivity Index (LSCI), published by the United Nations Conference on Trade and Development (UNCTAD), measures the degree of connectivity and accessibility of ports to global liner shipping networks. The index aims to provide information on the efficiency and quality of liner shipping services by using quantitative indicators to assess the frequency, capacity, and geographical coverage of scheduled maritime services. It also takes into account other factors, including vessel size, transit time, and the availability of connections with other modes of transport, such as rail and road transport. The index ranks countries and ports on a scale ranging from 0 to 100, where a higher score indicates a greater level of connectivity and accessibility to liner shipping services (UNCTAD, 2025).

- **World Bank Container Port Performance Index (CPPI)**

The Container Port Performance Index (CPPI) is published annually in collaboration with S&P Global Market Intelligence. Its objective is to identify areas for improvement that ultimately benefit all stakeholders, ranging from shipping lines and national governments to end consumers. The index is designed to serve as a reference for stakeholders in the global economy, including port authorities and terminal operators, national governments, supranational organizations, development agencies, maritime interests, and other public- and private-sector stakeholders involved in trade, logistics, and supply chains. The CPPI is a quantitative tool for measuring the efficiency of ports in handling container vessels, based on the time elapsed between a vessel's arrival within the port limits and its departure from the berth. A shorter port stay reflects better port performance (World Bank, 2024).

- **Lloyd's List Top 100 Container Ports**

Published annually, the Lloyd's List Top 100 Container Ports ranks container terminals worldwide according to the volume of containers handled, measured in Twenty-foot Equivalent Units (TEUs). The ranking is used to indicate a port's global standing in terms of operational capacity and the scale of its commercial activity (Lloyd's, 2025).

Table (7) below presents the leading ports in the Middle East according to these indicators:

Table (7): Leading Middle Eastern Ports According to the LSCI, CPPI, and Lloyd's List Indicators			
#	Indicator	Leading Arab Ports	Selection Criterion
1	Indicator	Leading Arab Ports	Selection Criterion
2	UNCTAD Liner Shipping Connectivity Index (LSCI)	Jebel Ali Port (United Arab Emirates), Tanger Med Port (Morocco), East Port Said Port (Egypt), Khalifa Port (United Arab Emirates), Alexandria Port (Egypt)	Degree of connectivity of ports to global liner shipping networks.
3	World Bank Container Port Performance Index (CPPI)	East Port Said Port (Egypt), Tanger Med Port (Morocco), Hamad Port (Qatar), Port of Salalah (Oman), Jeddah Islamic Port (Saudi Arabia)	Time required for handling container vessels.
Source: (World Bank, 2024); (UNCTAD, 2025); (Lloyd's, 2025).			

3.2 Institutional and Regulatory Framework of the Maritime Transport Sector in Yemen

The Republic of Yemen is located in the southern part of the Arabian Peninsula. It is bordered by the Kingdom of Saudi Arabia to the north, the Arabian Sea and the Gulf of Aden to the south, the Sultanate of Oman to the east, and Red Sea to the west. Yemen's coastline extends for approximately 2,500 km. Along Yemen's territorial waters in Red Sea and the Arabian Sea lies a group of islands, the majority of which are located in Red Sea and are distributed along the Yemeni coastline. The largest and most important island in Red Sea is Kamaran Island, followed by the Hanish Archipelago. Mayyun (Perim) Island occupies a position of particular strategic importance owing to its control of the Bab al-Mandab Strait. In the Arabian Sea, Yemen's islands are located in close proximity to one another, the most prominent of which is the Socotra Archipelago (CSO-Yemen, 2008).

The Ministry of Transport (MOT) oversees the transport sector, which is divided into three subsectors: the maritime, air, and land transport sectors. Yemen's maritime transport sector comprises three port corporations responsible for port management, namely the Yemen Gulf of Aden Ports Corporation (YGAPC), the Yemen Red Sea Ports Corporation (YRSPC), and the Yemen Arabian Sea Ports Corporation (YASPC), in addition to the Maritime Affairs Authority (MAA).

The Yemen Gulf of Aden Ports Corporation (YGAPC) manages Aden Container Terminal (ACT), as well as the ship berths at Al-Mua'alla, Little Aden, Hugayf, and Al-Tawahi, in addition to the inner harbour of the Port of Aden, its navigation channels and waterways, breakwaters, anchorages, and mooring buoys. The Yemen Red Sea Ports Corporation (YRSPC) manages the Ports of Al Hudaydah and Al-Salif in Al Hudaydah Governorate, as well as the Port of Al-Mokha in Taiz Governorate. The Yemen Arabian Sea Ports Corporation (YASPC) manages three ports: the Port of Mukalla in Hadhramaut Governorate, the Port of Nishtun in Al Mahrah Governorate, and the Port of Socotra in the Socotra Archipelago Governorate (YASPC, 2026).

The three port corporations were established in 2007 with the objective of enabling Yemeni ports to contribute effectively to the implementation of the State's development plans and to carry out their responsibilities relating to the construction, development, modernization, operation, and enhancement of the ports and facilities under their jurisdiction, based on modern economic and commercial management practices. Within the framework of the State's general policy and the applicable legislation, these corporations were entrusted with a range of responsibilities and powers, including the preparation of comprehensive and detailed plans for the construction, development, and modernization of the ports and facilities under their authority in all relevant fields. They are also responsible for the expansion, upgrading, and deepening of ports, as well as the construction and maintenance of ship berths, breakwaters, and navigation channels (YGAPC, 2026).

The Maritime Affairs Authority (MAA) was officially established in 2001 pursuant to Republican Decree No. (352). It is a governmental authority responsible for implementing the State's functions in the field of maritime affairs and enjoys financial and administrative autonomy. Its responsibilities include ensuring maritime navigation safety, protecting the marine environment, conducting vessel inspection and oversight within Yemen's territorial waters, and implementing international conventions and treaties to which the Republic of Yemen is a party (MAA, 2026).

In addition to commercial ports, Yemen has a number of oil ports supervised by the Ministry of Oil and Minerals, the most prominent of which is the Port of Ash Shihr (Al-Dhabbah), located on the Arabian Sea in Hadhramaut Governorate. There is also the Balhaf Oil Port, which likewise overlooks the Arabian Sea in Shabwah Governorate, and the Port of Ras Isa on Red Sea (Ministry of Oil and Minerals, 2026). Furthermore, a number of fishing ports and fishing harbours are distributed along the Yemeni coastline.

3.3 Commercial Ports in Yemen: An Overview

Yemen's distinctive strategic location on Red Sea, the Gulf of Aden, the Arabian Sea, and the Indian Ocean, together with its coastline extending for more than 2,500 kilometres and its oversight of one of the world's most important maritime corridors—the Bab al-Mandab Strait—has enhanced its role in maritime transport and regional shipping activity. This role is further supported by the natural advantages enjoyed by Yemeni ports, including protection from prevailing winds and deep-water conditions (MOT, 2009).

Maritime transport constitutes a fundamental pillar of the economy of the Republic of Yemen, owing to its extensive coastline and its network of ports, including three principal ports: Aden, Mukalla, and Al Hudaydah. This is in addition to its strategically important islands and its location overlooking the Bab al-Mandab Strait, through which approximately 20,000 vessels pass annually within Yemen's territorial waters (National Information Center, 2019).

The current status of Yemen's commercial ports may be summarized as follows:

1. Port of Aden

According to the decree to establish Yemen Gulf of Aden Ports Corporation (YGAPC), the Port of Aden comprises a variety of facilities and terminals, as follows:

• Al-Ma'alla Multipurpose Terminal

This terminal accommodates vessels of various sizes and includes berths of different dimensions, as follows:

- A Ro-Ro berth measuring 150 metres in length, 20 metres in width, and with a water depth of 7.6 metres. It is used by general cargo vessels with an overall length of up to 144 metres.
- Four main berths (Berths 1–4), each measuring 187.5 metres in length, with a combined total length of 750 metres and an alongside depth of 11 metres. The turning basin located north of these berths is 280 metres wide and extends along the length of the main berths.
- Two berths (Berths 5 and 6) designated for domestic trade vessels and traditional dhows at the domestic trade quay. Their combined length is 250 metres, with an alongside depth of 6.7 metres. At the same depth, the berths are served by a turning area extending 250 metres from the quay walls along their length.
- The terminal also includes berths for lighters and barges, with a total length of 800 metres and depths ranging between 1.8 and 2.7 metres (YGAPC, 2026).

• Oil Harbour

Aden Refinery and the Oil Harbour were constructed in the mid-1950s to receive crude oil from other countries, refine it, and supply the various grades of fuel required by vessels calling at the port. This role contributed to the growing success of the Port of Aden as an intermediate bunkering centre between Europe, the Indian subcontinent, and the Far East. Up to 2014, Aden Refinery Company (ARC) handled approximately 12 million metric tonnes of crude and refined petroleum products. Since 2015, the refinery has handled only imports and exports of refined petroleum products (YGAPC, 2026).

• Gulf of Aden Terminal

This facility consists of a privately owned jetty with two berths having a combined length of 303 metres and a width of 28 metres. Berth No. 1, located on the northern side, was designed with an alongside depth of 14 metres below chart datum, while Berth No. 2, located on the southern side, was designed with a depth of 12 metres (YGAPC, 2026).

2. Port of Al Hudaydah

The coastal city of Al Hudaydah and its port on Red Sea coast occupy a central geographic position relative to the densely populated northern governorates. This location has enabled the city to play an important role in the Yemeni economy, making its port one of Yemen's most important seaports and the country's principal gateway to Red Sea, through which Yemen connects with the outside world and through which a substantial share of exports, imports, and the goods required for economic growth and development pass.

The Port of Al Hudaydah is located on the southeastern coast of Red Sea, approximately at the midpoint of Yemen's western coastline. It covers a total area of 314,955,726 square metres, of which 307,455,726 square metres constitute water area and 7.5 million square metres constitute land area. The port operates with a design capacity of up to 9,000,000 tonnes of general cargo, dry and liquid bulk cargo, and containerized cargo, in addition to 280,000 Twenty-foot Equivalent Units (TEUs). The port is served by a navigation channel measuring 10.433 nautical miles in length, 200 metres in width, and 10 metres in depth. The turning basin has a diameter of 400 metres and a depth of 10 metres (YRSPC, 2026).

The Port of Al Hudaydah has eight berths with a combined length of 1,461 metres, in addition to two berths, each measuring 250 metres in length, located within the port basin and designated for the discharge of petroleum tankers and other petroleum products. These berths have a draft of 10 metres at Lowest Low Water (LLW). The port also contains 12 warehouses with a total floor area of 37,230 m² and a total storage volume of 260,820 m³, designated for the storage and preservation of various types of cargo, particularly commodities that are sensitive to sunlight and humidity.

In addition, the port includes a number of paved concrete storage yards with a total area of 120,000 m², designated for stacking and storing containers of various sizes, as well as additional compacted and reclaimed storage yards covering a total area of 1,635,404 m², designated for storing a variety of cargoes, including timber, steel, and vehicles. The port also contains a dedicated storage area for hazardous materials (YRSPC, 2026).

3. Port of Mukalla

The Port of Mukalla serves as the headquarters of the Yemen Arabian Sea Ports Corporation (YASPC) and is the largest port under its administration. It is the only seaport in Hadhramaut Governorate overlooking the Arabian Sea. The port was inaugurated at its present location in the Khalf area of the city of Mukalla in January 1985 as a multipurpose port serving commercial cargo, fisheries, and petroleum products for the governorate and neighboring governorates.

Although the port was originally designed to accommodate vessels with a capacity of no more than 10,000 tonnes, this limitation has not been observed since the port's establishment due to the urgent need to receive larger vessels exceeding 20,000 tonnes, subject to the maximum permissible draft of 8.5 metres (YASPC, 2026).

The Port of Mukalla comprises three berths. The first berth is 177 metres long with a draft of 8.5 metres; the second berth is 184 metres long with a draft of 8.5 metres; and the third berth is 162 metres long with a draft of 4.5 metres. The port is also served by an anchorage located 1–2 nautical miles from the breakwater, an entrance channel 207 metres wide, a turning basin with a diameter of 230 metres, and a channel depth of 11 metres. The port's storage yards have the capacity to accommodate approximately 1,000 containers, while an external container yard provides a storage capacity of 8,000 containers (YASPC, 2026).

3.4 General Status of Yemeni Ports

The transport sector in Yemen is among the sectors most severely affected by the ongoing conflict, which has become a major source of concern for the private sector. The significant difficulties experienced by private sector activities as a result of the conflict have led to a substantial increase in transportation costs, which has, in turn, contributed to higher commodity prices in the domestic market (Qasim & Abdullah, 2024).

Yemeni ports are experiencing an escalating shortage of maintenance and resources as a result of the continuing conflict. This is compounded by the absence of comprehensive strategic plans, restricted access to essential equipment, infrastructure, and spare parts, limited preventive and corrective maintenance, inadequate staff training and capacity-building, as well as increased additional insurance premiums against war risks (UNDP, 2021).

Table (8): Yemen's Ranking According to International Port Performance Measurement Indicators	
Description	Rep. of Yemen
Logistics Performance Index (LPI), 2023	2.2
Port Infrastructure Quality Index	2.20
INFORM Risk Index, 2025	8.1
Source: (World Bank, 2023); (The Global Economy, 2019); (European Commission, 2026).	

The deterioration experienced by Yemeni seaports is attributable to the combined effects of the ongoing conflict, extensive damage to infrastructure, fragmented governance, and severe resource constraints (Humran, 2025).

Recent international indicators reflect Yemen's low ranking in logistics services, port infrastructure, and risk management. Yemen recorded a score of 2.2 in the 2023 Logistics Performance Index (LPI), a score of 2.20 in the 2019 Port Infrastructure Quality Index, and a score of 8.1 in the 2025 Risk Management Index, as shown in Table (8). These values are considerably lower than regional benchmarks and clearly indicate the weak performance of Yemeni ports and the inadequacy of their technical and operational preparedness. They further confirm that the current condition of Yemeni ports—in terms of infrastructure, services, and risk management capacity—remains far below internationally recognized standards and practices. These international indicators merely provide a quantitative reflection of the sector's decline and the challenges confronting the port sector in the Republic of Yemen.

3.5 Challenges and Constraints Facing Yemeni Ports

Yemen's seaports face a complex set of challenges closely linked to the conditions of war and conflict. Foremost among these are the deterioration of infrastructure and the destruction or disruption of land transport networks, which constitute the hinterland connections of the ports, in addition to the absence or weakness of logistics centres and dry ports. This naturally leads to longer transit times, higher transportation costs, and reduced port competitiveness. Yemeni ports also face regulatory and procedural challenges, including unlawful fees imposed at checkpoints, duplication of customs procedures, and the multiplicity of authorities involved in the transport and clearance chain. Furthermore, unplanned urban expansion around port areas and encroachments on master plans undermine both the operational efficiency of ports and their capacity to accommodate increasing traffic volumes (Qasim & Abdullah, 2024).

