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Wismar Business School

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# The Maritime Perspective of Africa

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# Inhaltsverzeichnis

# Vorwort

Die folgende Publikation hat ihren Ursprung in Seminararbeiten, die im Studiengang „Operation and Management of Maritime Systems“ im Sommersemester 2023 in Warnemünde stattgefunden haben. Dort hatten die Studenten im Modul „Management in Shipbuilding“ die Aufgabe in Gruppen im Rahmen eines „Problem Based Learning“ Ansatzes Ausarbeitungen zum Thema „Maritime Africa“ zu erstellen und vorzutragen. Die anfangs nur als Leistungsnachweis konzipierte Aufgabe wurde von den Studenten mit so großem Enthusiasmus und Engagement durchgeführt, dass die gesammelten Ergebnisse es wert waren der Öffentlichkeit präsentiert zu werden. Hierzu wurden die Ergebnisse der Gruppenausarbeitungen überarbeitet, ergänzt und erweitert, so dass dieses Heft im Rahmen der WDP-Reihe der Fakultät für Wirtschaftswissenschaften der Hochschule Wismar entstehen konnte.

Afrika ist im Zusammenhang mit Themen der maritimen Wirtschaft ein immer noch unterrepräsentiertes Thema in der wissenschaftlichen Literatur. Zwar werden die maritimen Strukturen entlang der afrikanischen Mittelmeerküsten, dem Suez-Kanal und dem Roten Meer relativ erwähnt, die Situation aber im Subsaharagebiet ist aber meist nur auszugsweise in der Öffentlichkeit bekannt. Dies wird der wachsenden Rolle Afrikas nicht gerecht, denn spätestens seit Beginn der Ukrainekrise ist Afrikas Rolle im Bereich der Rohstoffversorgung in der öffentlichen Diskussion verstärkt in den Mittelpunkt gerückt.

Dieser Blick auf die Rohstoffe Afrikas ist aber viel zu verengt, repräsentiert Afrika doch den Kontinent der Zukunft mit einer jungen Bevölkerung und einer vorausgesagten Verdoppelung der Bevölkerung innerhalb der nächsten 30 Jahre. Die damit verbundene wirtschaftliche Entwicklung, die bereits in einigen Bereichen eingesetzt hat, stellt auch die Frage nach der Verbesserung der maritimen Infrastruktur und die Anbindung an das weltweite maritime Transportnetz. Momentan verlaufen noch ca. 90% die maritimen Transporte auf der nördlichen Hemisphäre, was sich in Zukunft signifikant verändern wird. Hier soll das Heft eine erste Orientierung liefern und dem interessierten Leser die Annährung an das Thema „Maritime Africa“ erleichtern.

Großer Dank gebührt für die Entstehung des Heftes zunächst erst einmal den beteiligten Studenten des Studienganges OMMS2022 für ihre Beiträge, nämlich den Studenten Marc Joseph Arpon, Fabian Beiler, Klaas Büsen, Jaafar Dibah, Sayyed Shahzeb Hussain, Milad Malakmohammadi, Alexander Peschke und Alireza Seifnouri, ohne deren Einsatz das Heft gar nicht entstanden wäre.

Darüber hinaus bin ich zu großem Dank verpflichtet den Herrn Sayyed Shahzeb Hussain und Alireza Seifnouri, die in vorbildlicher Weise die Texte zusammengetragen und editiert haben und ohne deren enthusiastischen Einsatz dieses Heft niemals entstanden wäre. Und schließlich und endlich gebührt mein Dank Frau Dr. Eunice Omolola Olaniyi von der Universität Turku für ihr zur Verfügung gestelltes Wissen zum Thema, ihre Ergänzungen und ihre Lektoren-Tätigkeit.

Mögen alle Leser des Heftes genau viel Spaß an der Lektüre haben wie wir in der Entstehungsphase.

Wismar, im März 2024

Gunnar Prause

# 1. Introduction

The publication presented here has its roots in seminar papers developed during the summer semester of 2023, specifically within the "Operation and Management of Maritime Systems" course at Warnemünde. Within the "Management in Shipbuilding" module, students engaged in a group-based exploration of "Maritime Africa" as part of a Problem-Based Learning approach. Initially intended merely as an academic exercise, the students' fervor and dedication transformed this task into a significant body of work deemed valuable for public dissemination. Consequently, the outcomes of these group projects were meticulously revised, enhanced, and broadened, culminating in this edition of the WDP series by the Faculty of Business and Economics at the University of Wismar.

Africa, with its diverse cultures, abundant resources, and rapidly growing population, is positioning itself as a dynamic arena in the maritime sector. Historically, global sea trade has predominantly unfolded in the Northern Hemisphere, with Africa often overlooked. However, a paradigm shift is underway. By 2050, it is projected that Africa's population will double, signaling a period of substantial economic growth [1].

Research by McKinsey & Company [2] highlights the demographic changes sweeping across African nations, alongside significant investments in infrastructure development and a rising demand for resources. These developments have placed Africa at the forefront, challenging its previous marginalization in global sea trade. Presently, the Northern Hemisphere accounts for about 90% of the world's sea trade, leaving only a small share for regions like Sub-Saharan Africa, South America, and Australia (Figure 1). This distribution is set to change as Africa attracts more maritime interest.

This paper explores Africa's emerging maritime opportunities, focusing on the increasing flow of maritime goods and the demand for vessel transport. This analysis takes into consideration the flourishing economy of the Northern Hemisphere and its implications for Africa. We explore the continent's economic and maritime hubs, their historical development, and their future outlook. Additionally, the paper examines fleet requirements and growth forecasts, drawing on current trade patterns and anticipated trends. We also assess the needs for fleet construction and maintenance, the prospects of adopting alternative fuels, and the exploration of bunkering opportunities.

This document proposes a strategic framework for understanding Africa's evolving position in global sea trade, acknowledging the fluid nature of global dynamics which could prompt swift changes. Despite this, it offers a foundational perspective on Africa's potential to capitalize on sea trade for economic advancement.

Special acknowledgment is extended to the OMMS2022 program students for their invaluable contributions, including Marc Joseph Arpon, Fabian Beiler, Klaas Büsen, Jaafar Dibah, Sayyed Shahzeb Hussain, Milad Malakmohammadi, Alexander Peschke, and Alireza Seifnouri. The publication of this issue would not have been possible without the meticulous

editing efforts of Mr. Sayyed Shahzeb Hussain and Mr. Alireza Seifnouri. Lastly, heartfelt gratitude is offered to Dr. Eunice Omolola Olaniyi from the University of Turku for her insightful contributions, additions, and editorial oversight.

## 2. Demographics of Africa


*Figure 1. True extent of Africa*
*Source: McKinsey & Company 2018 [2]*

Spanning over 30 million km², Africa's vast territory eclipses the combined areas of China, India, the United States, and most of Europe, accounting for approximately one-fifth of the Earth's total land surface. This expansive continent, often misconceived as a monolithic entity, is in reality a diverse mosaic of 54 (or 55) sovereign countries, representing a significant portion of the globe's nations. Together, these states are home to about one-sixth of the world's population, emphasizing Africa's critical role in global demographics. Countries like Algeria and the Democratic Republic of the Congo (DRC), each more than quadrupling the size of metropolitan France, illustrate the continent's impressive scale [1].

As of July 5, 2023, Africa's population reached 1,440,690,616, comprising around 16.72 percent of the global populace. With 43.8 percent of its inhabitants living in urban areas, the continent is witnessing a significant urban migration, indicative of its rapid urbanization pace. The median age across Africa is remarkably young at 19.7 years, dropping even lower to 16 years in regions like the Sahel and Uganda [3].

African cities are among the fastest-growing urban areas worldwide. Currently, Cairo, Kinshasa, and Lagos each have populations exceeding 5 million. Future projections estimate that by 2050, up to 35 cities in 21 African countries could reach this population milestone. Additionally, the continent is expected to host up to 15 mega-cities, each with more than 10 million residents, with cities like Cairo, Kinshasa, Lagos, and Luanda potentially reaching mega-city status before 2030. These forecasts highlight the rapid urban expansion and its demographic implications [4].

Africa's high fertility rates and swift population growth are closely linked, often coinciding with elevated poverty levels and lower literacy rates. The causal relationship between high fertility and poverty remains debated [1]. On the literacy front, nine African nations rank among the ten least literate countries globally, with Niger at the lowest with a 19.1% literacy rate [5]. Nevertheless, Africa's overall literacy rate stood at 67.4% in 2021. The continent exhibits wide educational disparities, from South Africa's high literacy rate of 80.3% to West

Africa's regional low of 54.1%, underscoring the urgent need for targeted educational initiatives [6].

While many affluent countries face demographic aging, Africa charts a different path with a 2.5% annual population growth rate, doubling the global average. This growth rate is projected to remain above 2% until mid-century, fueled by healthcare advancements and the continent's expansive land area, hinting at continued demographic expansion, particularly in Sub-Saharan Africa [1].