The principal challenges and constraints facing Yemeni ports may be summarized as follows:

- Geopolitical tensions and security threats in Red Sea and the Gulf of Aden, including attacks on vessels and port infrastructure, which have resulted in the classification of the region as a “high-risk area” (Humran, 2025). In addition, maritime risks and threats to Yemeni and regional maritime security have intensified within the regional maritime geostrategic zone encompassing Red Sea and the Indian Ocean, to the extent that the vital Yemeni and Arab maritime domain has become an arena of regional maritime conflict (Humran, 2024).
- Diversion of shipping routes, significant increases in transit times and fuel costs (Humran, 2025), together with rising freight charges, marine insurance premiums, and war-risk surcharges imposed on vessels bound for Yemen. These challenges are compounded by shortages of qualified personnel, weak capacity-building in port operations and maritime security, and limited digital transformation and port information systems (UNDP, 2021).
- Extensive damage to port infrastructure and a substantial decline in operational capacity, coupled with the absence of modern operating systems and shortages of maintenance resources and technical capabilities (Humran, 2025). In addition, the limited institutional capacities of ports have contributed to increased transportation and logistics costs at every stage of the food supply chain, costs that are ultimately passed on directly to consumers (UNDP, 2021).
- Fragmented maritime governance and the existence of multiple decision-making and control authorities over ports, together with the complex procedures associated with inspection, supervision, and the issuance of permits, create a high-risk environment that discourages investment and vessel traffic (Humran, 2025). In addition, there is an absence of modern maritime administrative policies and a lack of Yemeni, Arab, and

regional maritime political integration across maritime sectors, coupled with the weak implementation of Marine Spatial Planning (MSP) (Humran, 2024).

- Challenges affecting Yemen's marine environment, which is exposed to a range of natural and human-induced risks, particularly those associated with intensive maritime activities and the movement of civilian and military vessels powered by fossil fuels. These activities have generated cumulative adverse impacts on the marine environment and ecosystem of Red Sea and the Indian Ocean (Bouwman, 2024). Furthermore, the presence of the United States Navy and other Western naval forces in the region, together with their extensive military maritime activities, has had adverse effects on the marine environment, creating additional challenges for the management and protection of sustainable maritime development (Humran, 2024).
- Limited investment and financial resource constraints resulting from the economic collapse, together with the inability of international assistance to meet the requirements for reconstruction and modernization, have perpetuated a vicious cycle of deteriorating infrastructure, weak performance, and declining revenues (Humran, 2025).
- Social, economic, and humanitarian impacts, whereby port disruptions and rising shipping costs lead to shortages of fuel, food, and essential commodities, as well as higher prices. This further aggravates the humanitarian crisis, making the development of the maritime sector not only an economic necessity but also a humanitarian imperative (Humran, 2025).

3.6 Aden Container Terminal: Capabilities and Future Opportunities

The Yemen Gulf of Aden Ports Corporation (YGAPC) was established under its current name pursuant to Republican Decree No. (61) of 2007, replacing the Yemen Ports Authority in Aden. The following facilities were transferred to the newly established corporation: (1) Aden Container Terminal (ACT); (2) the ship-handling berths at Al-Ma'alla Port and the Little Aden, Hugayf, and Al-Tawahi areas, in addition to the inner harbour of the Port of Aden (Establishment Decree of the Corporation, 2007).

Aden Container Terminal (ACT) was officially inaugurated in 1999. It accounts for approximately 70% of the activity of the Port of Aden and is located on the northern shore of the port. The terminal handles transit cargo as well as import and export containers serving the domestic market. It was initially operated by international companies specializing in container terminal operations. Since 20 September 2012, however, it has been managed by a Yemeni national company, Aden Ports Development Company (YGAPC, 2026). Table (9) presents the successive management periods of the companies responsible for operating Aden Container Terminal over the past twenty years.

Table (9): Management Periods of the Successive Operators of Aden Container Terminal				
#	Operating Company	From	To	Management and Operating Period
1	Port of Singapore Authority (PSA)	1999	2003	4 years
2	Overseas Ports Management (OPM)	2003	2007	4 years
3	Dubai Ports World (DP World)	2008	2012	4 years
4	Aden Ports Development Company (APDC)	2012	2024	12 years
Source: (Amzarbah, 2023)				

The data presented in Table (9) indicate that the management and operating contracts for Aden Container Terminal (ACT) were of relatively short duration and were awarded successively to several operators. This adversely affected the stability of the terminal's operational plans and development programs. The differing operational and development strategies adopted by these companies resulted in the absence of a long-term cumulative investment approach. Consequently, the role of most operators was largely confined to maintaining the status quo and replacing obsolete equipment with new equipment solely to ensure continuity of operations, without achieving any qualitative improvement in performance. Moreover, the terminal did not benefit from sustained strategic investment capable of strengthening its competitive position, with the exception of the investments made during its initial construction in 1999. This significantly constrained the terminal's development and prevented the full utilization of its operational potential (Amzarbah, 2023).

In addition, terrorist incidents had a significant impact on the terminal. The bombing of the USS Cole at the Port of Aden in 2000 led to the withdrawal of the Singaporean terminal operator, Port of Singapore Authority (PSA) (Al-Subhi & Al-Qamli, 2024). Likewise, Dubai Ports World (DP World) withdrew from operating the Port of Aden despite having concluded a 30-year operating agreement, which was not implemented as intended and was subject to extensive political and economic criticism. The dispute between the company and the Yemeni Government was ultimately resolved through the mutual termination of the contract (Rubban Al-Safina Magazine, 2025).

The withdrawal of international operators from the management of Aden Container Terminal was attributable to several interrelated security, economic, and institutional factors, as well as the limited scope of the preliminary studies underpinning the contracts and their implementation and monitoring mechanisms. The agreements were not based on sufficiently detailed assessments of operational and security risks, nor were they supported by flexible financial models capable of accommodating fluctuations in the maritime transport market. Furthermore, the agreements lacked clearly defined quantitative performance indicators and periodic review mechanisms that would have enabled contractual obligations to be adjusted in response to changing circumstances.

In addition, differences emerged between the contracting parties regarding the scope of development, implementation priorities, and project timelines. It also became evident that, when selecting an operating partner, any potential regional conflict of interest should be avoided by ensuring that the success of the contracted port represents a direct operational and commercial interest for the operator, rather than merely constituting an additional facility within a broader port network in which commercial priorities may overlap among geographically proximate or functionally similar ports.

Aden Container Terminal (ACT) possesses a number of important attributes that qualify it to become one of the competitive container terminals in the region. The most notable of these attributes are as follows:

- It is the largest container terminal in Yemen and the most modern in terms of equipment and electronic systems (Amzarbah, 2024). The terminal enjoys a strategic location on the international shipping route linking the East and the West, through which approximately 15% of global container traffic passes (ACT, 2024). Vessels require no more than 4 nautical miles to alter course and reach the pilot station. The terminal is also naturally protected from waves and the northeast and southwest monsoon winds, enabling uninterrupted year-round operations (YGAPC, 2023). It is located only 105 nautical miles from the Bab al-Mandab Strait (ACT, 2024) and

complies with the requirements of the International Ship and Port Facility Security (ISPS) Code.

- The terminal is closely integrated with the economic city of Aden and the surrounding governorates, making it part of a commercial centre with a history extending back more than 3,000 years (YGAPC, 2023). It also plays a vital role in connecting Yemen's major population centres over relatively short distances (Amzarbah, 2024).
- The terminal and its workforce have demonstrated a strong capacity for operational continuity, even during periods of crisis. Despite the conflicts and wars experienced in Yemen, the terminal suspended operations for only three to four months during 2015, after which it resumed operations promptly (Alghaithi, 2022).
- The terminal has development plans to expand its storage capacity to 1,545,000 Twenty-foot Equivalent Units (TEUs) and extend the quay 400 metres westward. A second expansion phase is also planned to increase storage capacity to 3,325,000 TEUs and further extend the quay by 1,000 metres to the west (ACT, 2024).
- The terminal operates an Electronic Data Interchange (EDI) system, which is used for uploading inbound and outbound container data, automatically generating invoices for services provided to vessels, automatically calculating container charges, and providing shipping lines with daily reports on containers entering and leaving through the port gate (ACT, 2024).

Table (10): Performance Measurement of Aden Container Terminal, 2021–2023

Indicator	Unit of Measurement	2021	2022	2023
Number of Containers Handled	TEU	418,711	365,470	282,652
Berth Occupancy Rate	%	42%	35%	29%
Yard Utilization Rate	%	62%	52%	43%
Vessel Productivity	Moves/Hour	25	23	30
Quay Crane Productivity	Moves/Hour/Crane	16	16	18
Vessel laytime/laydays	Hours	78	66	55
Source: Aden Container Terminal (ACT), 2023				

Despite the strengths and competitive advantages possessed by Aden Container Terminal (ACT), the terminal continues to experience performance shortcomings resulting from several factors. Among the most significant are the political conditions that have affected the country since 2011, with the situation deteriorating further after 2015 due to the Yemeni crisis and the ongoing conflict. These developments have led to a decline in commercial activity at Yemeni ports, the suspension of interest in and support for port sector development projects, and the reluctance of some shipping lines to call at Yemeni ports because of the unstable security environment (Al-Yazeedi, 2021).

All of these factors have resulted in a substantial increase in shipping costs, underscoring the importance of rehabilitating Yemeni ports to make them safer, more efficient, and less costly for commercial operations. Such measures are of critical importance. If port infrastructure is rehabilitated, shipping companies' operating costs will decline, while the number of vessels calling at Yemeni ports and the number of commercial enterprises seeking to conduct business in Yemen will increase (UNDP, 2021).

According to a specialized assessment conducted by the United Nations Development Programme (UNDP) in Yemen in 2021 to evaluate the performance of the Port of Aden, the port requires a comprehensive investment package to maintain its current operational capacity. The assessment found that operational capacity had declined as a result of inadequate maintenance, deteriorating infrastructure, and limited institutional capacity. It also concluded that the port lacks long-term investment plans and that risk management has not been systematically integrated into decision-making processes. Furthermore, the assessment highlighted weak awareness of health, safety, and environmental (HSE) issues at the port, delays in cargo-handling equipment, and deficiencies in coordination and organization between the port authorities and the Customs Authority (UNDP, 2021).

Table (10) presents selected statistics for Aden Container Terminal through 2023, the latest year for which published data are available. The statistics indicate a decline in the number of containers handled by the terminal during the period 2021–2023. They also show decreases in berth occupancy and yard utilization rates, while vessel productivity improved, increasing to 30 moves per hour in 2023, compared with 23 moves per hour in 2022 and 25 moves per hour in 2021. The statistics further indicate improvements in quay crane productivity and reductions in vessel time in port compared with the same years. These findings confirm the need for continued development and performance enhancement at the terminal, while sustaining the efforts that have contributed to the improvements reflected in the aforementioned indicators.

The port's relatively low level of performance can be observed through its low berth occupancy rate, low yard utilization rate, vessel productivity, quay crane productivity, and vessel time in port, all of which remain below global averages (Statista, 2024).

It is worth noting that Aden Container Terminal (ACT) possesses a number of strengths and opportunities, alongside the weaknesses and threats it faces. These may be summarized as follows:

Strengths	Weaknesses	Opportunities	Threats
The most effective and efficient port in the Republic of Yemen.	The port's location in the temporary capital creates security and administrative complexities.	A relatively secure investment climate and political and security stability that encourage investment in the port.	Instability in the security and political environment hinders investment in the port.
Proximity to an international maritime strait linking East and West.	Limited draft and depth of the navigation channel and container vessel berths.	Leveraging the port's geographical location to transform it into a regional and international logistics hub.	Competition from neighboring ports with modern infrastructure and lower operating costs.
A naturally protected port that operates year-round with minimal interruption from natural factors.	Weak infrastructure and inconsistency in specifications and services within the container terminal.	Developing the port into an advanced logistics platform supporting the national economy.	Insufficient government investment in the port's infrastructure, energy, transport, and communications sectors.

Strengths	Weaknesses	Opportunities	Threats
High container-handling efficiency with short unloading, delivery, and storage times.	Weak technological infrastructure and electronic systems for port management and operations.	Establishing special economic zones and logistics clusters to support port activities.	Rising operating and maintenance costs amid ongoing economic challenges.
The container terminal has the capability to handle cargo directly using shore-based cranes.	Inadequate integration with road, rail, and air transport networks.	Building effective partnerships with local and international private-sector stakeholders.	Competing regional ports outperform in operational efficiency and cost competitiveness.
A large and modern container terminal in terms of specifications and electronic systems.	Shortage of certain specialized technical personnel.	Linking the port to national, regional, and international transport and logistics projects.	Weak domestic demand for port services due to prevailing economic conditions.
Availability of qualified and trained personnel with extensive accumulated experience in port operations.	Limited continuous training programmes to keep pace with modern developments.	Potential government support for developing the port's institutional and legal framework.	Weak purchasing power among individuals and businesses limits the expansion of port-related activities.
The port's inland location is at a moderate distance from the country's major population centres.	Heavy reliance on limited resources for financing, maintenance, and renewal.	Integrating the port into a comprehensive national transport and logistics strategy.	Geopolitical and regional risks that may affect shipping and trade flows through the Arabian Sea and the Gulf of Aden.
Source: (Amzarbah, 2024)			

To strengthen the future role of the Port of Aden and restore its historic position in serving international shipping and supporting development in Yemen, it is important to focus on providing a number of essential requirements and prerequisites, the most important of which are the following:

Infrastructure Development

According to relevant reports, the port's operational capacity has declined as a result of inadequate maintenance and deteriorating infrastructure, making rehabilitation essential in order to reduce shipping companies' costs and increase the number of vessels calling at the terminal (UNDP, 2021). The container terminal, in particular, requires the implementation of storage-yard expansion projects and the acquisition of advanced, high-technology equipment capable of serving ultra-large container vessels. Among the most important projects in this regard are the deepening and widening of the port's navigation channel (Elhussiny, 2020).

Achieving Digital Transformation Requirements

This requires the provision of remote sensing devices, the installation of electronic gates and renewable energy sources, and efforts to implement ISO energy management requirements. It also involves the deployment of advanced Zodiac software solutions, which facilitate the electronic integration of customers into the system as registered users, enabling them to conduct transactions, generate invoices, and make electronic payments, among other services (Amzarbah, 2023).