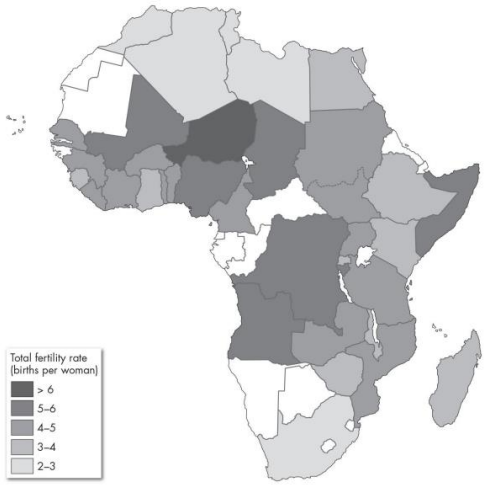



*Figure 2. Total fertility rate in Africa*
*Source: UNPD 2019 [7].*

It is however important to note that the fertility rates across Africa show considerable variation (Figure 2). The continent's average fertility rate stands at 4.5, but there's a notable range: North Africa's rate is lower at 3.5, while South Africa and its neighboring countries report a rate of 2.2. In contrast, Eastern and Western Africa record the highest fertility rates, averaging around 5. Efforts in North Africa to enhance access to family planning and modern contraception methods have been observed. Ethiopia's capital, Addis Ababa, represents a unique case with its fertility rate dropping below 2, although Ethiopia's national average fluctuates between 4.5 to 5% [7].

In addtion, despite advancements in education and socioeconomic conditions, certain areas within Africa continue to maintain high fertility rates. For instance, in Nigeria, the fertility rate persists at 4.5 even among the wealthiest individuals and those with secondary or higher education. In the Democratic Republic of Congo (DRC), women who have attained secondary education bear, on average, 6 children. There are also significant intra-country variations; for example, Kenya's central province has reached a replacement-level fertility rate of 2.1, while some districts in Somalia experience fertility rates between 6 and 7. These disparities underscore the complex demographic dynamics within Africa.

Yet, the demographic evolution in Africa opens the door to potential increases in per capita incomes, a phenomenon often referred to as the demographic dividend, which hinges on the creation of jobs and enhancements in worker productivity. This why under scenarios assuming continued high fertility, Africa's prospects for significant per capita income growth

appear limited due to sluggish advancements in job creation and productivity. With an expected surge in the working-age population by 780 million, the rate of fertility decline will influence educational demands, labor market needs, and dependency ratios. However, meeting the needs of the expanding workforce under a lower fertility scenario would necessitate the creation of 12-15 million new jobs per year, largely fueled by the private sector. The lack of robust social protection systems means that unemployment is not a viable option for many, positioning household enterprises as the dominant employment model. The nature of employment, whether in low-productivity traditional sectors or in sectors poised for transformation, will ultimately depend on the skill levels of the workforce and the confidence of private investors in the economic environment [4].

*Table 1. Number of people employed in Africa. Source: Statista 2023 [8)]*

| Characteristic | Number of people employed in thousands |
|---|---|
| Nigeria | 60,462.71 |
| Ethiopia | 56,041.79 |
| Congo, Democratic Republic of the | 32,204.33 |
| Tanzania, United Republic of | 29,324.32 |
| Egypt | 26,468.93 |
| Kenya | 24,449.83 |
| Uganda | 17,703.93 |
| South Africa | 15,638.73 |
| Madagascar | 14,659.29 |
| Mozambique | 14,112.53 |
| Ghana | 13,423.29 |
| Angola | 13,360.35 |
| Cameroon | 11,886.17 |

In 2022, Eastern Africa was distinguished by hosting the largest portion of Africa's workforce, with numbers exceeding 484 million individuals [8]. When examining employment rates across the entire continent in Table 1. Nigeria and Ethiopia emerged as leaders, achieving the highest employment figures among all African nations for that year.

Furthermore, Africa is rich in untapped resources such as oil, gas, and fertile land, complemented by a predominantly young demographic. The agricultural sector leads in employment opportunities, closely followed by the oil and mining industries, which are pivotal to the continent's economy. Emerging sectors showing potential for growth and job creation include infrastructure, mining, services, finance, information and communication technology (ICT), entrepreneurship, transport, logistics, and entertainment. These industries are diverse, requiring a broad spectrum of skills and qualifications, and offering rewarding careers in fields ranging from farming and engineering to finance, software development, and the creative arts [9].

As of 2020, agriculture accounted for 43.8 percent of total employment in Africa, underscoring its status as the continent's economic backbone. It employs roughly two-thirds of

Africa's workforce, contributing significantly to the gross domestic product (GDP)—between 30 to 60 percent—and forming about 30 percent of the export value. Agriculture alone employs approximately 225 million people, nearly half of the continent's workforce [10]. In contrast, the industrial sector, as of 2020, represented only 14.6 percent of Africa's total employment. Within this sector, South Africa's trade industry provided jobs for around 3.25 million individuals, while its manufacturing sector employed about 1.8 million people in 2022 [11].

## 3. Demand Patterns

Despite its significant engagement in agriculture, Africa continues to be a substantial importer of food. In 2018, the continent's food import bill exceeded $47 billion, reflecting its reliance on the global market for sustenance [12]. Figure 3. shows that over two decades, from 1998 to 2018, Ethiopia and Ghana witnessed a dramatic increase in food imports, soaring by more than 1,000%. Similarly, Nigeria and Kenya experienced notable growth in their import figures, with increases exceeding 300%, and Tanzania saw its food imports climb by 122%. This surge in imports occurs amidst economic pressures such as the devaluation of African currencies and a downturn in commodity prices, both of which pose significant challenges to food security. Despite these hurdles, a considerable portion of household income is spent on food; nearly 50% in Kenya and about 56% in Nigeria, highlighting the persistent issue of affordability and access to food across the continent.

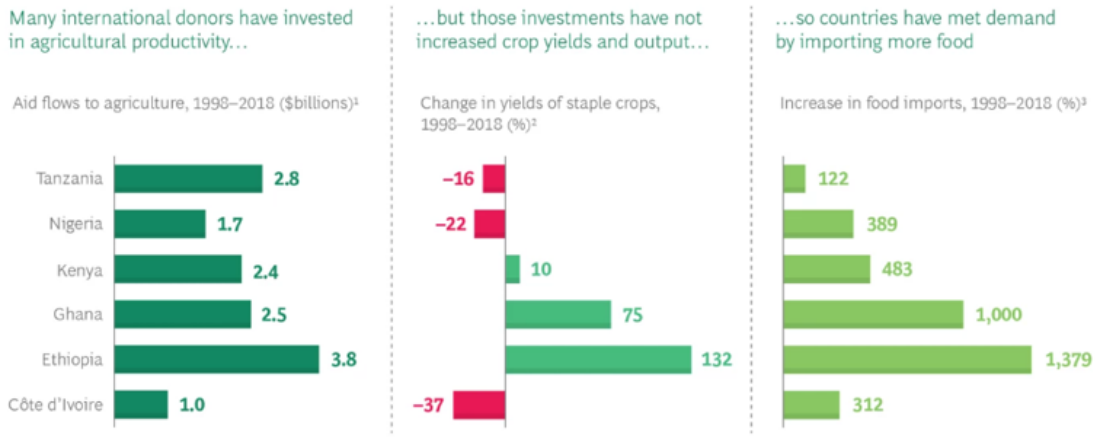
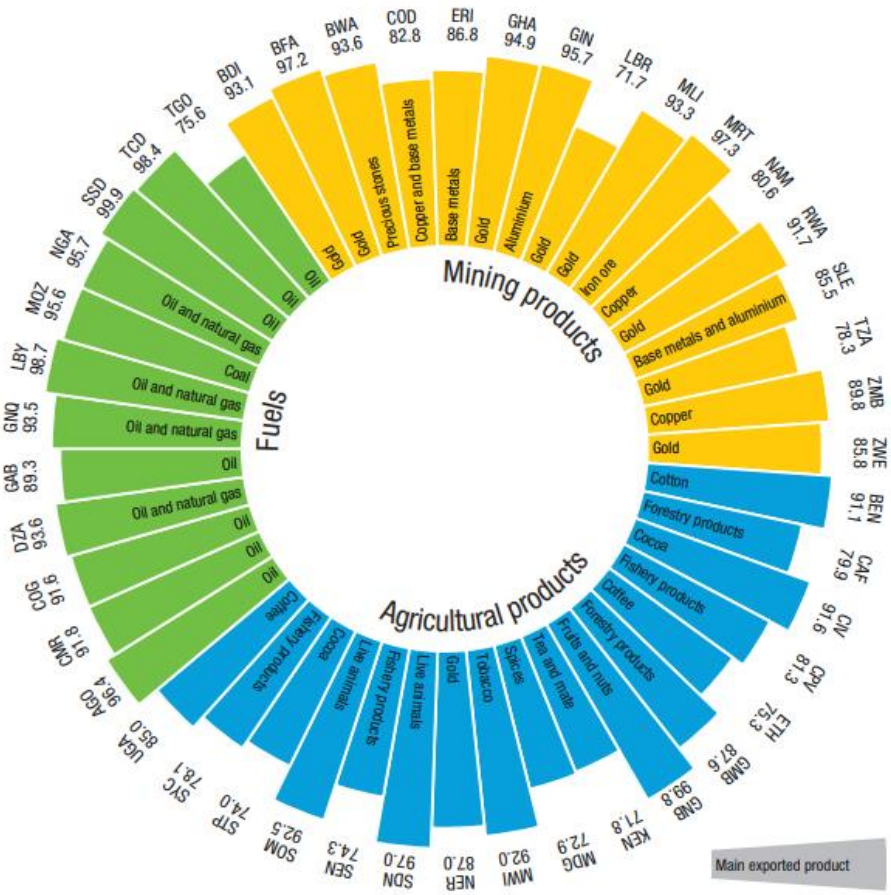