Improving the Integrated Administrative System

This can be achieved through the development of long-term investment plans, strengthening coordination and organizational mechanisms between the container terminal and the Customs Authority (UNDP, 2021), and fostering effective partnerships with globally competitive private-sector operators. Such measures would contribute to improving logistics services, enhancing supply chain quality, and increasing the terminal's competitiveness (Al-Bishi, 2020).

Risk Management and Compliance with Safety Requirements

This includes strengthening occupational health and safety standards for both port employees and users (UNDP, 2021). This aspect also extends to enhancing security discipline throughout the city of Aden as a whole (Qardash, 2021).

Human Capital Development

This requires intensifying training and capacity-building programmes for local personnel (Elhussiny, 2020), as well as recruiting and developing highly trained staff capable of maintaining and repairing equipment, managing asset investment cost expectations, and properly prioritizing maintenance requirements. Such measures would contribute significantly to improving the performance of the terminal. In addition, employee awareness of safety-related issues should be enhanced, particularly in light of the current shortcomings in the implementation of general safety measures (UNDP, 2021).

3.7 Ports in Red Sea and Arabian Gulf Region (General Overview)

In addition to Yemen, this paper examines seven commercial ports located in seven Arab countries with the objective of developing a comprehensive understanding of the current status and performance of the region's ports. It subsequently ranks these ports in accordance with internationally recognized indicators and classifications and derives lessons learned that may be applied to improve the performance of the Arab port system in general and Yemeni ports in particular. To enhance the practical value of the paper, personal interviews were conducted with Arab maritime experts and business executives whose activities are directly associated with the operations of these ports. The purpose was to draw upon their practical experience in assessing the status of the ports concerned and to formulate practical recommendations for the development of the maritime transport sector and commercial ports in the Arab world.

1. Jebel Ali Port, United Arab Emirates

Jebel Ali Port serves as the principal gateway for more than 80 weekly liner shipping services, connecting over 150 ports worldwide. The port has been recognized as the Best Seaport in the Middle East for twenty-four consecutive years and is one of the world's largest container ports. It also contains the largest man-made harbour in the world (DP World, 2026). According to

the Lloyd's List rankings for 2025, Jebel Ali Port ranked ninth globally and first among Middle Eastern ports (Lloyd's, 2025).

DP World has completed the implementation of the Zodiac Operating System at Container Terminal 3 of Jebel Ali Port. This system enhances the port's future readiness through the adoption of Fourth Industrial Revolution (Industry 4.0) technologies, making the terminal one of the most advanced and intelligent port terminals in the region, comparable to the world's leading smart port terminals. The system comprises 18 integrated subsystems, including an automated crane operating system and berth planning system. It also enables the terminal to manage rail operations, track the real-time location of containers, and perform customs clearance, cargo delivery, and other operational functions (Al-Ibrahimi, 2021).

The port comprises four container terminals. Container Terminal 1 has a capacity of 9 million TEUs, with 15 berths and 51 quay cranes. Container Terminal 2 has a capacity of 6.5 million TEUs and is equipped with 32 quay cranes and eight berths. The advanced technologies deployed at this terminal have contributed to a 30% reduction in carbon emissions. Container Terminal 3, equipped with state-of-the-art technologies, has become one of the world's largest semi-automated container terminals. It comprises five berths with a handling capacity of 3.8 million TEUs and is equipped with 19 automated quay cranes and 50 automated rail-mounted gantry cranes (RMGs). The terminal is capable of accommodating ultra-large container vessels (ULCVs) with capacities exceeding 18,000 TEUs. Container Terminal 4 is currently under development and has been designed to meet both current and future market requirements. Upon completion, the total capacity of the port will reach 22.4 million TEUs (DP World, 2023).

2. Jeddah Islamic Port, Kingdom of Saudi Arabia

Jeddah Islamic Port ranks as the leading port on Red Sea. It has enjoyed historical prominence since its establishment during the reign of Caliph Uthman ibn Affan (may Allah be pleased with him) in 646 CE (25 AH). The port serves as the Kingdom of Saudi Arabia's primary gateway for exports and imports and is the foremost re-export hub on Red Sea. Approximately 75% of the maritime trade destined for Saudi ports passes through Jeddah Islamic Port (Mawani, 2026).

The city of Jeddah has long been recognized as Saudi Arabia's modern commercial centre, while Jeddah Port historically occupied a strategic position along the ancient Silk Road, which connected China with Europe. Today, the port's terminals handle more than 60 million tonnes of cargo annually (Hallak, 2022). It is among the few ports worldwide that do not suffer from the congestion and delays experienced by many other ports (Lloyd's, 2022). According to the Lloyd's report for 2025, Jeddah Islamic Port ranked 55th globally.

The port includes comprehensive logistics services, two container terminals with a combined handling capacity of 7.5 million TEUs, two general cargo terminals, and two ship repair docks for the maintenance of marine assets. The port occupies an area of 12.5 km² and is equipped with 18 berths and 111 cranes (Mawani, 2023).

In 2022, the port received the Best Port Award and won the Digital Transformation Award at the International Green Shipping Summit Awards, during its seventh edition held in Rotterdam, the Netherlands, on 15–16 February 2023 (Ibrahim, 2023). According to the **Lloyd's List** rankings for 2025, Jeddah Islamic Port ranked 55th globally and fourth among Middle Eastern ports (Lloyd's, 2025).

3. Port of Salalah, Sultanate of Oman

The Port of Salalah was established in 1998 and has since become one of the largest ports in both the region and the Sultanate of Oman (Port of Salalah, 2026). According to the World Bank's Container Port Performance Index (CPPI) 2023, it ranked second among the world's container terminals (World Bank, 2024). It was also ranked 66th globally in the Lloyd's List report for 2025.

The port is managed by APM Terminals, a member of the Maersk Group, which operates 76 container terminals worldwide. The container terminal at the Port of Salalah relies primarily on transshipment traffic generated by Maersk (Port of Salalah, 2021).

The Port of Salalah Container Terminal comprises six berths with a total length of 2,197 metres, a maximum draft of 18 metres, and an annual handling capacity of 5 million Twenty-foot Equivalent Units (TEUs). Supported by the Government of Oman, renewable energy initiatives are gaining momentum as part of a long-term vision to transform Salalah into a green energy hub (Port of Salalah, 2023).

The Port of Salalah has implemented an Asset Digitalization System to monitor productivity and operational efficiency, in addition to laser-based anti-collision systems that provide protection for both equipment and pedestrians (APM Terminals, 2023).

The port has also joined the TradeLens platform, the blockchain-enabled system jointly developed by Maersk and IBM to enhance and secure maritime shipping operations. The platform includes more than 100 participating organizations, comprising shipping companies, ports, terminal operators, third-party logistics providers, freight forwarding companies, and customs clearance service providers (Al-Shahri, 2020).

4. Port of Aqaba, Jordan

The Aqaba Port Authority was established in 1952 pursuant to a Royal Decree. In 1978, it was restructured as the Ports Corporation, which became responsible for the operation of Jordan's ports and port facilities. The Port of Aqaba is owned by the Aqaba Development Corporation (ADC) and currently comprises 12 terminals extending across 32 berths. The port consists of three principal components: the Main Port of Aqaba, the Aqaba Container Terminal (ACT), and the Aqaba Industrial Terminal (Al-Sheikh, 2022).

The port is located on the northeastern shore of the Gulf of Aqaba, at the southernmost tip of the Hashemite Kingdom of Jordan, within the Aqaba Special Economic Zone (ASEZ). The port system benefits from its proximity to the capital, Amman, and other major regional cities. Aqaba is located approximately 350 kilometres from Amman, around 180 kilometres from the NEOM region in Saudi Arabia, and approximately 980 kilometres from Baghdad. It is also connected to King Hussein International Airport, as well as to regional road networks and land border crossings with Saudi Arabia, Egypt, and Iraq (Aqaba Development Corporation, 2026).

The Port of Aqaba constitutes the foundation upon which Red Sea city of Aqaba was established, and the city's economy depends heavily on the port sector. This played a key role in the designation of Aqaba as a Special Economic Zone in 2001, providing it with investment

incentives that have transformed it into a global tourism and investment destination on Red Sea. The city offers a world-class port system distinguished by the quality and sophistication of its services and its ability to handle a wide range of cargoes, including containers, dry bulk cargo, liquid bulk cargo, as well as cruise vessels throughout the year. These capabilities have enabled Aqaba to establish itself as a leading hub for both industrial and cruise shipping (ASEZA, 2026).

5. East Port Said Port

The Port of East Port Said was established at a strategic location on the eastern side of the northern entrance to the eastern branch of the Suez Canal, at the crossroads of three continents and along the principal East–West maritime trade route (MTS, 2026). The port is one of the flagship projects of the Suez Canal Economic Zone (SCZone), which was established as a public authority operating under the Special Economic Zones Law. The objective was to insulate the zone from conventional government administrative procedures and bureaucratic complexities by creating an independent, flexible, rapid, and decisive decision-making framework vested in a single competent authority (Suez Canal Authority, 2025).

The foundation stone for the port was laid in March 1999, while the first phase of its container terminal commenced operations in 2004. Since the establishment of the Suez Canal Economic Zone, the port has been developed in accordance with a comprehensive master plan under which the Port of East Port Said constitutes a principal component of the integrated East Port Said Development Area, covering approximately 145 km². This area comprises an industrial zone of 64 km², three logistics zones with a combined area of 24 km², and a port whose first development phase includes 7.4 km of quay length, a main turning basin with a diameter of 950 metres, an auxiliary turning basin with a diameter of 870 metres, extensive back-up storage yards serving the container terminals, a multipurpose terminal, a clean dry bulk terminal, a dedicated roll-on/roll-off (Ro-Ro) vehicle terminal, and a logistics back-up area covering 6 km². The port has become a major transshipment hub in the Eastern Mediterranean region, handling approximately 79% of Egypt's total container transshipment traffic and around 43% of the country's total container trade (MTS, 2026).

The existing container terminal, operated by AP Moller and Maersk Line, serves as a major container hub. In mid-November 2025, during the preparation of this study, the second container terminal was inaugurated with a handling capacity of approximately 2.2 million TEUs, representing an increase equivalent to 45% of the port's previous capacity. The expansion project included the construction of a 955-metre quay and a 510,000-square-metre container yard. Earlier expansion phases had already increased the port's total quay length from 5 km to 7.4 km, while the harbour basin measures 550 metres in width, extends 7 kilometres in length, and has a depth of 18.5 metres (SCZone, 2026).

6. Port of Djibouti

The Port of Djibouti is one of the most important pillars of the national economy of the Republic of Djibouti, serving as one of the country's principal sources of public revenue. It is also regarded as one of the most important and modern ports in East Africa, distinguished by its advanced facilities, equipment, and services. The port functions as a major maritime hub situated at the intersection of numerous international shipping routes (Issa, 2023).

The port also serves as a secure regional hub for cargo transshipment and distribution, benefiting from an ideal strategic location that makes it the natural gateway linking 19

countries with a combined population of approximately 380 million people (Port de Djibouti, 2026). The port's role within Djibouti's economy has been significantly influenced by regional political developments and by the economic growth of neighbouring countries, particularly Ethiopia. Construction of the port and the railway connecting it to the Ethiopian highlands commenced simultaneously in order to facilitate access to Ethiopia and strengthen regional trade connectivity (Issa, 2023).

Djibouti's first modern container terminal commenced operations in February 1985. From June 2000, Dubai Ports World (DP World) assumed the management of the Port of Djibouti under a 20-year concession agreement. However, beginning in July 2011, the port underwent a series of institutional and regulatory changes during which the concession arrangement was terminated (Port de Djibouti, 2026).

7. Port Sudan

Sudan enjoys a strategic geographic location along Red Sea coastline, extending for more than 800 kilometres. This location has provided the country with an exceptional opportunity to become a regional hub for maritime transport and transit. Sudan is also endowed with abundant and diverse natural and agricultural resources, making it a strong candidate to become the "breadbasket of the world" in the future (UNCTAD, 2023). The Sudan Sea Ports Corporation (SSPC) occupies a prominent position along Red Sea coast, with its affiliated ports handling substantial volumes of import and export cargo. Foremost among these is the Port Sudan Port Complex, which comprises several ports, including the South Port, dedicated to container traffic; the Green Port, serving cargo vessels; and the Port of Suakin, which primarily handles passenger traffic and cargo destined for the Port of Jeddah in the Kingdom of Saudi Arabia (Sudan Sea Ports Corporation, 2026).

Port Sudan is the principal gateway for cargo movement and maritime trade between Sudan and neighbouring countries. The port plays a vital role in supporting the national economy by accommodating various types of vessels and handling a wide range of cargoes, including containers, general cargo, and bulk commodities (Abu Shama, 2024).

Construction of Port Sudan commenced in 1905. The port received its first vessel in 1906 and was officially opened to commercial operations in 1909 (Maha Ahmed & Amin Al-Haj, 2025). It is a natural harbour situated approximately at the midpoint of the western coast of Red Sea. The entrance channel has a depth of approximately 61 metres and a width of 274 m, while the utilised water area of the harbour basin covers approximately 1.3 million Sqm (Abu Shama, 2024). The Sudan Sea Ports Corporation administers several seaports, in addition to one river port and one dry port (Maha Ahmed & Amin Al-Haj, 2025).

The port benefits from its proximity to international shipping lanes and possesses considerable potential for future expansion due to the extensive land area available for development. It is naturally protected from waves and sea currents, while both the port and the surrounding area are generally unaffected by seasonal monsoon winds. The port also provides 29 offshore anchorage areas designated for vessel waiting and waste disposal operations (Abu Shama, 2024).

The Port Sudan Port Complex consists of a network of specialised berths and terminals distributed among the North Port, South Port, container terminals, and specialised cargo-handling facilities. The North Port is dedicated to handling general cargo and various bulk commodities, whereas the South Port and the container terminals comprise several berths

equipped to serve container vessels and bulk wheat carriers, enabling the port to accommodate the majority of Sudan's foreign trade. The complex also includes specialised facilities for handling petroleum products and other strategic commodities, in addition to Prince Osman Digna Port, which is dedicated to passenger services, livestock exports, and certain cargoes destined for the opposite coast of Red Sea. Accordingly, Port Sudan serves as Sudan's principal maritime gateway and the country's primary link to international trade (Maha Ahmed & Amin Al-Haj, 2025).

3.8. Challenges Facing the Region's Ports

The challenges and constraints confronting ports vary according to their geographic location, competitive position, port infrastructure and superstructure, and level of technological advancement. Ports in the Arabian Gulf, for example, face challenges that differ from those confronting the ports of Yemen, Djibouti, and Sudan. Meanwhile, the ports of Egypt and Jordan generally encounter challenges similar to those faced by Gulf ports, albeit with certain differences.