*Figure 3. Aid flow, yields of staple crops and food imports in Africa*
*Source: Mitchell et al. 2021 [12].*

Limited investment in agriculture by African governments, combined with the increasing prevalence of obesity linked to shifting dietary patterns, presents formidable challenges. In Kenya, for instance, public spending on agriculture has been confined to a mere 3-6% of the total budget. The scenario by Mitchell *et al* is further complicated by rising incomes, which have spurred a greater intake of processed foods, consequently elevating obesity rates across the continent. Despite these trends, the agricultural sector continues to be a vital source of employment in Africa, particularly for the youth, signaling a pressing need for structural economic reforms. Moreover, bridging the gender disparity in agriculture is imperative. Empowering female farmers not only has the potential to enhance productivity but also plays a pivotal role in tackling malnutrition.




*Source:* UNCTAD, 2021a, with updated data for the year 2020.
*Note:* The commodity group classification (agricultural products, fuels and mining exports) also includes re-exports. Non-commodity-dependent African countries are Comoros, Djibouti, Egypt, Eswatini, Lesotho, Mauritius, Morocco, South Africa and Tunisia.
*Abbreviations:* AGO, Angola; BDI, Burundi; BEN, Benin; BFA, Burkina Faso; BWA, Botswana; CAF, Central African Republic; CIV, Côte d'Ivoire; CMR, Cameroon; COD, Democratic Republic of the Congo; COG, Congo; CPV, Cabo Verde; DZA, Algeria; ERI, Eritrea; ETH, Ethiopia; GAB, Gabon; GHA, Ghana; GIN, Guinea; GMB, Gambia; GNB, Guinea-Bissau; GNQ, Equatorial Guinea; KEN, Kenya; LBR, Liberia; LBY, Libya; MDG, Madagascar; MLI, Mali; MOZ, Mozambique; MRT, Mauritania; MWI, Malawi; NAM, Namibia; NER, Niger; NGA, Nigeria; RWA, Rwanda; SDN, Sudan; SEN, Senegal; SLE, Sierra Leone; SOM, Somalia; SSD, South Sudan; STP, Sao Tome and Principe; SYC, Seychelles; TCD, Chad; TGO, Togo; TZA, United Republic of Tanzania; UGA, Uganda; ZMB, Zambia; ZWE, Zimbabwe.

*Figure 4. Commodity exports as share of total merchandise exports*
*Source: UNCTAD 2021[13].*

According to the United Nations Conference on Trade and Development (UNCTAD) [13], an overwhelming 83% of African countries are heavily reliant on primary commodities for their export earnings, accounting for 45% of the world's commodity-dependent nations (Figure 4). This dependency subjects these countries to sector-specific shocks, heightening their susceptibility to economic volatility and hindering sustainable growth. Fluctuations in commodity prices can drastically affect export revenues, production, investment, employment, and fiscal stability. Conversely, spikes in commodity prices can lead to unsustainable government spending. Efforts to diversify export bases often result in merely shifting the focus from one primary commodity to another, rather than breaking free from the cycle of commodity dependence [14].

In the realm of infrastructure, Africa's steel industry is poised for growth, driven by an

uptick in construction activities and the adoption of locally produced steel. Innovations in specialized steel alloys are being developed to cater to specific industry needs. The market is categorized into long and flat steel, with the construction sector as a primary consumer. Flat steel finds extensive use in construction, heavy machinery, and automotive manufacturing, whereas long steel is integral to the energy, mining, and automotive industries. Urbanization and demographic expansion are expected to bolster demand for steel in residential construction and infrastructure projects. Leading entities in the African steel market include ArcelorMittal, Hesteel Group, and Egyptian Steel Group [15].

A UN report in 2015 [16] projects that wood demand in Africa will triple by 2050 due to population growth and economic development. Forests, covering 35% of the continent, play a crucial yet underappreciated economic role. While the formal wood industry contributes marginally to GDP, the informal sector, including charcoal and fuelwood, dominates wood usage and employs a significant portion of the labor force. Between 1990 and 2010, Africa experienced a loss of 75 million hectares of forest, underscoring the challenges of land degradation and deforestation.

The demand for animal products in Africa is set to quadruple by 2050, raising concerns over disease spread, environmental degradation, and social impacts. Expansion into wild areas to meet this demand increases the likelihood of diseases jumping from wildlife to livestock and humans. To mitigate these risks, it is imperative for African countries to enhance veterinary services, ensure access to clean water, and establish comprehensive regulatory frameworks. Drawing lessons from East Asia's experiences with SARS and bird flu, it's crucial to improve rural infrastructure to prevent disease transmission [17].

The Economic Commission for Africa anticipates a substantial increase in maritime transport demand by 2030, spurred by the African Continental Free Trade Area (AfCFTA). This agreement is expected to raise the share of intra-African freight carried by sea from 22% in 2019 to 22.7% by 2030, with cargo volumes potentially doubling from 58 million to 132 million tons, contingent upon critical infrastructure developments. North Africa is forecasted to see the most significant growth in vessel demand at 35%, with notable increases in maritime routes connecting North to East and West Africa. Additionally, nations like Gabon, Ghana, Somalia, and Mozambique could experience heightened port activity due to AfCFTA, suggesting a potential need for a 200% expansion in Africa's maritime transport fleet capacity to accommodate the anticipated trade growth without further infrastructure enhancements.

# 4. Maritme Infrastructure

The discussion of infrastructure is crucial for advancing maritime prospects in Africa. Adequate infrastructure, encompassing ports, hinterland connectivity, and shipyards, is key to enabling efficient and smooth trade and transport activities. Through investment in solid infrastructure, African nations can boost their competitive edge, draw foreign investment, spur economic expansion, generate employment, and fully leverage the possibilities within their maritime sectors and markets. However, numerous challenges and areas of underdevelopment persist, particularly in the Sub-Saharan region, highlighting the need for focused improvements and strategic planning in these critical areas [14].

## 4.1. Ports

Ports are integral to Africa's trade dynamics, acting as critical junctures for both the export of commodities and the importation of manufactured goods. Although Africa's trade volume remains modest in comparison to other regions, its economies are witnessing growth and diversification. Ports link Africa with global supply chains, crucial for economic development, trade promotion, job creation, and poverty reduction. However, challenges such as suboptimal performance, limited capacity, insufficient infrastructure, and elevated logistics costs persist, hindering their full potential [18].

Seaports are influenced by a myriad of factors, including natural events, geographic conditions, political climates, and market dynamics, making them susceptible to external shocks like economic downturns and natural calamities. Their operation involves intricate interactions with various entities, emphasizing the importance of intermodal connections. While ports can significantly contribute to hinterland development, focusing solely on their establishment without considering efficient operation, proper hinterland connectivity, or the economic state of the hinterland can lead to setbacks [19].

Olukoju [20] further emphasid that historically developed during the colonial era, African ports were designed to facilitate European access to raw materials. This period also saw the construction of railways to link ports with their hinterlands. Despite the post-colonial establishment of national shipping lines, the dominance of foreign shipping, primarily by former colonial powers, continues to this day.

Recent years have seen significant investments by Chinese state-owned companies in African ports and infrastructure under the “Belt and Road Initiative,” particularly along the west coast [21, 22]. These investments, structured often as EPC+F+I (Engineering, Procurement, Construction + Financing + Investment), bring technological and economic advancements but also raise concerns about the equitable distribution of benefits and the transparency of Chinese investment practices [23].

Efficiency and effectiveness in port operations are crucial for the development of the port state and the broader region. The PwC 2018 [18] study analyzing port performance across Africa highlighted that nearly half of Sub-Saharan Africa's port capacity is concentrated in West Africa, followed by Southern Africa. Despite this capacity, West African ports exhibit the lowest utilization rates, indicating both available capacity and unrealized potential. In contrast, ports in Southern Africa, particularly in South Africa, show higher utilization rates,

underlining South Africa's dominance in container business. East African ports face congestion, revealing a need for infrastructure development to meet international standards (Figure 5).

With Africa representing a mere one percent of global container throughput, enhancing port and transport efficiency could significantly impact the continent's economic landscape. Given Africa's rich mineral and uncultivated arable land, improving ports and transport networks is essential for transforming its vast potential into real economic success [20].

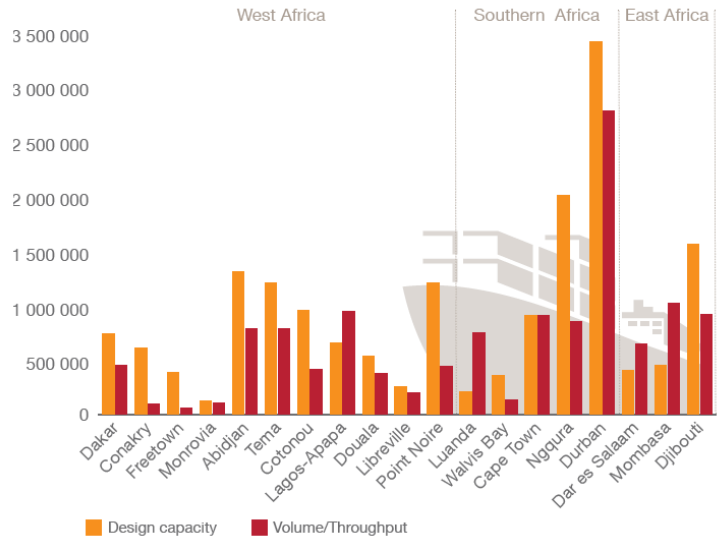



*Figure 5. Design capacity of SSA ports versus actual throughputs*
*Source: PwC 2018 [18]*

## 4.2. Hinterland Connectivity (Rail and Road)

Hinterland connectivity is a critical factor in Africa's developmental challenges. The deficiency in essential infrastructure, such as roads and railways, restricts trade capabilities and inflates the costs for both imports and exports. In 1971, the United Nations Economic Commission for Africa introduced the concept of a Trans-African Highway, envisaging nine highways covering nearly 40,000 miles to link major port cities across the continent. Although more than half of this network has been constructed, significant gaps remain, notably on the corridor between Mombasa and Lagos [19].

Challenges such as difficult terrain, conflict, and political instability have impeded progress. Consequently, Africa faces elevated transportation costs compared to developed regions. Enhancing port operations and access infrastructure is vital to reducing transit times and boosting trade. Yet, Africa needs to progress substantially to align with international trade norms, emphasizing not only on port enhancement and efficiency but also on the expansion of rail and pipeline networks to alleviate the heavy dependence on road transport and tackle logistical hurdles within the shipping and maritime sector [18].

The advancement of Africa's economy and society is closely tied to the reliability of its

road networks. Current deficiencies in road infrastructure and maintenance hinder regional growth and accessibility. Although plans are underway for significant investments, with an average annual expenditure of $4.6 billion, aiming for a total of $78 billion by 2030 [24]. The continent needs an additional 60,000km to 100,000km of roads to enhance connectivity. The African Development Bank has identified an annual infrastructure funding shortfall ranging from $67.6 billion to $107.5 billion. Transportation costs in Africa are markedly higher, by 50-175%, compared to other regions due to inadequate infrastructure. Moreover, bureaucratic hurdles and extensive paperwork further complicate trade, as transport companies may manage up to 1,600 documents for a single truck to cross international borders [25].

China's involvement in Africa's infrastructure development is longstanding and significant. Chinese state-owned enterprises have heavily invested in a range of infrastructure projects across the continent [26]. As depicted in Figure 6, these investments include leading the construction of the Tanzam railway, offering alternative transport routes for African countries circumventing Apartheid-era South Africa. Additionally, Chinese firms have been instrumental in refurbishing road and railway systems in Angola and Zambia, aiding in the modernization of their transport networks. These infrastructure projects extend to nations like Nigeria, Zimbabwe, and Sudan, where Chinese entities have embarked on large-scale development initiatives [21].

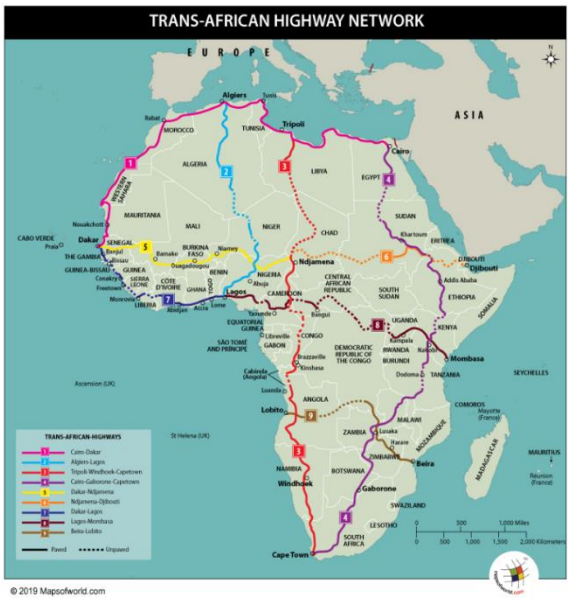



*Figure 6. Trans-African Highway Network*
*Soruce: Mapsofworld [26]*

There are currently multiple projects running to improve and develop rail and road connections throughout Africa. Table 2 shows some of these major projects:

*Table 2. Major rail and road related developments. Source: PwC 2018 [18]*

| Country location | Name of the project | Funding | Stage in project cycle |
|---|---|---|---|
| **Côte d'Ivoire** | Dabou-San Pedro Highway Rehabilitation Programme | 1.2 bil. USD | Conceptual |
| **Regional – Burkina Faso, Côte d'Ivoire** | Burkina Faso-Côte d'Ivoire Railway Rehabilitation Programme | 700 mil. USD | Planning |
| **Regional – Tanzania, Uganda** | Masaka-Kumunasi Road | 1.2 bil. USD | Planning |
| **Regional – Rwanda, Tanzania** | Isaka-Kigali Standard Gauge Railway | 900 mil. USD | Bankable feasibility |

## 4.3. Shipyards

The shipyard industry in Africa has seen significant growth in recent years, with expansions in both shipbuilding and maintenance facilities [27]. South Africa leads in southern Africa with a dense cluster of shipyards in the ports of Durban and Cape Town, home to internationally renowned firms like Damen Shipyards.

In contrast, West Africa features a diverse array of shipyards across several countries, including Nigeria, Cameroon, Ghana, Ivory Coast, and Equatorial Guinea, with additional shipyards located in Namibia, Kenya, and Senegal, albeit more isolated from major clusters [28].

In Northern Africa, the shipbuilding industry is concentrated in Egypt, Tunisia, and Algeria, where the coastal geography is advantageous for shipbuilding and repair activities. Notable facilities include the Alexandria Shipyard Company in Egypt, which undertakes significant construction and repair projects, and the Tunisian Shipbuilding and Repair Company, known for its work on a variety of vessels. The Ports of Algiers in Algeria and Tunis in Tunisia are also key sites for ship repair, offering a wide range of services including hull and engine repairs [29].

The shipbuilding and repair market in Western Africa is on the rise, fueled by the need for new vessels and maintenance services. The region benefits from a lengthy coastline and rich maritime tradition. Shipyards here are capable of constructing a wide range of vessels, with Damen Shipyards Group in Lagos, Nigeria, being a significant contributor, especially for the Nigerian Navy and the oil and gas industry. Nigerdock in Lagos offers comprehensive ship repair services, emphasizing the growing repair market focused on cargo ships, tankers, and fishing vessels [30].

Southern Africa is witnessing notable growth in the shipbuilding and repair sectors, spurred by the burgeoning oil and gas industry and an increased demand for offshore support vessels. South Africa's shipbuilding industry, in particular, is flourishing with a focus on specialized vessels for the oil and gas sector, while the ship repair industry in the region is expanding with various shipyards providing maintenance services for a wide array of vessels. The strategic position of Southern Africa on major shipping routes further boosts its attractiveness for ship repair and maintenance activities [31].

However, the capacity for new vessel construction in Africa might not meet the rising

demand. It is anticipated that the need for newbuild vessels will predominantly be met by shipyards in China, Korea, and Japan, where shipbuilding capabilities are more advanced. Consequently, the strategic emphasis for African shipyards may shift towards specializing in smaller vessels, like tugboats and fishing vessels, and enhancing repair and docking facilities [32].

A future reasoning is that African ports are likely to become preferred destinations for older vessels characterized by smaller tonnages and more cost-effective construction, partly due to the region's relatively relaxed environmental regulations. This is exemplified by the absence of a more strigent shipping Sulphur Emission Control Areas (SECAs) on its waters. The establishment of Sulphur Emission Control Areas (SECAs) by the International Maritime Organization (IMO) was aimed to reduce sulphur emissions from shipping, particularly around the Baltic Sea region (BSR) and the North Sea [33]. Since 2015, a sulphur cap of 0.1% w/w was applied in these areas, however to enforce the compliance globally, ships operating outside of SECAs were only required to lower their sulphur emissions to 0.5% w/w, since 2020 [34]. The implication is that compliance and its costs are relax around Africa and other regions outside SECA.

One of the challenges for shipowners regarding the SECA rule is the various economically viable alternatives for meeting SECA regulations [35]. Olaniyi and Prause [36] found that shipowners in the BSR have considered several options to comply with SECA standards. Popular methods include transitioning from heavy fuel oil (HFO) to lower sulphur alternatives such as marine gas oil (MGO), marine diesel oil (MDO), ultra-low sulphur fuel oil (ULSFO), or compliant fuel blends. Other strategies involve the use of exhaust gas cleaning systems (scrubbers) in conjunction with HFO or the adoption of alternative fuels like liquefied natural gas (LNG). However, these compliance strategies often come with significant financial implications, leading shipowners to carefully balance capital and operational expenditures in their decision-making processes [37].