The principal challenges facing the region's ports may be summarized as follows:

First: Geopolitical Tensions, Strategic Strait Crises (Bab al-Mandab and the Strait of Hormuz), and Maritime Security

Maritime security is not, in itself, the primary driver of regional conflicts; rather, it has become a strategic instrument employed by maritime powers that recognize its significance and influence in managing geopolitical conflicts, to the extent that it has become a point of intersection between regional security and global security (Kashk, 2025). States are facing growing challenges in this regard, including the risk of military confrontations at sea—such as those witnessed in the region between the United States and Iran—in addition to the threats posed by terrorism, piracy, organized crime, smuggling, and illicit trade (Miller, 2025). All of these risks and challenges have a direct impact on seaports throughout the region, whether high-performing ports such as those in the Arabian Gulf and the Port of East Port Said, or relatively less competitive ports such as the Port of Aden, the Port of Djibouti, and Port Sudan.

A clear illustration of the importance of maritime security to the stability of regional maritime trade is the ongoing Strait of Hormuz crisis. The Strait constitutes a vital maritime artery through which approximately 20% of global oil supplies transit, making it a cornerstone of international energy security and a major driver of price volatility whenever military or political tensions arise (Lal et al., 2026). The Strait is no longer merely an oil corridor; it has also become a strategic safeguard for the global natural gas market. Approximately 80 million tonnes of liquefied natural gas (LNG) pass through the Strait annually, the majority originating from Qatari and Emirati exports, representing approximately 20% of global LNG trade. Table (11) presents the 2025–2026 estimates of the strategic distribution of energy flows through the Strait of Hormuz (OPEC, 2026).

Table (11): Estimated Energy Flows Through the Strait of Hormuz (2025–2026)

Energy Resource	Annual/Daily Volume	Share of Global Trade	Primary Destination(s)
Crude Oil	17.5 million barrels/day	28% of global seaborne crude oil trade	China, India, Japan
Petroleum Products	3.5 million barrels/day	12%	Asian and European markets

Liquefied Natural Gas (LNG)	80 million tonnes/year	20% of global LNG trade	East Asia and Europe
Oil Condensates	1.2 million barrels/day	15%	Asian petrochemical complexes
Source: (Khalfawi <i>et al.</i>, 2026).			

The data presented in Table (11) demonstrate that the Strait of Hormuz constitutes a critical chokepoint in global maritime transport. Approximately 17.5 million barrels of crude oil (around 28% of global seaborne crude oil trade) and 3.5 million barrels of petroleum products transit the Strait each day. In addition, it carries substantial volumes of liquefied natural gas (LNG) amounting to 80 million tonnes annually (representing 20% of global LNG trade), together with 1.2 million barrels per day of oil condensates, primarily destined for Asian and European markets and their petrochemical complexes. These figures demonstrate that a significant share of the energy powering industrial production and electricity generation in East Asia and Europe depends on the uninterrupted flow of maritime traffic through the Strait. Consequently, any disruption to navigation in this waterway would pose a direct threat to the stability of global maritime trade and international energy security.

Any disruption in the Strait would effectively result in an energy paralysis for electricity generation facilities in East Asia and Europe (IEA, 2025). This strategic logistical significance has made the Strait a persistent source of geopolitical pressure within the context of the United States–Iran conflict, with Tehran employing threats to close the waterway as a geopolitical deterrent aimed at disrupting energy flows destined for Asian and global markets. Given these circumstances, this critical geographic concentration imposes increasing pressure on global supply chains (Lal *et al.*, 2026).

Second: Operational Challenges and the Competitive Capacity of Ports

Ports across the study area are facing growing operational and competitiveness challenges, primarily the need to expand their handling capacity in line with increasing cargo volumes and to transition toward operating models based on automation and digital technologies. Such modernization is essential to streamline procedures and reduce cargo handling times, and it must be accompanied by enhanced connectivity with inland transport networks—including roads, railways, and inland waterways—to ensure the efficient movement of cargo to and from ports. In addition, ports require closer coordination with shipping lines, regulatory authorities, and other stakeholders to ensure business continuity during periods of disruption and to address the growing pressures associated with the transition toward green ports capable of responding to climate change challenges. Furthermore, ports face the challenge of securing accurate data and reliable performance metrics for identifying operational deficiencies and guiding investment decisions, thereby strengthening their competitiveness at both the regional and global levels (World Bank, 2025a). These challenges are particularly significant for the region's more advanced ports, such as those in the Arabian Gulf, the Port of East Port Said, and the Port of Aqaba, as they strive to maintain their competitive position relative to neighbouring ports.

Third: Challenges in Keeping Pace with Global Trends and Managing Change

Ports throughout the region face difficulties in keeping pace with the rapid transformations occurring in the global economy, shipping markets, and maritime fleets, together with the associated disruptions to supply chains, evolving corporate responsibility requirements, climate change, and digitalization. These developments require ports to redefine their strategic priorities and build strong institutional capacities for adaptability and resilience. They also

underscore the need for systematic and continuous change management. Port authorities therefore require integrated reform cycles comprising assessment, planning, implementation, performance measurement, and feedback, to be reviewed every few years, with clearly defined objectives, coordinated national policies, and careful alignment of reforms with existing concession agreements and institutional frameworks to avoid conflicts (World Bank, 2025a; UNCTAD, 2024).

Fourth: Challenges Related to Private Sector Participation, Economic Regulation, and Risk Allocation

The participation of the private sector in port investment is becoming increasingly important. However, this is accompanied by challenges in aligning such investments with national strategies in order to avoid unplanned expansion of port capacity and fragmented development. It also requires the establishment of economic regulatory frameworks that provide a neutral and predictable business environment while maintaining sufficient flexibility to enable ports to adapt to technological and commercial developments. Another key challenge lies in the equitable and efficient allocation of legal, political, commercial, environmental, financial, and social risks between the public and private sectors, ensuring that each party assumes responsibility for the risks it is best equipped to manage at the lowest possible cost. At the same time, partnership agreements should not become so complex that they discourage investors or increase financing costs (World Bank, 2025a).

Fifth: Social, Environmental, and Digital Challenges, and the Port–City Relationship

Ports face social and labour-related challenges associated with managing workforce transitions resulting from automation and privatization without undermining social stability. This requires the provision of safe and decent working environments, comprehensive training programmes, and transparent workforce rationalization processes undertaken with the participation of workers' representatives. At the environmental level, ports are under increasing pressure to comply with green port requirements, reduce emissions, and adapt to the impacts of climate change, all of which require substantial investment in clean energy and environmentally sustainable infrastructure. The situation is further complicated by the expansion of digitalization and the accompanying cybersecurity risks, which necessitate robust information security frameworks and the development of specialized human capital. In addition, ports face challenges concerning the port–city interface, namely balancing the maximization of economic benefits—including employment, revenue generation, and logistics services—with the mitigation of adverse impacts on surrounding urban communities, such as pollution, congestion, and land-use conflicts. Addressing these issues requires integrated planning mechanisms and effective local partnerships (World Bank, 2025a; IMO, 2023; UNCTAD, 2024).

3.9. Performance of Container Terminals in Red Sea and Arabian Gulf Region According to International Indicators

The ports covered by this study were evaluated in accordance with internationally recognized performance indicators used to assess the performance of seaports and their respective countries based on the principal performance dimensions discussed in Section (3.1) of this study. The assessment also includes comparative analyses of the maritime transport performance of the countries concerned, as the performance of a country's ports is closely linked to the overall performance of the country itself. The principal indicators include the Logistics Performance Index (LPI) published by the World Bank for 2025, the Port

Infrastructure Quality Index, the Port Services Efficiency Index (2024), and the Risk Management Index (2025). Table (12) presents the comparative performance of the ports covered by the study, as follows:

Table (12): Comparison of the Eight Commercial Ports Based on International Performance Indicators									
No.	Indicator / Port	Jebel Ali	Jeddah	Salalah	Aden Container Terminal	East Port Said	Aqaba	Djibouti	Port Sudan
1	Container Port Performance Index (CPPI), 2024	262	36	15	323	3	43	364	--
2	Lloyd's List Ranking, 2025	9	55	66	--	53	--	--	--
3	Port Liner Shipping Connectivity Index (PLSCI), 2025 (Points)	791	413	193	63	306	171	181	71
Source: (World Bank, 2024); (UNCTAD, 2025); (Lloyd's, 2025).									

The comparison ports were ranked based on the Container Port Performance Index (CPPI) for 2024, while also presenting the rankings of the same ports for 2022 and 2023 to illustrate performance trends over the three-year period. Port of East Port Said ranked 10th globally in 2022, declined to 16th in 2023, and then improved significantly to 3rd place in 2024, reflecting a strong recovery in the most recent year following a period of relative decline. Port of Salalah, by contrast, maintained outstanding performance in both 2022 and 2023, ranking second worldwide in each year, before declining to 15th place in 2024. Although this represents a substantial decline, the port nevertheless remained among the world's highest-performing ports.

As for the Port of Jeddah, it recorded its strongest performance in 2022, ranking 29th globally, before falling to 58th in 2023 and subsequently improving to 36th in 2024. While the port regained part of its previous performance, it had not yet returned to its 2022 ranking. The Port of Aqaba ranked 59th in 2022, declined to 87th in 2023, and then improved again to 43rd in 2024. This performance pattern reflects a fluctuating trajectory characterized by a decline during the middle of the assessment period, followed by a notable recovery in the final year compared with 2023.

The comparison further indicates that Jebel Ali Port experienced a very substantial decline over the three-year period, falling from 38th place in 2022 to 43rd in 2023, and then to 262nd in 2024, representing a sharp deterioration relative to its previous standing. The performance index does not provide a specific explanation for Jebel Ali's decline to 262nd place within a single year. However, given that the index primarily measures vessel turnaround time, together with the severe disruptions affecting global trade routes and Red Sea crisis, major regional hub ports have become more susceptible to experiencing exceptional levels of congestion and delays. These factors may have had a significant impact on Jebel Ali's assessment during that year, without necessarily indicating any deterioration in its structural capabilities or its status as a leading regional hub port.

Within the same context, Aden Container Terminal (ACT) improved from 262nd place in 2022 to 237th in 2023, before declining markedly to 323rd in 2024, indicating a short-term improvement in 2023 followed by a more significant decline in the subsequent year. The Port

of Djibouti ranked 26th in 2022, before dropping sharply to 337th in **2023**, and continued to decline to 364th in 2024. As for Port Sudan, no data were reported in the Container Port Performance Index (CPPI) for 2022. It was subsequently ranked 388th in 2023, before being excluded from the index in 2024. Accordingly, the Port of East Port Said was the best-performing port according to this indicator, whereas Port Sudan recorded the weakest performance among the ports covered by the study.

According to Lloyd's List Top 100 Container Ports for 2025, the data for the four Arab ports included in the ranking indicate that Jebel Ali Port (Dubai) occupies a highly advanced global position, ranking 9th worldwide, with a throughput of 15,536,000 TEUs in 2024. It is followed by the Port of East Port Said, ranked 53rd, with a throughput of 3,905,266 TEUs; the Port of Jeddah, ranked 55th, with 3,722,865 TEUs; and the Port of Salalah, ranked 66th, with a total throughput of 3,304,700 TEUs. These figures highlight a substantial gap between Jebel Ali Port and the other three ports, as Jebel Ali handled more than four times their respective container volumes.

With regard to year-on-year changes in container throughput, Jebel Ali was the only port to record positive growth during 2024, achieving an increase of 7.4% compared with 2023. By contrast, container throughput declined by 1.8% at the Port of East Port Said, by 12.8% at the Port of Salalah, and by a significant 33.4% at the Port of Jeddah.

The decline in cargo throughput at Red Sea ports is directly consistent with the repercussions of Red Sea crisis. The adverse impact of the crisis on the Port of Jeddah, together with the diversion of shipping routes away from Red Sea corridor, were the principal factors behind Reduction in vessel calls. The same crisis also affected the Port of East Port Said through the decline in transit traffic via the Suez Canal, resulting in reduced container transshipment volumes, albeit to a lesser extent. As for the Port of Salalah, its decline is most likely attributable to the restructuring of global liner shipping networks and Redistribution of transshipment volumes to alternative ports.

With regard to the Port Liner Shipping Connectivity Index (PLSCI), the 2025 data for the ports covered by the study were used to calculate an annual value for each port by taking the simple average of the four quarterly scores, after which the ports were ranked from the highest to the lowest level of connectivity. The calculations indicate that Jebel Ali Port ranks first with an annual score of approximately 791 points, a level that substantially exceeds that of all other ports and reflects its position as a major hub within the global liner shipping network. It is followed regionally by the Port of Jeddah, with approximately 413 points; the Port of East Port Said, with approximately 306 points; the Port of Salalah, with an average of approximately 193 points; the Port of Djibouti, with approximately 181 points; and the Port of Aqaba, with approximately 171 points. All of these scores exceed the global benchmark average of 100 points, although they remain considerably lower than that of Jebel Ali Port. By contrast, the ports exhibiting relatively weak connectivity in 2025 include Port Sudan, with approximately 71 points, and Aden Container Terminal, with only about 63 points, both of which are below the global benchmark average.

3.10. International Indicators Relevant to Maritime Port Operations at the Country Level

In addition to the foregoing indicators, which assess the performance of individual ports, there are also international indicators that evaluate the overall performance of a country rather than that of a specific port. These indicators are useful in assessing the status of national port

systems. Naturally, the comparison ports examined in this study are at the forefront of such assessments, as they represent the leading ports in each of the selected countries. These indicators include the Logistics Performance Index (LPI)⁴ the Port Services Efficiency Index (2024)⁵, the Port Infrastructure Quality Index⁶, and the (INFORM Risk Index)⁷

Table (13): International Indicators Relevant to Maritime Port Operations by Country								
Indicator	United Arab Emirates	Saudi Arabia	Oman	Yemen	Egypt	Jordan	Djibouti	Sudan
Logistics Performance Index (LPI), 2023	4.0	3.4	3.3	2.2	3.1	3.0	2.7	2.4
Port Services Efficiency Index, 2024	5.5	4.9	5.0	--	5.0	4.6	--	--
Port Infrastructure Quality Index, 2019	5.50	4.80	5.10	2.20	4.80	4.40	--	--
INFORM Risk Index, 2025	2.3	2.7	2.3	8.1	5.0	4.4	5.5	7.8
Source: (World Bank, 2023), (TTDI, 2025), (TheGlobalEconomy, 2019), (European Commission, 2026).								

Table (13) presents the standing of the countries covered by the study according to the relevant international indicators. The table shows that the United Arab Emirates achieved the highest score among the eight countries in the Logistics Performance Index (LPI) for 2023, scoring approximately 4.0 out of 5, placing it among the countries with high logistics performance globally. It is followed by Saudi Arabia with a score of 3.4, Oman with 3.3, Egypt with 3.1, and Jordan with 3.0, while Djibouti scored 2.7, Sudan 2.4, and the Republic of Yemen ranked lowest with a score of **2.2**.

The Port Services Efficiency Index for 2024 also shows that the highest rating among the countries under review was achieved by the United Arab Emirates, with a score of 5.5, followed by Egypt and the Sultanate of Oman, each with a score of 5.0, then Saudi Arabia

(4) The Logistics Performance Index (LPI) is the principal benchmark for measuring countries' performance in logistics and supply chains. It is of particular significance to seaports, as it links port efficiency with the overall performance of supply chains and international trade. The index is published in the World Bank's annual reports and covers 139 countries, assigning each country an LPI score on a scale ranging from 1 (low performance) to 5 (high performance).

(5) The Port Services Efficiency Index 2024 is an indicator based on the World Economic Forum's Executive Opinion Survey, in which executives are asked: "How efficient are the seaport services in your country?" Responses are measured on a scale from 1 (very poor and among the worst globally) to 7 (excellent and among the best globally). This index forms part of the Infrastructure and Services pillar of the Travel & Tourism Development Index (TTDI), which measures the readiness of infrastructure and services to support travel and tourism. It is used to rank countries according to the effectiveness of their port management and operations, including the speed of procedures, the quality of port services, and their integration with land and air transport systems. (TTDI, 2025).

(6) The World Economic Forum provides a Port Infrastructure Quality Index for countries worldwide. Although the most recent available data date back to 2019, with no subsequent updates, the index remains one of the most important tools available for comparing port performance, given the absence of more recent international indicators of a similar nature. The index assesses the quality of port infrastructure on a scale from 1 to 7, where 7 represents the highest level of quality and 1 the lowest. Based on data from 139 countries, the global average score in 2019 was approximately 4.03. Singapore recorded the highest score at approximately 6.5, while Tajikistan recorded the lowest score at 1.0. (theglobeconomy, 2019).

(7) The INFORM Risk Index is a composite indicator that measures the level of humanitarian crisis and disaster risk in each country on a scale from 0 to 10, with higher scores indicating higher levels of risk. It was developed by the Inter-Agency Standing Committee (IASC) Reference Group on Risk, Early Warning and Preparedness, in collaboration with the Joint Research Centre (JRC) of the European Commission. The index is an open-source global risk assessment tool used to evaluate crisis and disaster risks across 191 countries.

with 4.9, and Jordan with 4.6. No data were available for Yemen, Djibouti, or Sudan. This indicates that the aforementioned Gulf countries, together with Egypt and Jordan, provide port services characterized by a high level of operational efficiency compared with the countries for which data are unavailable. The absence of data itself is one indication of the weakness of conditions in those countries and reflects the difficulty of obtaining such data, which constitutes an indicator of institutional and operational shortcomings.

The Port Infrastructure Quality Index (2019) shows that the highest rating among the eight countries was achieved by the United Arab Emirates, with a score of 5.50, followed by the Sultanate of Oman with 5.10, then Saudi Arabia and Egypt, each with a score of 4.80. Jordan recorded 4.40, while Yemen received a low score of 2.20. No data were available under this indicator for either Djibouti or Sudan.

The results of this indicator reflect a clear disparity in the quality of container ports and their supporting infrastructure between the Gulf countries and Egypt on the one hand, and Yemen and the countries lacking data on the other.

There is no doubt that the significant challenges facing seaports have drawn the attention of port operators to the necessity of preparing for risks and managing them effectively (UNCTAD, 2021). For example, the COVID-19 pandemic underscored the need for a different approach to future challenges and disruptions, as well as the adoption of modern and innovative approaches to port management. These include strengthening risk management, enhancing resilience, understanding vulnerabilities and potential losses, and developing contingency plans and coordinated mechanisms for disaster and emergency response (UNCTAD, 2022).

The INFORM Risk Index is based on three principal dimensions: (1) Hazards and Exposure; (2) Vulnerability; and (3) Lack of Coping Capacity. Each dimension is assigned equal weight in the overall methodology. The first measures the likelihood of natural or human-induced hazards; the second assesses the degree of social and economic vulnerability of individuals and households to such hazards; while the third evaluates the strength or weakness of institutions, infrastructure, and governance systems in responding to and recovering from crises (European Commission, 2026).

Although the Index does not assess ports directly, it is closely related to port performance through the Hazards and Exposure dimension, which includes data on coastal and maritime hazards that may affect port areas, including berths, equipment, and vessel movements. The Lack of Coping Capacity dimension also encompasses infrastructure and institutional capacity. Consequently, countries with stronger institutional capabilities and more robust infrastructure—including port infrastructure—achieve better coping-capacity scores, thereby reducing their overall level of risk.

The Index provides disaster risk profiles for 191 countries and utilizes 50 different indicators covering the conditions that contribute to crises and disasters. It includes data on both natural and human-induced disaster risks, the extent to which local communities are exposed to such risks, and the capacity of local infrastructure and institutions to withstand and respond to them. The Index's methodology is distinguished by its standardized, rigorous, and scientifically based approach, which is globally applicable and collaboratively updated, enabling organizations across different sectors to contribute to and coordinate its development (UNDP, 2026).

The INFORM Risk Index (2025) scores indicate that the highest level of risk is recorded in Yemen, with a score of 8.1, followed by Sudan at 7.8, Djibouti at 5.5, Egypt at 5.0, and Jordan at 4.4. Saudi Arabia records a score of 2.7, while both the United Arab Emirates and the Sultanate of Oman score 2.3 each. The scores achieved by the latter three countries place them within the relatively low-risk category, indicating that their ports operate in a more stable environment with lower exposure to disasters and conflicts. Consequently, they are better positioned to maintain uninterrupted vessel and container flows and ensure the continuity of supply chains. In contrast, the ports of Yemen, Sudan, Djibouti, and Egypt face a higher risk of operational disruption and interruption.

Table (14) summarizes the best-performing ports and the best-performing countries under each of the three international indicators, presented separately.

Table (14): Summary of International Indicators				
No.	International Port Indicators	Best Performer	International Country Indicators	Best Performer
1	Container Port Performance Index (CPPI), 2024	Port of East Port Said	Logistics Performance Index (LPI), 2023	United Arab Emirates
2	Lloyd's List Ranking, 2025	Jebel Ali Port	Port Services Efficiency Index, 2024	United Arab Emirates
3	Port Liner Shipping Connectivity Index (PLSCI), 2025	Jebel Ali Port	Port Infrastructure Quality Index, 2019	United Arab Emirates
--	--	--	INFORM Risk Index, 2025	United Arab Emirates and Oman

3.11. Port Governance

Port governance is defined as "the adoption and enforcement of the rules governing conduct, and the exercise of authority and institutional resources, for the development and management of port activities in a manner that benefits society and the economy" (Pallis, 2022).

Port authorities play a pivotal role within the port governance framework. Ports are regarded as hybrid entities that combine the characteristics of public law with the considerations of private law, regardless of their ownership structure or administrative affiliation. The functions of ports range from those of landlord, regulator, and operator, while contemporary literature has introduced a fourth function, namely that of community builder and supporter of local development. Some of these functions may be delegated to specialized operators, while port authorities continue to perform their regulatory and supervisory responsibilities (World Bank, 2025a).

The implementation of port governance is regarded as one of the principal indicators for measuring port performance. It encompasses transparency and accountability through the publication and auditing of financial statements, the disclosure of traffic statistics and tariff schedules, and the promotion of cooperation among ports through participation in, or partnerships with, other administrative entities. It also includes support for industrial and port clusters through the adoption of business continuity plans, addressing operational and service bottlenecks that impede access, resolving or overseeing the resolution of administrative bottlenecks, managing information and communication technology (ICT) systems on behalf of the port community, and strengthening the relationship between the port and the city, as well as communication with the public (UNCTAD, 2023).

Given the importance of applying port governance principles to reform and improve port performance, this study presents one of the key indicators used to assess countries'

implementation of governance principles within their institutions, activities, and legal frameworks, owing to its direct relevance to port performance.

The Worldwide Governance Indicators (WGI), issued by the World Bank, measure the quality of governance across six principal dimensions: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. The results, expressed on a scale from 0 to 100, indicate each country's relative position within the global distribution (World Bank, 2026).

Port performance is not determined solely by operational factors; rather, it is profoundly influenced by the surrounding governance environment, including the stability of public policies, the quality of the legal framework governing investment and trade, the effectiveness of government institutions responsible for managing and overseeing ports, the strength of the rule of law in the enforcement of contracts, and the level of corruption associated with licensing, fees, and customs procedures. The stronger these governance dimensions become, the greater the ability of ports to attract investment, implement expansion and digitalization projects, and deliver stable and competitive services within global supply chains. Table (15) presents the Worldwide Governance Indicators (WGI) by country for 2024.

Table (15): Ranking of the Comparison Countries According to the Worldwide Governance Indicators (WGI)						
Country	Control of Corruption	Rule of Law	Regulatory Quality	Government Effectiveness	Political Stability	Voice and Accountability
United Arab Emirates	71	66	27	76	79	42
Saudi Arabia	63	60	66	67	65	29
Oman	58	47	55	62	76	41
Jordan	53	60	59	56	60	44
Egypt	31	44	47	49	49	39
Djibouti	29	40	41	42	53	35
Sudan	26	32	28	36	31	34
Yemen	15	24	30	15	19	27
Source: (World Bank, 2026).						

Higher scores in Table (15) reflect a more stable, transparent, and efficient institutional environment. They indicate how authority is exercised within a country and the extent to which its institutions are capable of formulating, implementing, and enforcing rules fairly. These are critical factors for sectors that depend on substantial investments and complex regulatory frameworks, such as ports. Accordingly, improvements in these indicators generally translate into a greater capacity to formulate stable port policies, conclude transparent concession agreements, protect investors' rights, and reduce the costs associated with port and customs operations.

The table further demonstrates that certain governance dimensions are more directly associated with port performance than others, particularly Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. Government Effectiveness reflects the state's ability to plan and implement port development projects, coordinate the

activities of the various entities operating within ports, and ensure the continuity of port services. Regulatory Quality reflects the clarity and adequacy of the laws and regulations governing investment, concession arrangements, and port operations, thereby enhancing the attractiveness of ports to investors, shipping lines, and logistics service providers. Rule of Law and Control of Corruption, meanwhile, are decisive factors in reducing the risks associated with port investments. Stronger rule of law improves the protection of contracts and investors' rights and strengthens the enforcement of legal judgments, while more effective control of corruption reduces bribery and favoritism in licensing, customs procedures, and berth allocation, thereby lowering transaction costs and reducing vessel and container dwell times at ports.

Against this backdrop, the overall rankings indicate that the United Arab Emirates and Saudi Arabia, followed by Oman and Jordan, outperform the remaining countries across most governance dimensions. These four countries enjoy relatively high levels of political stability, government effectiveness, and control of corruption, which partially explains the superior operational efficiency of their ports, their greater ability to attract investment, and their progress toward the development of smart ports. Egypt and Djibouti occupy an intermediate position, reflecting a mixed governance environment that is likewise reflected in the performance of their ports. Sudan and Yemen, by contrast, rank at the bottom across most governance dimensions, indicating a fragile governance environment characterized by elevated risks, unstable regulatory frameworks, and weak enforcement. Such a fragile governance environment makes port modernization, the transition toward smart ports, and investment in infrastructure and digitalization a slow and costly process, leaving these ports significantly less competitive than the more stable and institutionally robust ports of the Arabian Gulf and Red Sea.

Based on the foregoing, it can be concluded that Yemen's ports remain significantly behind the major ports of Red Sea and the Arabian Gulf in terms of efficiency, resilience, and responsiveness to shocks. Table (16) summarizes the principal differences between Yemen's ports and the leading ports in Red Sea and Arabian Gulf region.

Table (16): Key Differences Between the Performance of Yemeni Ports and the Major Ports of the Arabian Gulf and Red Sea		
Indicator	Yemeni Ports	Major Ports in the Arabian Gulf and Red Sea Region
Overall Performance	● Operate under unstable political and security conditions. ● Limited cargo throughput volumes. ● Limited liner shipping services.	● Operate under stable political and security conditions. ● High cargo throughput volumes.
Infrastructure and Technologies	● Limited digital infrastructure that has not kept pace with recent developments, particularly digital systems. ● Weak physical infrastructure.	● Digital infrastructure aligned with global technological developments. ● Advanced physical infrastructure.
Operations	● Rely on manual procedures and are characterized by weak inter-agency integration. ● Limited capacity to meet the requirements of shipping lines.	● High operational efficiency, supported by sound governance and compliance with international standards. ● Rely on digital or semi-digital systems to manage their operations.
Human Resources	● Limited availability of specialized technical personnel.	● Availability of adequate resources and a well-trained workforce.
Resilience	● Characterized by fragility resulting from conflict and shortages of fuel and financing.	● Greater capacity to absorb and withstand disruptions.

Key Challenges and Opportunities in the Transition Toward Sustainable Trade Systems and Smart Ports

Red Sea and Arabian Gulf region is among the world's regions most affected by geopolitical and security developments, climate change, and economic transformations. Consequently, sustainable trade—which seeks to balance economic growth, resource conservation, and social equity—together with the development of smart ports, represents an ambitious objective that faces a wide range of interconnected and complex challenges. At the same time, sustainable trade has the potential to create significant development and employment opportunities that contribute to the achievement of the Sustainable Development Goals (SDGs) across both their overall and sectoral dimensions.

4-1. Challenges to the Transition Toward Sustainable Trade Systems

Based on the current geopolitical and economic conditions prevailing in Red Sea and Arabian Gulf countries, together with the findings of the field study conducted by the research team, it can be concluded that the region faces a number of overarching challenges affecting sustainable trade and economic integration, and, consequently, the ability of its countries to transition toward smart ports. Table (17) below highlights the principal challenges.