Therefore, while Africa might present a more conducive regulatory environment for maritime operations, global efforts led by IMO to curb greenhouse gas emissions and enforce sulphur caps could somewhat temper this trend. Climate change stands as one of the most challenging scientific and political issues of our time [38]. From a scientific perspective, the evidence regarding human-induced warming of the climate system is unequivocal [39]. According to the Fifth Assessment Report form IPCC [40], this intricate and dynamic process of unprecedented environmental change has now reached severe levels, marking the dawn of a new era characterized by environmental breakdown [41]. Anticipated climate change encompasses not only shifts in global average temperatures but also alterations in the frequency and intensity of extreme weather and climate events. These events include severe flooding, high precipitation, storms, droughts, wildfires, heatwaves, and cold waves, in addition to the growing threats posed by rising sea levels [42]. Despite the overwhelming scientific consensus on the reality of human-induced climate change, translating this knowledge into action remains a persistent challenge [43].

To preserve and enhance the quality of life in Africa, we must develop a range of adaptation planning methods and toolkits to confront climate disruptions, sustainable shipping and Africa shipbuilding. Within this context, a pivotal theme for the shipping industry is the need to formulate strategies to navigate the challenges. These strategies not only aid in reducing

environmental impact but also foster the industry's long-term sustainability and resilience

Disruptions brought on by climate change also highlight how important it is for business to embrace sustainable practices and technology [44]. A greater focus is being placed on creating ships with energy-efficient engines and environmentally acceptable materials, in addition to being commercially and environmentally sustainable [45]. The marine industry's ability to meet the growing demand for maritime services and transportation while navigating the problems posed by climate change depends on this shift towards sustainability [46].

This discussion implies that, to gauge the shipbuilding industry's ability to meet demand, it is crucial to consider the capacities of active shipyards globally. UNCTAD [47] figures show that as of October 2021, the total shipbuilding capacity stood at 35.5 million Compensated Gross Tonnage (CGT), with China contributing 49% of this capacity (Figure 8). Although there has been a recent decline in capacity, it is expected to recover partially (Figure 9). However, to meet the future needs of the industry, this capacity will need to expand in the coming years.

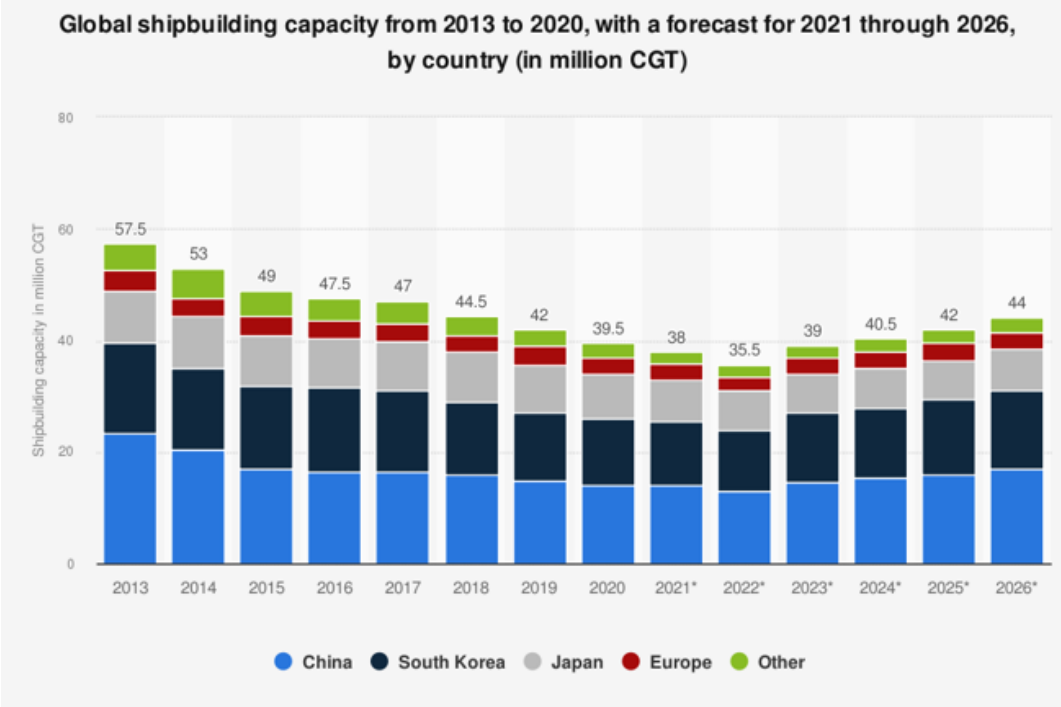



*Figure 8. Global shipbuilding capacity from 2013 to 2020, with a forecast for 2021 through 2026, by country*
*Source: Statista 2022[48].*

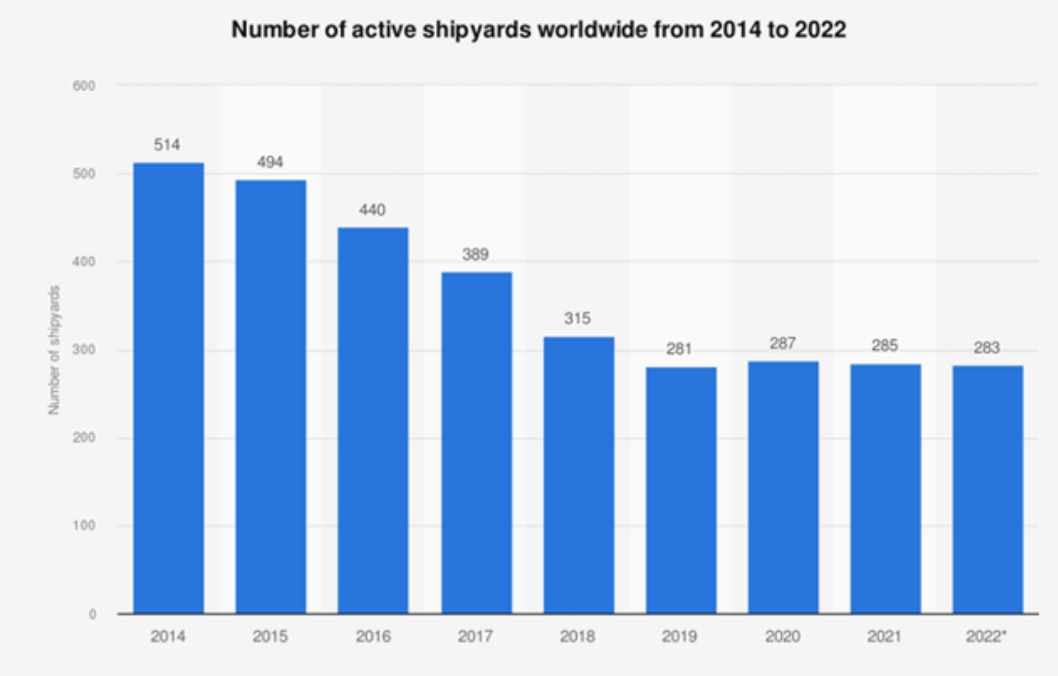



*Figure 9. Number of active shipyards worldwide from 2014 to 2022*
*Source: Statista 2022[49]*

## 5. Emerging Economic/Maritime Hubs and Hotspots

This section examines the maritime sector in sub-Saharan Africa (SSA), distinguishing it from North Africa, which is more integrated into global maritime supply chains due to its proximity to the Suez Canal and the Mediterranean Sea.

The evaluation of SSA's maritime capabilities underscores the importance of ports as primary access points to the continent. This analysis highlights the economic and maritime centers across SSA, categorized into four main regions: East Africa, West Africa, Middle Africa, and Southern Africa [47].

SSA's economy has traditionally centered on commodity exports such as oil, coal, iron ore, precious metals, cocoa, timber, and palm oil. However, the trade in manufactured goods is gaining prominence as many African countries aim to diversify and expand their economies. In this context, container trade emerges as a crucial factor in pinpointing the maritime and economic nerve centers across SSA [50].

Key metrics for identifying maritime hubs include trade volume per port and hinterland size. A 2018 study by consultancy firm PwC [18] maps out the major container ports in Africa, detailing their design capacity, throughput, hub attractiveness score (HAS), trade corridors, and actual TEU volumes per annum is shown in Figure 10. According to this study, the port of Durban in South Africa is poised to become a leading hub, boasting the highest HAS of 94 and the largest container throughput in SSA. Other notable ports include Cape Town and Ngqura in South Africa, both with a HAS of 50, followed by Abidjan in Ivory Coast and Mombasa in Kenya, each scoring 46. Djibouti, Lagos-Apapa (Nigeria), and Tema (Ghana) also feature prominently with a HAS of 40. The study further mentions Dar-es-Salaam (Tanzania) and Dakar (Senegal) with scores of 35 and 33, respectively, for comparison, Rotterdam's HAS stands at 421.

Given the competitive nature of port dominance within a region, the study suggests Durban has the strongest potential to become Southern Africa's main hub, with Cape Town and Ngqura facing challenges due to geographical disadvantages and insufficient hinterland connections. In East Africa, Mombasa is favored over Djibouti for its larger hinterland and established market connections, relegating Dar-es-Salaam to a more regional role due to Mombasa's superior hinterland links and higher container throughput.

The PwC report also notes that many large shipping lines establish hubs outside Africa, attributing this to the comparative inefficiency of African ports against their Asian and European counterparts. These external hubs are strategically utilized to serve the African market.

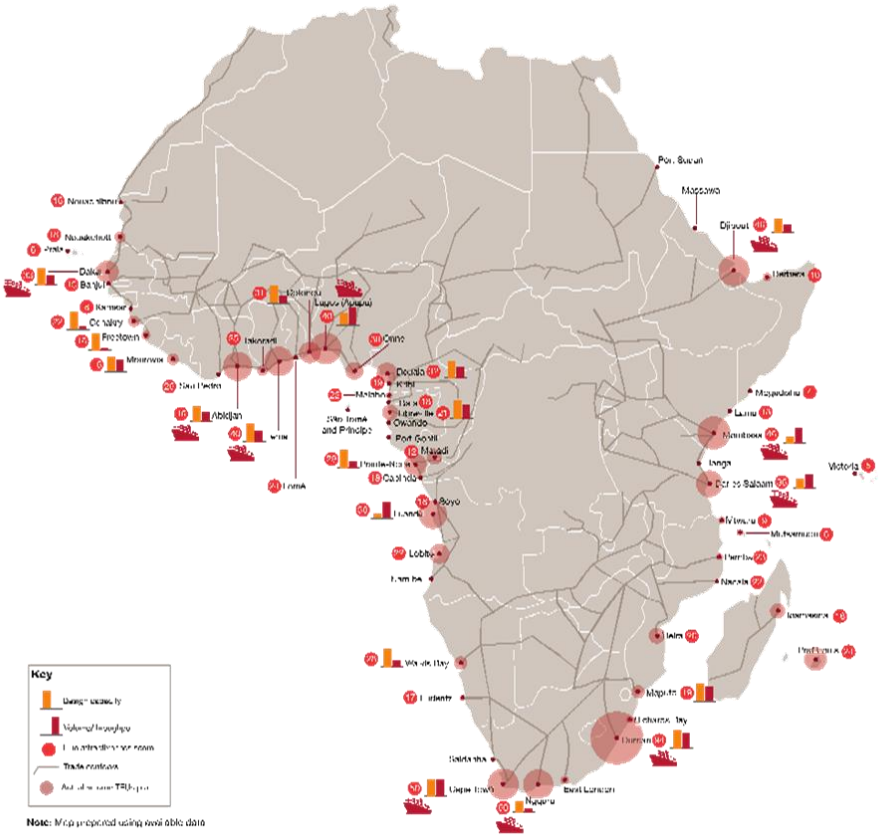



*Figure 10. Ports of sub-Saharan Africa*
*Source PwC 2018 [18]*

Reflecting on Africa's trade dynamics, it is clear that the continent's wealth in natural resources, including coal, iron ore, and oil, heavily influences its trade structure towards a commodity-based system. This context necessitates a detailed examination of bulk and break-bulk port facilities across sub-Saharan Africa (SSA), given that transport and terminal handling costs can constitute 20-30% of the total Free on Board (FOB) costs for bulk commodities. The efficiency of bulk ports thus becomes critical. Studies, including one by PwC in 2018, indicate that purpose-built bulk terminals are the most effective for the loading and discharging of bulk cargo.

In West Africa, for example, the port of Nouadhibou in Mauritania stands out as the premier bulk port, primarily handling iron ore. This is significant due to the country's status as the second-largest African iron ore producer; with the mining company SNIM contributing 9% to Mauritania's GDP. Southern Africa, in contrast, boasts a higher concentration and larger bulk ports, with the port of Richards Bay, a dedicated coal handling facility, being especially notable for its immense volume of approximately 100 million tons [51]. Following Richards Bay is the port of Saldanha, known for its iron ore exports. Moreover, the port of Durban, while renowned for its container handling capabilities, also plays a pivotal role in managing

bulk and break-bulk cargoes, processing around 40 million tons in 2018 (Figure 11). In East Africa, the ports of Dar es Salaam and Mombasa lead in handling both containers and bulk commodities, underscoring their multifaceted importance to the region's trade infrastructure.

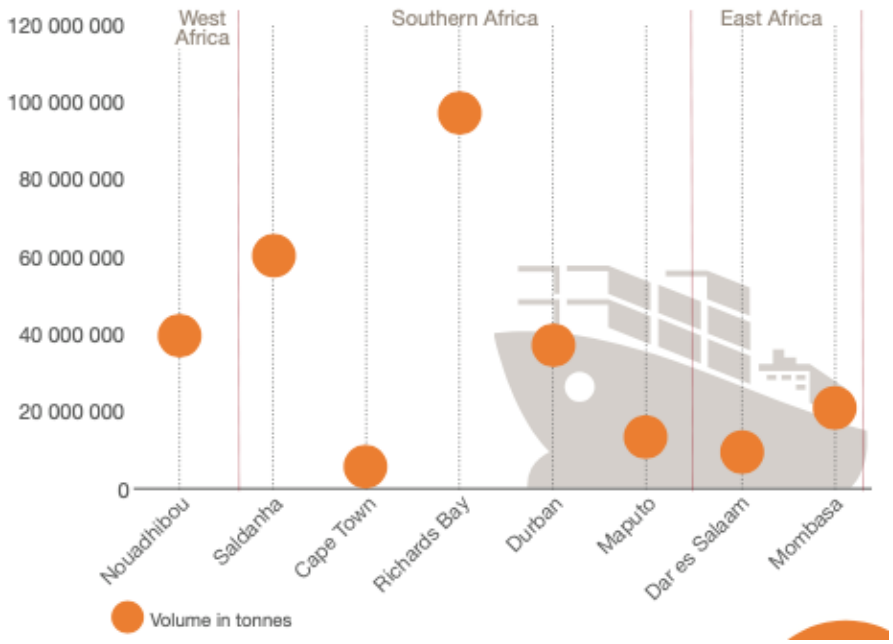



*Figure 11. Sub-Saharan Africa - Largest bulk and break bulk ports*
*Source: PwC 2018 [18].*

## 6. Maritime hotspots in sub-Saharan Africa

Based on data from the United Nations Conference on Trade and Development (UNCTAD). The analysis reveals significant regional variations in maritime activities across sub-Saharan Africa (SSA), particularly in the volume of goods loaded and discharged. Western Africa emerges as the dominant player within SSA, attributable to two main factors: its population distribution and natural resource exports (Figure 12).

Nigeria, with a population exceeding 200 million, demands a substantial inflow of merchandise, food, and other essentials, underscoring the region's high volume of goods discharged. This population dynamic, coupled with West Africa's rich endowment in natural resources, contributes to its leading position in both the loading and discharging of goods. The export of natural resources from West Africa further amplifies its prominence in maritime trade [50].

Southern Africa is also identified as a maritime focal point, particularly through the export activities at ports like Richards Bay, which specializes in coal exports. Additionally, the port of Durban, the largest container port in SSA, plays a pivotal role in the region's maritime infrastructure [51]. However, when it comes to the discharge of goods, Figure 12. shows that volumes in Southern Africa do not match those of West Africa, primarily due to the smaller population size. Nevertheless, it is noteworthy that Southern Africa leads in crude oil imports among all regions in SSA, highlighting a specific area of dependency and trade flow that distinguishes the region's maritime trade profile.

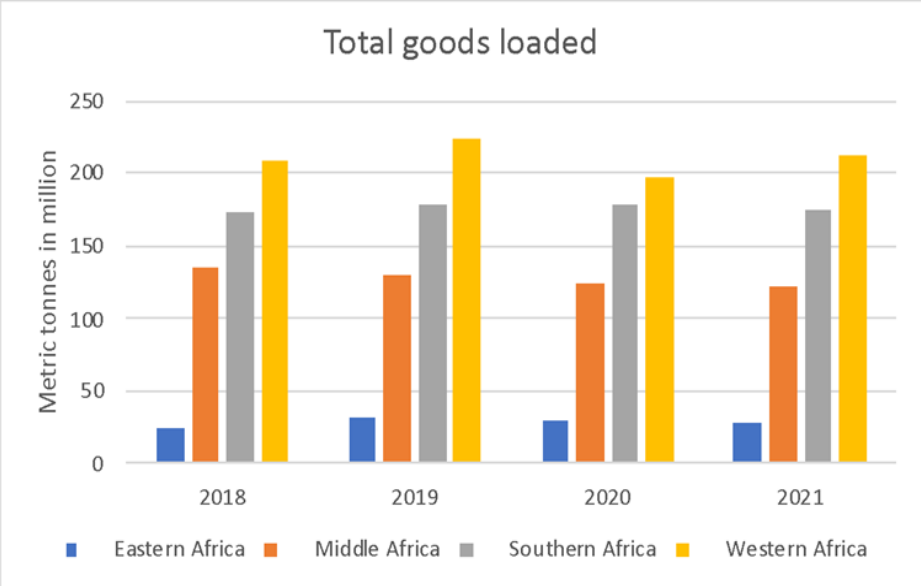



*Figure 12. Total goods loaded in sub-Saharan Africa*
*Source: UNCTAD 2023 [52]*

East Africa's trade dynamics distinctly position it as an import-centric region within sub-Saharan Africa (SSA), with its export figures trailing behind those of other areas depicted in

Figure 13. The region's minimal engagement in oil shipments contrasts with its higher volumes of dry cargo and other tanker trade cargoes. This disparity is further highlighted by the substantial quantities of goods received, particularly in the categories of dry cargo and tanker trade, underscoring East Africa's significant import activity.