Table (17): Challenges Hindering the Transition Toward Sustainable Trade Systems in the Region			
Category	Challenges	Countries Most Affected	Countries Least Affected
Political and Security Challenges	• Political and security instability and civil conflicts affecting several countries in the region. • Regional competition over major strategic projects. • Militarization of international maritime corridors and the diversion of global shipping routes away from the region. • Rising insurance and freight costs ultimately borne by the end consumer.	Yemen, Sudan	Saudi Arabia, United Arab Emirates, Egypt, Jordan, Oman, Djibouti
Resource and Environmental Challenges (Water Scarcity and Climate Change)	• Water scarcity, as Red Sea and Arabian Gulf region is among the most water-scarce regions in the world, directly affecting sustainable production. • Difficulty in producing agricultural or industrial goods for export that comply with "green" standards due to dependence on energy-intensive desalination or non-renewable groundwater resources. • Accelerating climate change, increasing supply chain costs and reducing the sustainability of ports and shipping routes. • Increasing incidents of marine pollution and weak emergency response systems.	Yemen, Saudi Arabia, United Arab Emirates, Jordan, Oman, Djibouti	Egypt, Sudan
Logistics and Infrastructure Challenges	• Most ports in the region continue to operate under the traditional port model, despite the advancement achieved by some ports. • Weak legal and institutional frameworks governing maritime transport and ports.	Yemen, Sudan, Jordan, Djibouti	Saudi Arabia, United Arab Emirates,

	• Limited and aging shipping fleets (except fleets dedicated to oil and gas transportation). • Inadequate port and logistics infrastructure (berths, facilities, and road and rail connectivity). • A widening digital divide between many countries in the region and the rest of the world, making it more difficult to implement sustainable trade, which requires a high degree of transparency in tracking supply chains, shipping, unloading, cargo handling, and other logistics operations.		Oman, Egypt
Financial and Economic Challenges	• The need for substantial capital investment to develop and operate smart ports, which is difficult for some countries in the region to secure. • High initial costs and concerns regarding return on investment. • Limited public-private partnerships in financing major economic projects, particularly infrastructure projects.	Yemen, Sudan, Egypt, Jordan, Djibouti	Saudi Arabia, United Arab Emirates, Oman

4-2. Challenges of the Transition Toward Smart Ports

Several international studies and reports have shown that the digital transformation of ports in Red Sea and Arabian Gulf region, as well as seaports across other economic regions, may face a range of threats and challenges, the most significant of which are summarized in Table (18) below.

Table (18): Threats and Challenges Facing Ports in Digitalization Initiatives	
Challenges	Category
• Impacts of cyberattacks (ransomware, phishing, and data breaches). • The need for robust cybersecurity frameworks and measures to safeguard data integrity.	Cybersecurity and Data Protection
• The need to upgrade the digital skills of the workforce. • Resistance to change and the need for effective change management strategies.	Workforce Adaptation and Organizational Change
• Compatibility issues between legacy and new systems. • Challenges associated with complying with international regulations and data protection laws.	Technology Integration and Compliance
• Difficulty in balancing operational efficiency with environmental and social responsibility. • The need to address potential job losses resulting from digitalization.	Sustainability and Long-Term Impact
Source: (World Bank, 2025a).	

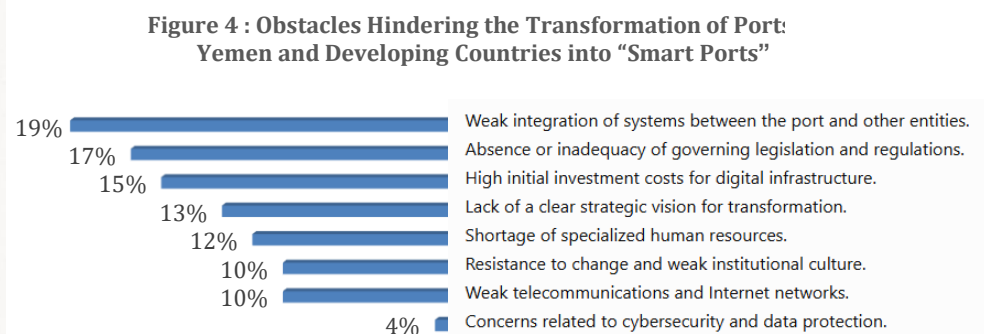
The findings of the field study also identified a number of obstacles and challenges that hinder the transition of ports in Yemen and other developing countries toward smart ports (Figure 4). The most significant of these challenges include the weak integration of operational systems

within ports and the fragmented distribution of responsibilities between port administrations and other relevant entities, such as security agencies, customs authorities, and other institutions. In addition, the existing legislative framework has not kept pace with global developments relating to the operation and management of smart ports. Another major challenge is the high capital investment required for the digital infrastructure on which smart ports depend, particularly in light of the very limited financial resources available in Yemen and other developing countries. Other challenges include the absence of a clear strategic vision for port management, a shortage of qualified personnel, and resistance to change within the ports themselves.

4-3. Challenges Hindering the Participation of Youth and Women in Port Operations

Despite the economic and social importance of youth and women in Yemen, given their substantial share of the country's human resources and their potential to contribute to transformative economic and social development if their capacities are effectively utilized, the study team observed that the participation of youth and women in port operations remains very limited, both in

Yemen and in the other countries covered by this study. The findings of the field study (Figure 5) revealed a number of barriers and constraints limiting broader participation by



youth and women in port-related activities. Foremost among these is the prevalence of misconceptions and restrictive social norms, which constitute a major obstacle to the employment of women and young people in seaport operations. A considerable proportion of these two groups—particularly women—perceives port work as physically demanding and strenuous, requiring significant physical strength and endurance. This perception discourages them from pursuing, or even considering, employment in the port sector.

Another major challenge is the limited availability of education and training opportunities for youth and women in the skills required by port operations. This is primarily attributable to the limited number of academic specializations offered by Arab universities and technical institutes in port management and related maritime activities. It is further compounded by the weakness of policies and legislative frameworks designed to encourage the recruitment and integration of young professionals and women into the port sector.

On the other hand, the lack of a supportive working environment within ports constitutes another constraint limiting the participation of women and youth.

Port employers generally prefer recruiting individuals with extensive professional experience rather than recent graduates, less experienced young professionals, or women in general.

Figure 5: Barriers Limiting the Participation of Women and Youth in Port Employment(%)



Finally, limited awareness among youth and women of the employment opportunities available within the port sector represents another obstacle restricting their participation in port operations, in addition to the shortage of career guidance and vocational counseling programs related to port and maritime occupations.

4-4. Opportunities Arising from the Transition to Sustainable Trade Systems and Smart Ports

Despite the significant challenges facing the countries of the region in adopting sustainable trade systems and transitioning toward smart ports, contemporary global trends in sustainable maritime trade are centered on positioning maritime transport and ports at the core of the global blue economy. These trends also encompass Redefinition of the roles of port authorities, the implementation of digitalization and trade facilitation through Port Community Systems (PCS) and Single Window systems, the acceleration of decarbonization and the transition to green ports and green shipping corridors, and the strengthening of the resilience of ports and maritime infrastructure against geopolitical and climate-related shocks, while placing particular emphasis on enabling developing countries to translate their strategic geographic locations into sustainable development gains (OECD, 2025; UNCTAD, 2025; IAPH, 2022; OECD, 2024; World Bank, 2025).

Given the geopolitical and economic importance of the countries of the region to global trade and international maritime transport, it can be argued that their transition toward the concepts of sustainable trade and smart ports would generate numerous economic, social, and political benefits that would positively affect the living standards and overall development of their populations. The following seven benefits/opportunities illustrate this potential:

1. Promoting Sustainable Trade Practices as a Driver of Economic Growth

Achieving the 2030 Sustainable Development Goals (SDGs) requires strong integration among productive sectors—particularly the manufacturing and innovation sectors—and the trade sector in order to develop global value chains and create more employment opportunities (Shaheer Zaki, 2021). Accordingly, promoting sustainable trade practices has become increasingly important for achieving economic growth while minimizing adverse environmental and social impacts through the adoption of trading practices that are beneficial to both producers and consumers. In other words, it seeks to align economic development with environmental protection and social well-being. This can be achieved by encouraging cooperation among governments, businesses, and civil society organizations to develop and

implement sustainable trade policies based on providing incentives and support to companies that adopt sustainable production practices. Such incentives may include tax exemptions and access to financing for green initiatives, in addition to raising consumer awareness of the importance of sustainable trade and empowering consumers to make informed purchasing decisions. Priority should also be given to investments in research and development to drive innovation in sustainable technologies and practices (FasterCapital, 2025).

2. Enhancing Environmental Sustainability and Reducing Emissions (Supporting Green Supply Chains)

This aspect involves integrating environmentally friendly practices throughout the entire supply chain, from the sourcing of raw materials through manufacturing, packaging, and distribution. This can be achieved through the adoption of energy-efficient technologies, waste reduction measures, and the use of renewable resources, thereby enhancing the competitiveness of companies in the global marketplace. In this context, ports can expand the use of smart applications and technologies that reduce carbon emissions, while also improving energy efficiency by minimizing unnecessary operating time for equipment and vessels. They can further deploy machine learning-based energy management systems to reduce peak energy demand and lower port emissions, representing an advanced approach to the sustainable development of seaports (Fernandes et al., 2026; Al-Khabouli, 2024; Leng et al., 2026). Such measures enable countries to reduce greenhouse gas emissions, improve air quality, and create new employment opportunities in the clean energy sector.

3. Delivering Innovative Logistics Services

As the transport sector is one of the most significant economic sectors—both in terms of generating value added to the economy and creating employment, as well as its direct and indirect contribution to environmental pollution—the transition to smart ports and the acceleration of cargo loading and unloading services enable companies to optimize transport and logistics operations. This contributes to reducing fuel consumption and emissions, lowering operating costs, increasing the financial returns generated by the sector, and creating additional investment opportunities.

4. Creating High-Value Employment and Expanding Opportunities for Youth and Women

The transition from conventional ports to smart ports contributes to the expansion of port activities and enhances their operational capacity, thereby generating demand for high-value technical and specialized jobs. Smart ports typically create new occupations, including data analysts, digital systems operators, Internet of Things (IoT) engineers, cybersecurity specialists, software developers, energy efficiency experts, and other highly skilled professionals. This is accompanied by the reskilling and upskilling of the traditional workforce, particularly in maintenance and operations, in addition to generating thousands of indirect employment opportunities across various transport sectors, trade in services, and the establishment of maritime technology companies supporting port operations. Given the educational background and skill sets required to work in smart ports, employment opportunities for young men and women are expected to be significantly greater than those available in conventional ports, as they are generally better equipped through their education and specialization to meet these emerging requirements.

5. Promoting Fair Trade for Developing Countries

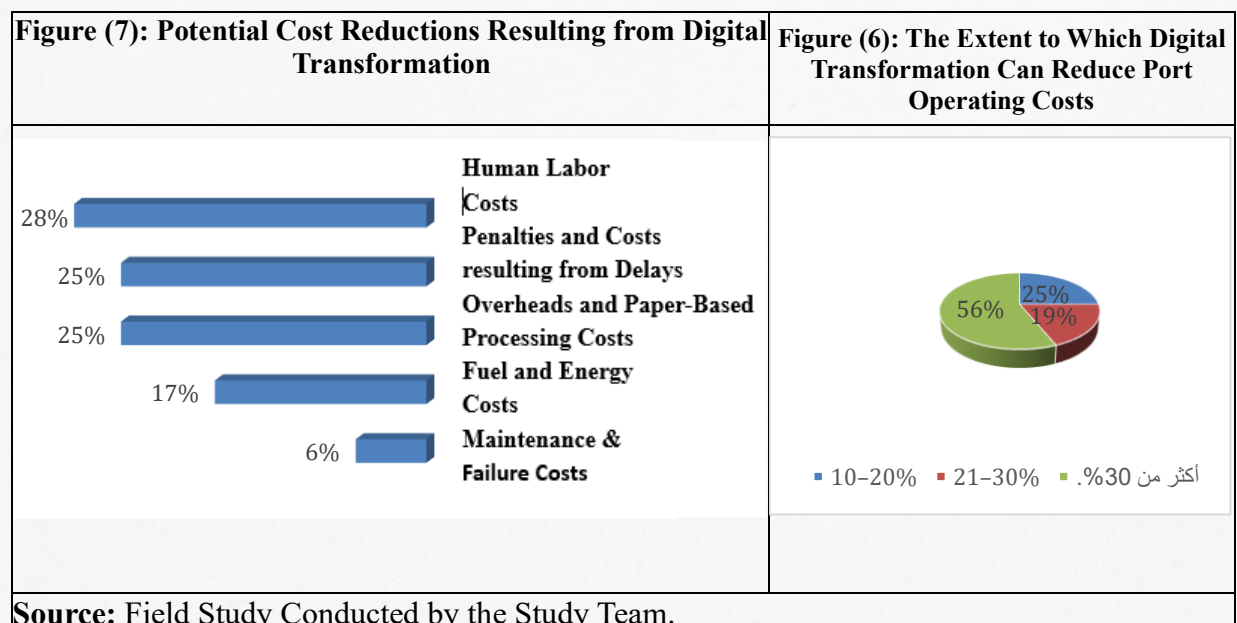
Fair trade practices aim to ensure that producers in developing countries receive fair prices for their products, enjoy decent working conditions, and adhere to environmentally sustainable production methods. By promoting fair trade, countries can support small-scale farmers and artisans, enhance their access to global markets, reduce poverty, and stimulate economic growth in underserved regions.

6. Enhancing Operational Efficiency and Reducing Logistics Costs

To improve their operations, smart ports integrate technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) with applications for predicting vessel arrivals and container volumes, berth and crane scheduling, and the automation of truck gate operations. In general, these measures reduce vessel and other transport waiting times within the port, improve resource utilization, accelerate vessel turnaround, and lower operating costs.

On the other hand, the automation of port operations contributes to reducing human error and lowering manual operating costs, thereby enhancing the international competitiveness of national products in global markets (Fernandes et al., 2026; Al-Na'al, 2026). Furthermore, emphasis on applications that directly reduce operating costs through predictive maintenance and the use of digital twins contributes to improved planning and reduced resource wastage. These applications can be adopted progressively, even in resource-constrained ports, provided that minimum data availability and connectivity requirements are met (Fernandes et al., 2026).

Within this context, 56% of the maritime experts and professionals who participated in the field study (Figure 6) believe that digital transformation and the use of Artificial Intelligence can reduce port operating costs by more than 30%. Meanwhile, 19% of the respondents believe that digital transformation and Artificial Intelligence can reduce operating costs by 20–30%, whereas 25% believe that Reduction would be less than 20%. Regarding the composition of port operating costs, participants in the field study considered labor costs to represent the largest component of any reduction in operating costs resulting from the transition to digital systems (Figure 7). This is followed by costs associated with demurrage and delay penalties, administrative and paper-based transaction costs, fuel and energy costs, and finally maintenance costs.



7. Rehabilitating Existing Human Resources Capacities

At present, the shortage of qualified personnel is one of the most significant constraints facing ports in the Arab world. This reality underscores the need for continuous investment in training and capacity building in the fields of data analytics, programming, industrial engineering, and smart systems management. It also requires that human resource development be considered an integral component of port digital transformation strategies. Accordingly, the transition toward smart ports represents a genuine opportunity to rehabilitate and enhance the capabilities of the workforce employed in this sector (Al-Khabouli, 2024; Al-Na'al, 2026).