Several factors contribute to East Africa's import reliance. Its geographical proximity to Asia offers a logistical advantage, facilitating the influx of goods. Additionally, the densely populated hinterland, which requires a steady flow of imports to meet its needs, amplifies the demand for foreign goods. These elements combined reinforce East Africa's role as a primary destination for imports, contrasting with its modest export levels [53].

Conversely, Middle Africa's export profile is dominated by crude oil, surpassing even West Africa in the volume of oil dispatched. This singular focus on crude oil exports marks Middle Africa's significant contribution to the global energy market. However, the region records the lowest import figures across SSA, indicating a more constrained inbound trade flow. This pattern reflects a focused economic structure heavily reliant on oil exports, which shapes Middle Africa's overall trade balance and maritime activity [54].

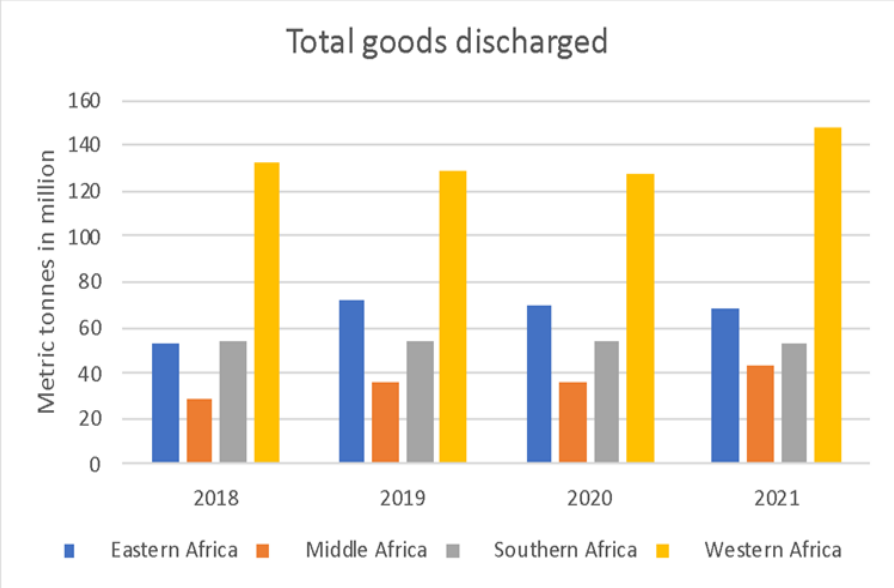



*Figure 13. Total goods discharged in sub-Saharan Africa*
*Source: UNCTAD 2023 [42]*

In the subsequent sections, we will conduct a detailed examination of port statistics for each region within sub-Saharan Africa, utilizing data sourced from the UNCTAD. This analysis aims to offer a granular perspective on the maritime infrastructure and trade dynamics across the continent, highlighting the unique characteristics and operational capabilities of the ports within these regions.

## 6.1. East Africa

The UNCTAD statistics categorize the following countries as part of East Africa: British

Indian Ocean Territory, Burundi (landlocked), Comoros, Djibouti, Eritrea, Ethiopia (landlocked), French Southern Territories, Kenya, Madagascar, Malawi (landlocked), Mauritius, Mozambique, Rwanda (landlocked), Seychelles, Somalia, South Sudan (landlocked), Tanzania, Uganda (landlocked), Zambia (landlocked), and Zimbabwe (landlocked). For more information, refer to UNCTAD's official statistics portal [55] and various world map resources [56].

### *6.1.1 Cargo Types*

In East Africa, dry cargo emerges as the predominant cargo type, as illustrated in Figure 14. The region saw 21 million metric tons of dry cargo loaded and 50 million tons discharged in 2021. Compared to dry cargo, crude oil and other tanker trade cargoes hold lesser significance for the region. Specifically, only 2 million metric tons of crude oil were loaded in 2021, with no recorded discharges. Other tanker trade cargoes, encompassing refined petroleum products, liquefied natural gas (LNG), liquefied petroleum gas (LPG), and chemicals, amounted to 5 million metric tons loaded and 18 million metric tons discharged, according to UNCTAD statistics for 2021.

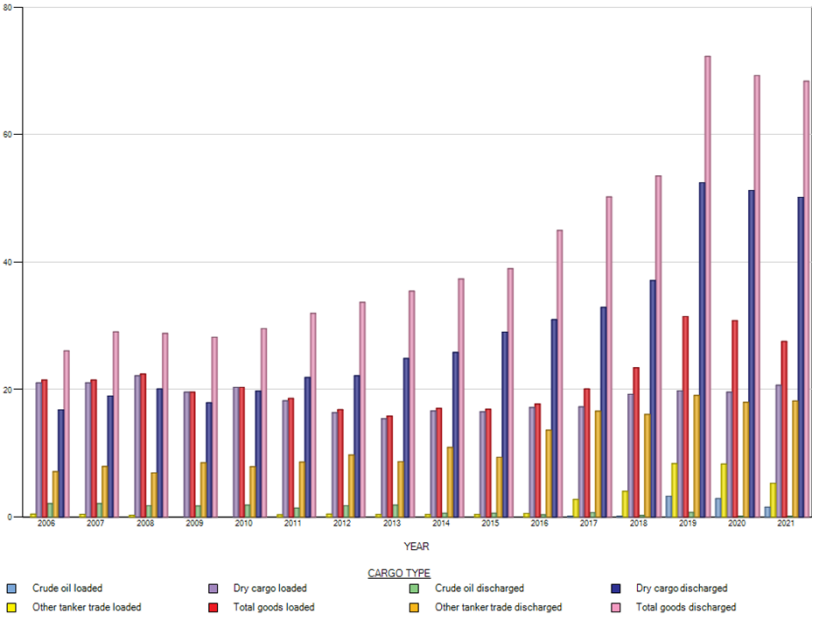



*Figure 14. East Africa, Cargo types loaded and discharged in million metric tons Source: UNCTAD 2021 [57].*

### *6.1.2. Container Trade*

The leading maritime nations in East Africa's container trade include Djibouti, Kenya, Tanzania, Mozambique, and Mauritius. Data from 2010 to 2021 highlights the growth in container port throughput within these countries. Figure 15 shows that in 2021, Kenya's Port of Mombasa achieved the highest throughput, recording 1,435,565 TEUs, followed by Djibouti with a throughput of 692,000 TEUs. Mozambique also reported significant activity, with a

throughput of 440,582 TEUs for the same year. Historically, Tanzania's Dar es Salaam port often ranks third in the region. Mauritius, despite being an island nation, reported throughput figures comparable to Mozambique, although specific numbers for 2021 were not disclosed. These statistics, alongside the findings from a PwC study, suggest that the Port of Mombasa in Kenya remains the most promising candidate for becoming a hub port in East Africa.

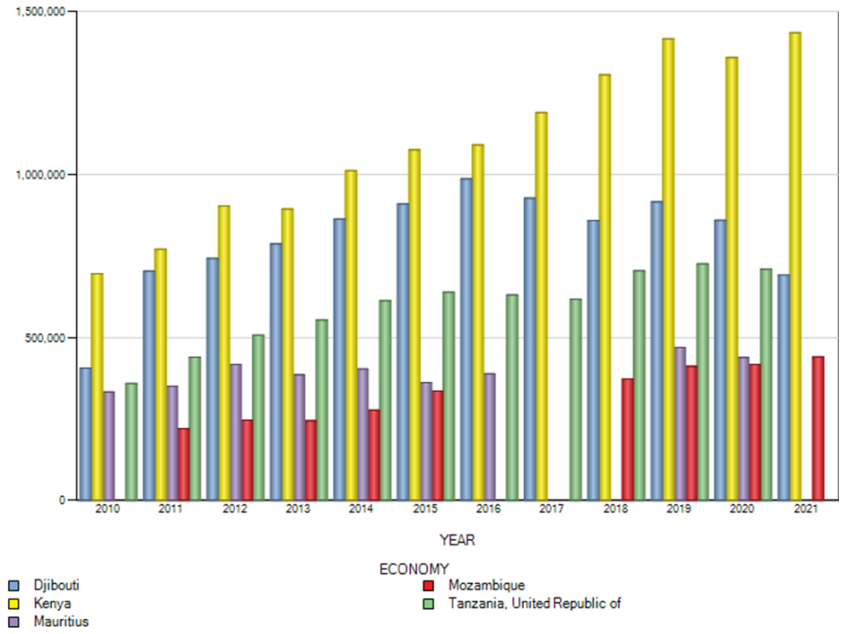



*Figure 15. East Africa, Container port throughput in TEU (Twenty-foot Equivalent Unit) Source: UNCTAD 2021 [57]*

## 6.2. West Africa

UNCTAD statistics classify the following countries as part of West Africa: Benin, Burkina Faso (landlocked), Cabo Verde, Ivory Coast, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali (landlocked), Mauritania, Niger (landlocked), Nigeria, Saint Helena, Senegal, Sierra Leone, and Togo. For more detailed information, please refer to the UNCTAD's official statistics portal [55] and various world map resources [56].