4-5. The Future of Maritime Trade in Red Sea and Arabian Gulf Region

Based on the foregoing analysis of the status of sustainable maritime trade in Red Sea and Arabian Gulf region, the performance of the ports operating therein, and the views of the experts and professionals who participated in the field component of the study, three scenarios can be developed regarding the future of maritime trade in the region, as follows:

Table: Future Scenarios for Maritime Trade in Red Sea and Arabian Gulf Region

Scenario	Key Determinants	Outcomes
Pessimistic	Continued conflict and war in Yemen and Sudan, with possible expansion into other areas; continued security challenges in Red Sea region and the Strait of Hormuz; and limited investment spending on digital infrastructure across the region.	Very slow progress; difficulty in transitioning to smart and sustainable ports; a longer timeframe required to keep pace with developments in the maritime port sector; diversion of trade routes away from the region to other areas; a decline in the role of some regional ports; and changes in shipping routes.
Moderate	Improvement in the overall security situation across the region, while future hotspots of tension remain due to security imbalances in Yemen and the southern Red Sea.	Continuation of regional maritime trade operating under pressure and constantly changing conditions; multiple challenges; a Gulf region better able to adapt and reposition itself; a less stable and more costly Red Sea environment; and Yemen remaining the most vulnerable and least integrated country in the region.
Optimistic	Achievement of political stability in Yemen and the region, accompanied by increased investment during the recovery and reconstruction phase, particularly in essential infrastructure.	A shift of major hub ports from the Arabian Gulf toward the Arabian Sea basin, where ports are not constrained by maritime chokepoints; this, in turn, would lead to fundamental economic and developmental changes with positive impacts on all countries of the region.
Conclusion	To achieve a sustainable trade environment in the region, it is	

	important for all neighboring countries to cooperate, address common challenges and obstacles, enhance coordination, and exchange information and assistance in order to improve maritime trade throughout the region.	
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The maritime port sector and its associated trade potential in Yemen and Red Sea and Arabian Gulf region undoubtedly possess numerous comparative advantages that qualify them to play a leading role as a driver of economic recovery, growth, and development, particularly in Yemen, given its strategically important location along one of the world's principal trade routes. Accordingly, the Yemeni government authorities, other stakeholders across the region, and international development partners need to reassess the role and potential of this sector—not merely as a provider of services at the local, regional, or international levels, but also as a source of revenue capable of contributing to Yemen's overall economic performance, improving individual incomes, and generating employment opportunities that collectively promote economic, political, and security stability, thereby contributing positively to overall security and stability in the region and globally.

Accordingly, the proposed priorities and policy measures may be classified as follows:

5-1. Policies Required to Promote Sustainable Trade

Timeframe	Required Policies and Measures	Implementing Entity	Supporting and Partner Entities	Southern Red Sea Countries	Northern Red Sea Countries	Arabian Gulf Countries
Short Term	Provide incentives and support for companies adopting sustainable trade practices, such as tax exemptions or access to financing for green initiatives.	Governments	Specialized regional and international organizations and funds	✓	✓	✓
	Promote cooperation between governments and the private sector (manufacturing and trading companies) to develop and implement sustainable trade policies.	Governments	Specialized international organizations	✓	✓	✓
	Promote the adoption of green supply chains and investment in renewable energy.	Governments	Specialized international and national organizations	✓	✓	✓
Medium and Long Term	Adopt national strategies to promote sustainable trade, taking into account the continuous diversification of products and export markets.	Governments	Private sector	✓	✓	
	Adopt agricultural and industrial production strategies based on encouraging and incentivizing agricultural and industrial producers to supply domestically produced goods suitable for export, while diversifying import sources to maintain supply stability.	Governments	Specialized international and national organizations	✓	✓	
	Give priority to investment in research and development to stimulate innovation in sustainable technologies and practices.	Governments	Universities and research centers	✓	✓	✓

5-2. Policies Required to Promote the Transition toward Smart Ports

Timeframe	Required Policies and Measures	Implementing Entity	Supporting and Partner Entities	Southern Red Sea Countries	Northern Red Sea Countries	Arabian Gulf Countries
Short Term	Review existing port concession and operating agreements and link them to efficiency, modernization, and digital transformation objectives.	Governments	—	✓		
	Update the legal and regulatory framework governing ports to support digitalization and electronic data interchange through the enactment and implementation of the necessary legislation and regulations to attract private sector investment.	Governments	Private sector organizations	✓	✓	
	Implement a package of administrative policies and reforms, including: a. Implementing a Single Window system and establishing a unified digital platform linking the port with customs authorities, freight forwarders, shipping lines, and relevant government agencies. b. Introducing information systems and digital transformation initiatives. c. Establishing a specialized digital transformation and innovation unit within each port authority. d. Building workforce capacity and training specialized personnel on digital systems.	Governments	Specialized regional and international organizations and funds	✓	✓	
	Strengthen institutional coordination among different ports and between ports and relevant government authorities, such as customs, maritime security authorities, and coast guards.	Port Authorities	Government	✓		
Medium and Long Term	Develop a national port development policy linked to a comprehensive economic and development vision that takes into account the comparative advantages and capabilities of ports, together with the mechanisms required to utilize them in an economically viable manner.	Port Authorities	Government, private sector organizations, and consulting firms	✓	✓	
	Strengthen maritime governance (port governance and the separation of ownership from operations) through the establishment of a Supreme Ports Council or an independent ports authority, while promoting innovation and digitalization within the maritime transport and port industry.	Port Authorities	Government, private sector organizations, and consulting firms	✓	✓	
	Enter into investment partnerships for port operation and management under BOT (Build-Operate-Transfer), BOOT (Build-Own-Operate-Transfer), and other operating arrangements, while enacting a Public-Private Partnership (PPP) Law. This includes: a. Developing digital and logistics infrastructure (telecommunications, Internet connectivity, Internet of Things (IoT), automatic identification systems, and cybersecurity). b. Deploying Artificial Intelligence (AI) applications. c. Implementing an integrated Terminal	Government	Private sector and specialized regional and international organizations	✓		

Timeframe	Required Policies and Measures	Implementing Entity	Supporting and Partner Entities	Southern Red Sea Countries	Northern Red Sea Countries	Arabian Gulf Countries
	Operating System (TOS) with smart gates, digital yard management, and container and equipment tracking.d. Automating cargo handling equipment in ports.					
	Establish a sustainable financing mechanism for port development projects instead of relying on temporary solutions.	Government	Private sector and specialized regional and international organizations	✓		
	Establish partnerships with domestic and foreign private sector entities for the operation and management of strategic ports, giving preference, at the initial stage, to contracting with major international terminal operators.	Government	Private sector and specialized regional and international organizations	✓	✓	✓
	Getting benefits from the experience of other ports, such as Jebel Ali and Singapore , in operations management, container and equipment tracking, and truck traffic management.	Port Authorities	Governments and specialized international organizations	✓	✓	

5.3. Policies Required to Increase the Participation and Empowerment of Youth and Women in Leading the Transformation of Ports

Timeframe	Required Policies and Measures	Implementing Entity	Supporting and Partner Entities	Southern Red Sea Countries	Northern Red Sea Countries	Arabian Gulf Countries
Short Term	Establish specialized training programs tailored to the requirements of the transition toward smart ports.	Universities and academies	Government, private sector, and specialized organization	✓		
	Adopt preferential employment policies for youth and women.	Port Authorities	Universities and academies	✓	✓	
	Establish business incubators or support funds for youth entrepreneurship.	Governments	Private sector and civil society organization	✓	✓	
	Adopt mentoring programs to connect current maritime leaders with promising young professionals.	Youth and women's organizations	Port Authorities	✓	✓	
Medium and Long Term	Establish partnerships between universities, maritime institutes, and ports to provide the academic and professional	Government	Port Authorities and universities	✓	✓	✓

Timeframe	Required Policies and Measures	Implementing Entity	Supporting and Partner Entities	Southern Red Sea Countries	Northern Red Sea Countries	Arabian Gulf Countries
	specializations required by smart ports.					
	Promote regional cooperation among the countries of the region by allocating scholarship and fellowship programs for young professionals at leading Arab and regional ports.	Governments	Specialized regional and international organization	✓	✓	✓
	Encourage port authorities to include youth representatives on their boards of directors or advisory committees.	Youth and women's organizations	Port Authorities	✓	✓	✓
	Organize annual competitions and innovation initiatives in the field of smart ports.	Youth and women's initiatives	Port Authorities	✓	✓	✓

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Appendix (1): Pioneers for the Ports of the Future Initiative

Background	The port sector is witnessing rapid transformations, both globally and regionally, toward digitalization and automation under the concept of smart ports, creating significant opportunities for economic growth and high-value employment. Given the strategic importance of smart ports across Red Sea and Arabian Gulf region, there is a growing need to empower young people and women to become active contributors to this transformation by developing their technical and logistics skills and strengthening their role in innovation and entrepreneurship.
Problem Statement	Most countries in Red Sea and Arabian Gulf region suffer from a significant gap in the digital and logistics skills of young people and women. This gap stems from the weak linkage between education and labor market needs, limited practical training opportunities within the port sector, and the absence of platforms that support innovation in the logistics field.
Objective	To enhance employment opportunities for young people and women within the ports and logistics sector and empower them to contribute effectively to the development and operation of smart ports through: building their capabilities in modern port-related technologies; supporting innovation and the development of smart solutions in the logistics sector; and enhancing employment and entrepreneurship opportunities.
Target Beneficiaries	• University graduates in engineering and technical disciplines, as well as graduates of maritime academies specializing in transport and logistics. • Employees working in the logistics sector and in shipping and maritime transport companies. • Entrepreneurs.
Scope of Work	• Training and Capacity Building: Specialized training programs in supply chain management, data analytics, the Internet of Things (IoT), and port management. • Innovation Laboratory: A dedicated space supporting young innovators in developing projects, applications, and digital systems that support smart port operations. • Strengthening Partnerships: A partnership program with a number of international ports to provide training grants and fellowships for personnel working at ports across the region and facilitate knowledge transfer in the field of smart ports. • Interactive Digital Platform: A platform linking recent university and maritime academy graduates, as well as young entrepreneurs and women, with ports, providing access to available employment opportunities and showcasing innovative projects and initiatives.
Partners	• Government: Port authorities, maritime academies and institutes, universities, youth support funds, and youth development initiatives. • Private Sector: Logistics companies and technology companies.

	• International Cooperation: International organizations, global ports, and foreign government initiatives.
Implementation	• Phase I (3 months): Establishment and partnership development. • Phase II (6–12 months): Launch of the first training program, operation of the innovation laboratory, and implementation of a hackathon. • Phase III (Ongoing): Expansion of the initiative, project support, and performance evaluation.
Performance Indicators	• Number of male and female trainees. • Number of cooperation programs implemented with partners (strategic partnerships). • Number of young people and women employed in smart ports. • Number of innovative projects and systems developed under the initiative.
Funding	• Funding requirements shall be determined upon completion of the project design. • Seek grants from government, private-sector, and international entities to finance the initiative. • Efforts should be made to ensure the long-term financial sustainability of the initiative.
Potential Risks	• Insufficient funding. • Limited expertise. • Weak institutional coordination.
Expected Impact	• Enhancing the capabilities and readiness of young people and women to work in the ports and logistics sectors. • Supporting digital transformation in ports. • Creating direct and indirect employment opportunities. • Promoting innovation within the logistics sector.

Appendix (2): Transforming the Port of Aden into a Smart Port – A Preliminary Roadmap

The Port of Aden enjoys a globally strategic location due to its proximity to the Bab el-Mandeb Strait, one of the world's most important maritime trade routes. Transforming the Port of Aden into a smart port could position it as a major logistics hub in the region.

Phase	Objective	Required Actions for Aden Container Terminal	Expected Impact
Phase I: Foundational Digitalization and Electronic Organization	Transition from paper-based procedures to a structured digital operating environment within the terminal.	Implement a Terminal Operating System (TOS) to manage berth, yard, and gate operations, while digitizing records, permits, and operational data and integrating them internally with terminal activities.	Reduce dependence on manual processes, improve data accuracy, minimize operational delays and errors, and prepare the terminal for subsequent integration with other stakeholders and supply chains.
Phase II: Integration Between the Terminal and Relevant Stakeholders	Transition from limited internal digitalization to an integrated ecosystem connected with stakeholders across the port community.	Gradually integrate with the Port Community System (PCS) , Maritime Single Window (MSW) , regulatory and customs authorities, shipping agents, and shipping lines, while standardizing electronic data exchange and electronic forms.	Accelerate information exchange, reduce paper-based duplication, improve cargo clearance procedures and coordination among stakeholders, and enhance the competitiveness of Aden Container Terminal within the broader logistics chain.
Phase III: Real-Time Tracking and Operational Visibility	Enhance transparency, reliability, and operational security for equipment, containers, and vessels.	Deploy tracking and sensing technologies such as RFID , GPS , AIS , surveillance cameras, and sensors to enable real-time tracking of containers, vehicles, equipment, vessel movements, and field operations.	Improve real-time visibility of container and equipment locations and operational status, reduce losses and misplacement, strengthen safety and security, and improve day-to-day operational decision-making.
Phase IV: Automation of Equipment, Gates, and Operations	Increase terminal productivity and reduce cargo handling time.	Gradually automate cranes, gates, equipment scheduling, and yard management while introducing intelligent cargo-handling and operational planning systems.	Reduce vessel and truck turnaround time within the terminal, increase equipment productivity, minimize human error, and optimize the utilization of terminal space and operational capacity.
Phase V: Port Call Optimization	Reduce congestion and waiting times while improving the coordination of	Implement Port Call Optimization and Just-in-Time Arrival concepts, integrating them	Reduce waiting times at anchorage and alongside berths, improve berth and equipment utilization,

and Predictive Planning	vessel arrivals and marine services.	with berth data, marine services, and operational readiness, while utilizing predictive analytics to forecast arrivals, demand, and resource allocation.	lower operating costs, and enhance service reliability for shipping lines.
Phase VI: Artificial Intelligence (AI) and Advanced Analytics	Transition from digital operations to intelligent operations driven by prediction and continuous optimization.	Utilize Artificial Intelligence (AI) , Big Data , and advanced analytics to forecast container flows, optimize equipment allocation, implement predictive maintenance, identify operational bottlenecks, and support operational and managerial decision-making.	Improve decision quality, enhance operational resilience, reduce equipment failures and bottlenecks, and increase the terminal's efficiency and long-term competitiveness.
Phase VII: Smart Control, Cybersecurity, and Governance	Establish an intelligent, secure, and sustainable operational ecosystem at both the terminal level and across the surrounding operational environment.	Establish an integrated monitoring and control center; consolidate operational, security, and safety data; implement cybersecurity policies and incident response plans; strengthen human resource capabilities; and establish a clear governance and institutional coordination framework.	Enhance rapid response capabilities, protect systems and data, improve safety and operational continuity, and ensure that digital transformation becomes a sustainable operating model rather than merely a temporary technological project.

Appendix (3): Individual Interview Questionnaire for Experts and Specialists in Ports and Sustainable Trade

Dear Sir/Madam,

We are currently conducting a study entitled "Sustainable Maritime Trade and Smart Ports in Yemen and the Arabian Gulf and Red Sea Region", with the objective of analyzing and understanding the current status of maritime trade and port systems in Yemen and the Arabian Gulf and Red Sea region, thereby contributing to the design of port development programs and projects in Yemen and the region. Your valuable insights will assist us in identifying the key challenges and opportunities associated with the transition toward sustainable maritime trade systems and smart ports, and in formulating effective partnership strategies with stakeholders.

We also assure you that your responses will be treated with the strictest confidentiality and will be used solely for research purposes.

General Information

Gender	• Male		• Female		
Name:		Current Position:		Country:	
Years of Experience	☐ Less than 10 years	☐ 11–15 years	☐ 16–20 years	☐ 21–25 years	☐ More than 25 years
Geographical Scope of Work	☐ Yemen	☐ Saudi Arabia	☐ Egypt	☐ Jordan	☐ Djibouti
	☐ Sudan	☐ United Arab Emirates	☐ Oman	☐ Other Country (please specify): _____	

Part I: Current Status of Maritime Trade and Its Sustainability

1. Which of the following best describes the current state of maritime trade and port performance?

Options	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman	Other
Very active maritime trade with highly advanced and competitive ports.									
Active maritime trade with moderate port performance requiring targeted improvements.									
Moderate maritime trade with evident bottlenecks in port									

Options	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman	Other
efficiency and infrastructure.									
Weak maritime trade with poor port performance and significant structural challenges.									

2. Does the performance of the ports keep pace with the requirements and trends of modern global trade?

Options	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman	Other
Yes									
No									

3. What are the five most significant challenges threatening the sustainability of maritime trade in Yemen and the Arabian Gulf and Red Sea region? (Select up to five options for each region.)

Challenges	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman
Political and security instability in some countries of the region.								
Weak legal and institutional framework governing maritime transport and ports.								
Inadequate port and logistics infrastructure (berths, equipment, road and rail connectivity).								
Digital gap and limited transition toward smart ports and integrated electronic systems.								
Financing and investment challenges								

Challenges	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman
and lengthy decision-making cycles for development projects.								
Environmental risks, increasing incidents of marine pollution, and weak response systems.								
High operating costs and port charges compared with competing regional ports.								
Weak regional integration of supply chains and maritime corridors among the countries of the region.								
Shortage of qualified human resources in sustainability, digital transformation, and maritime security.								

4. Based on your experience, rate from 1 to 5 the adequacy of the current legal and institutional framework for regulating sustainable maritime trade and smart ports (legislation, regulations, and institutional structure). (5 = Highest, 1 = Lowest)

Options	Yemen	Saudi Arabia	Egypt	Jordan	Djibouti	Sudan	United Arab Emirates	Oman	Other
Legislation and laws									
Administrative regulations									
Institutional structures									

5. In your opinion, what are the most significant manifestations of unsustainability (economic, environmental, and social) in maritime trade in the Republic of Yemen?

6. In your opinion, what is the most likely scenario for the future of maritime trade in Yemen and the Arabian Gulf and Red Sea region over the next decade if current policies continue without fundamental change?

Part II: Smart Ports and Digital Transformation

1. On a scale of 1 to 5, assess the level of digital transformation at each of the following ports: (5 = Highest, 1 = Lowest)

Port	Aden Container Terminal	Jebel Ali Port	Jeddah Islamic Port	East Port Said Port	Port of Djibouti	Port Sudan	Port of Aqaba
Rating							

2. What are the most significant obstacles hindering the transformation of ports in Yemen and other developing countries into "smart ports"? (Select up to four of the following options.)

High initial investment costs for digital infrastructure and smart equipment.

Weak and unreliable communication and Internet networks within and around the port.

Absence or inadequacy of legislation and regulations governing electronic transactions and digital data exchange.

Resistance to change and a weak institutional culture that supports digital transformation.

Shortage of specialized human resources in information technology and port systems.

Weak integration between port systems and other stakeholders (customs authorities, shipping lines, and security agencies).

Concerns relating to cybersecurity and the protection of sensitive data.

Lack of a clear strategic vision among decision-makers regarding the transition to a smart port.

3. In your opinion, what are the three highest-priority technologies or digital solutions needed to accelerate the smart transformation of Yemeni ports over the next five years?

4. What are the principal differences you observe between the performance of Yemeni ports and that of the major ports in the Arabian Gulf and Red Sea in terms of efficiency, resilience, and response to disruptions?

Part III: Digital Innovation and Its Role in Reducing Costs

1. In your opinion, to what extent can digital transformation and Artificial Intelligence (AI) reduce the operating costs of ports in the region over the next 5–10 years?

☐ Less than 10%	☐ 10–20%	☐ 21–30%	☐ More than 30%
	4	3	6

2. What is the estimated percentage reduction in vessel or truck turnaround time at ports that could be achieved through the implementation of advanced digital solutions?

☐ Less than 10%	☐ 10–20%	☐ 21–30%	☐ More than 30%
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3. In your opinion, which operating cost category is likely to experience the greatest reduction as a result of digital transformation?

Labor costs.

Fuel and energy costs.

Maintenance and equipment breakdown costs.

Administrative and paper-based processing costs.

Delay penalties and other delay-related costs.

Other please specify: (_____)

Part IV: Legal and Institutional Framework

1. What amendments or institutional mechanisms should be given priority in order to address the gap in attention to ports and enhance their development? (Select up to three options.)

Establish a Higher Ports Council or an independent ports authority with clear regulatory and coordination powers, reporting directly to the Council of Ministers.

Update maritime and national port laws in line with international standards (IMO, UNCTAD, IAPH).

Clearly separate the roles of port owner, regulator, and operator in order to minimize conflicts of interest.

Adopt an effective public-private partnership model for port development and operation projects.

Establish a specialized digital transformation and innovation unit within each port authority.

Adopt a governance and performance system based on clear Key Performance Indicators (KPIs) published transparently.

Strengthen institutional coordination between ports and other government entities (Customs, Coast Guard, Maritime Safety Authority, Ministry of Transport).

Develop a national/regional ports policy linked to a long-term economic vision.

Establish sustainable capacity-building programs for personnel in port management, sustainability, and digital transformation.

Part V: Regional Challenges and Opportunities

1. What are the most significant challenges facing the development of ports and maritime trade in Yemen compared with other countries in the region? (Select only three challenges and rank them from 1 = Most Critical to 3 = Least Critical among the selected challenges.)

Fragility of the legal and institutional framework and weak enforcement of maritime laws and regulations.

Aging port infrastructure and a shortage of modern facilities and equipment.

Weak digital transformation and the absence of integrated electronic systems (Port Community Systems, tracking systems, automation).

Political and security instability and its impact on investor confidence and shipping lines.

Limited financing and a low capacity to attract investments and international port partnerships.

Weak logistics connectivity (roads, railways, and logistics zones) compared with neighboring countries.

Deficiencies in environmental risk management and marine environmental protection compared with international standards.

Shortage of qualified and specialized human resources in port management, sustainability, and digital transformation.

Part VI: Youth and Women in Leading the Transformation

1. What are the main barriers preventing broader participation of youth and women in Arab ports? (Select up to three options.)

Societal perceptions that port work is physically demanding and unsuitable for women or educated youth.

The absence or weakness of clear policies and legislation encouraging the employment of women and youth in the maritime sector.

Limited training opportunities and specialized capacity-building in port operations, logistics, and digital transformation.

Preference for recruiting personnel with extensive experience over young professionals.

An unsupportive working environment (working hours, facilities, and job security) for the needs of women and youth.

Lack of career guidance and business incubation programs for youth and women in the maritime sector.

Limited awareness among youth and women of the career opportunities available in the port sector.

2. What are the three most important practical interventions you would recommend to increase youth participation and empower them to lead the transformation of Yemeni ports? (Select up to three options. You may also add other suggestions.)

Establish specialized training programs in port management, logistics, and digital transformation targeted at young people.

Allocate scholarship and fellowship programs enabling young people to work and receive training at advanced Arab and regional ports.

Adopt preferential recruitment policies (or designated quotas) to empower young people in technical and supervisory positions within ports.

Establish business incubators or support funds for youth entrepreneurship in maritime and logistics services.

Include youth representatives on the boards of directors or advisory committees of port authorities.

Launch mentorship programs linking current maritime leaders with promising young professionals.

Establish partnerships between universities, maritime institutes, and ports to create clear pathways from education to employment for young people.

Organize annual competitions and innovation challenges in smart ports and environmental sustainability targeting youth teams.

Other, please specify (_____)

Part VII: Concluding Recommendations for Decision-Makers

1. If you were asked to allocate 100 points among the key priorities for developing Yemeni ports over the next ten years, how would you distribute them according to your priorities?

Please allocate a total of 100 points across the following priorities (Total = 100):

Priority Area	Points
Modernizing the legal and institutional framework governing ports and maritime transport.	
Developing and upgrading port infrastructure and equipment.	
Digital transformation and the adoption of smart port technologies.	
Environmental and social sustainability, and corporate social responsibility.	
Strengthening maritime security and safety, and protecting maritime routes and ports.	
Promoting the participation of youth and women, and developing specialized human resources.	

Appendix (4): List of Experts Participating in the Study

No.	Name	Country	Position	Years of Experience
1	PhD Researcher Ahmed Mohammed Khalaf Al-Fawaz	Jordan	Consultant and Expert in International Transport and Logistics	More than 30 years
2	Dr. Saud bin Hathal Al-Sohaibi	Saudi Arabia	Director of the Logistics Zones Department, Saudi Ports Authority (Mawani)	More than 20 years
3	Major General (Dr.) Faleh Abdulrahman Al-Faleh	Saudi Arabia	Maritime Advisor to H.E. the Vice Minister of Transport and Logistics Services, Saudi Arabia	More than 30 years
4	Captain Faisal Mohammed Ali Awad Al-Karim	Sudan	Director of the Port Facility Security Department, Sudan Sea Ports Corporation	More than 30 years
5	Essam Nasser Al- Shaibani	Oman	Vice President for Quality, Health, Safety, Environment, and Sustainability, Asyad Group	More than 30 years
6	Captain (Dr.) Abdullah Wanees Al- Thabet	Libya	University Professor and Maritime Consultant	More than 20 years
7	Captain (Dr.) Taha Hussein Zoubi	Libya	Former Head of the Maritime Department at Brega Commercial and Industrial Port, Libya, and Maritime Consultant to the National Oil Corporation of Libya	More than 20 years
8	Captain (Dr.) Mahmoud El-Sayed Al-Bawab	Egypt	Dean of Quality of Maritime Education and Training, Arab Academy for Science, Technology and Maritime Transport (AASTMT), Egypt	More than 30 years
9	Captain (Dr.) Mostafa Ahmed Abdelhafiz	Egypt	University Professor and Former Dean of the Institute of International Transport, South Valley Branch, Arab Academy for Science, Technology and Maritime Transport (AASTMT)	More than 30 years
10	Ibrahim Mohammed Dadia	Yemen	Businessman	More than 20 years
11	Ihab Ahmed Basaleem	Yemen	General Manager, Basaleem Shipping Agency – Hadhramout	More than 20 years
12	Captain (Dr.) Shakib Mohammed Abdulwahid	Yemen	General Manager of Marine Operations, Yemen Gulf of Aden Ports Corporation (Port of Aden)	More than 30 years
13	Lubna Anwar Burhan	Yemen	General Director of Port Policies and Economics, Ministry of Transport	More than 20 years
14	Eng. Salem Ali Basameer	Yemen	Chairman of the Board, Yemen Arabian Sea Ports Corporation	More than 30 years
15	Eng. Mohammed Abdullah Mubarak Bin Aifan	Yemen	Advisor to the Minister of Transport for Ports and Maritime Affairs; Former Chief Executive Officer of the Yemen Gulf of Aden Ports Corporation; and Former Chief Executive Officer of the Maritime Affairs Authority	More than 30 years
16	Eng. Hisham Abdullah Al-Saqqaf	Yemen	Master's Degree in Commercial Management of Shipping Companies, World Maritime University, Kingdom of Sweden; General Manager, Gulf Agency (Yemen) Ltd.	More than 30 years

Appendix (5): Statistical Data

Total External Trade (US\$ million)										
	Exports					Imports				
	2020	2021	2022	2023	2024	2020	2021	2022	2023	2024
Yemen	935	1887	1495	1484	1299	8462	10423	12461	15268	13700
Saudi Arabia	173864	276198	411214	320018	305499	137997	152849	189877	206940	232806
United Arab Emirates	273099	317600	335100	317005	335388	234200	235400	246300	262815	300917
Oman	30508	43091	66052	59011	63016	21107	30918	38573	38776	43464
Sudan	3802	4279	4357	3628	3134	9838	9238	11095	7499	4911
Djibouti	5161	5610	5980	4785	3830	2911	3972	5091	5295	4385
Egypt	29323	43637	52116	42553	44849	70437	89206	96189	84218	94698
Jordan	7114	8517	11799	11630	12100	17257	21573	27403	25794	26954
Total	523806	700819	888113	760114	769115	502209	553579	626989	646605	721835

Agricultural Exports and Imports of Yemen and the Countries of the Region (US\$ million)

	Exports						Imports					
	2010	2015	2020	2021	2022	2023	2010	2015	2020	2021	2022	2023
Yemen	119	186	273	320	170	210	2609	3024	4529	5100	4839	5723
Saudi Arabia	2949	3659	3517	4093	3896	4210	16328	22549	19907	22710	26101	27238
United Arab Emirates	3998	7228	13129	14702	17799	18726	11799	16322	16320	18014	22770	22803
Oman	751	1381	1522	1829	954	1026	2323	3501	4466	5114	4934	5248
Sudan	523	1897	1516	1633	2076	2310	3160	2034	2358	2594	3105	2636
Djibouti	80	59	227	1771	2008	2000	474	1126	1287	1681	1914	1081
Egypt	2890	4381	5183	6287	6882	6920	11631	13158	13749	14868	17246	17685
Jordan	1062	1549	1121	1308	1007	1641	2475	3786	3940	4428	4020	5058