### *6.2.1. Cargo Types*

Figure 16 illustrates that dry cargo is the predominant cargo type in West Africa. In 2021,

the region loaded 105 million metric tons of dry cargo and discharged 107 million metric tons. This represents a significant increase from 2006, when 40 million metric tons were loaded and 62 million metric tons were discharged. Initially, crude oil dominated the loading segment, peaking at 111 million metric tons. However, by 2021, this figure had decreased to 76 million metric tons, indicating a shift in cargo dynamics over the years [52].

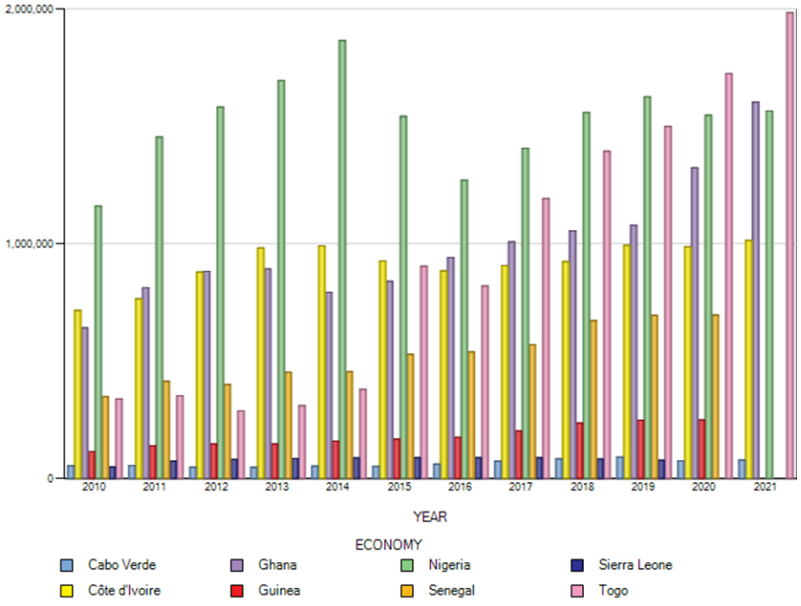



*Figure 16. West Africa, Cargo types loaded and discharged in million metric tons*
*Source: UNCTAD 2023 [52]*

### *6.2.2. Container Trade*

In West Africa, the principal maritime nations in the container trade sector include Cabo Verde, Ghana, Nigeria, Sierra Leone, Ivory Coast (Côte d'Ivoire), Guinea, Senegal, and Togo. The container port throughput volume is evident in Figure 17. Nigeria previously led in container handling volumes but was surpassed by Togo in 2020 [55]. The Port of Lomé stands as Togo's primary container facility. Since 2014, the shipping company MSC has been investing in this port through its terminal subsidiary, Terminal Investment Limited (TiL) [58].

Additionally, container throughput at Ghana's ports has shown significant growth in recent years. Remarkably, in 2021, Ghana's throughput volumes exceeded those of Nigeria. To enhance the container port of Tema, APM Terminals, in collaboration with partners, invested approximately 1 billion USD. This upgraded port commenced operations in 2020 [59].

The ports in Ivory Coast also demonstrate a high level of container throughput, with an annual figure of approximately 1 million TEU. The inauguration of a new terminal at the Port of Abidjan in 2022 is expected to boost the capacity to 2.5 million TEU per year [60].

This pattern of investment by major entities such as APM Terminals and MSC in several

West African container ports underscores the region's growing significance in the maritime industry. However, the future development of a hub port in the region remains uncertain.

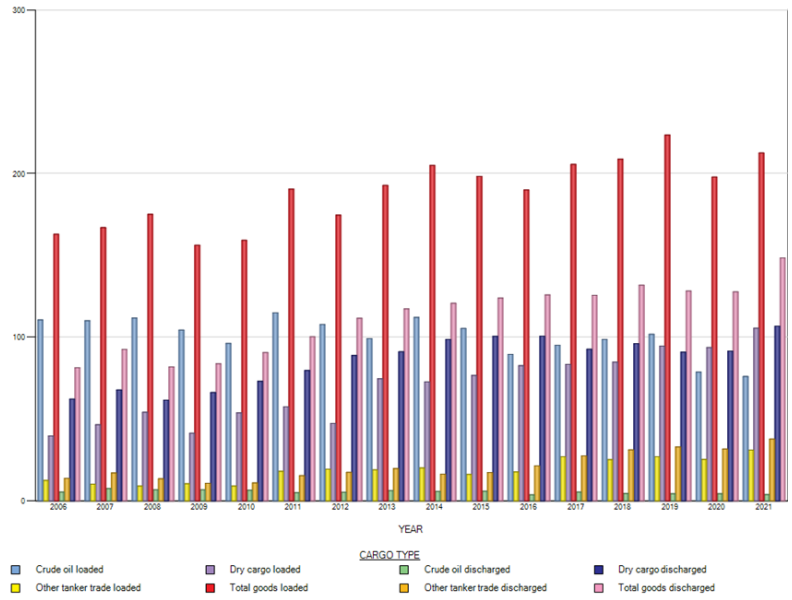



*Figure 17. West Africa, Container port throughput in TEU (Twenty-foot Equivalent Unit) Source: UNCTAD 2023 [55]*

## 6.3. Middle Africa

According to UNCTAD statistics, the countries comprising Middle Africa include Angola, Cameroon, the Central African Republic (landlocked), Chad (landlocked), Congo, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome, and Principe. These classifications are detailed on the UNCTAD website [55] and corroborated by resources such as Maps of World [56].

### *6.3.1. Cargo Types*

The maritime trade within Middle Africa is primarily characterized by its focus on crude oil cargo. In 2021, out of a total of 122 million metric tons of goods loaded, crude oil constituted 88 million metric tons (Figure 18). On the import side, the region imported a mere 1 million metric tons of crude oil, underscoring its status as an oil-exporting region. In contrast, the trade balance for dry cargo reveals that 33 million metric tons of dry cargo were imported in 2021, while only 19 million metric tons were exported [55].

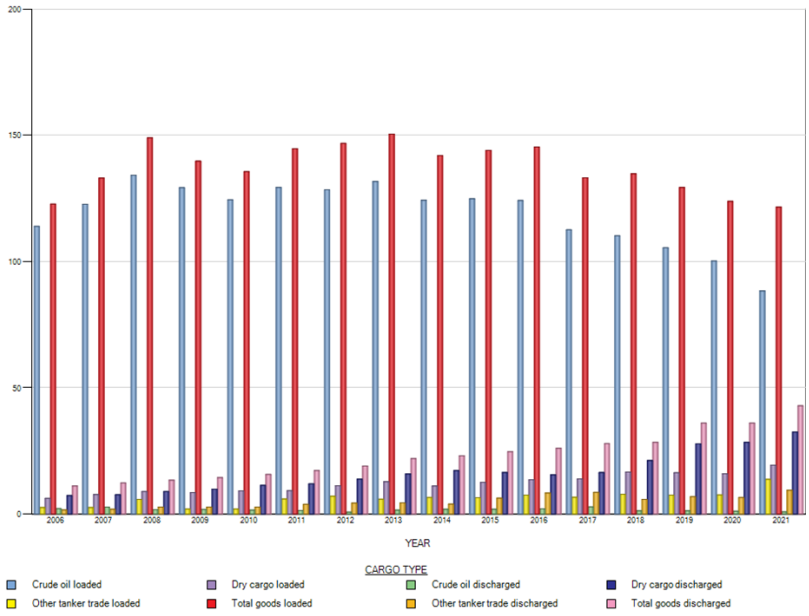



*Figure 18. Middle Africa, Cargo types loaded and discharged in million metric tons Source: UNCTAD 2023 [55]*

### *6.3.2. Container Trade*

In Middle Africa, the leading maritime nations in the container trade sector include Angola, Cameroon, Congo, Gabon, and the Democratic Republic of Congo. The Port of Pointe-Noire in Congo had the highest container throughput in 2021, with a total of 1,003,734 TEU. Data for the other countries in 2021 is not available. However, examining the figures from 2020 reveals that the Port of Luanda in Angola achieved a throughput of 700,000 TEU (Figure 19). When compared to other regions in Africa, the container throughput in Middle Africa is relatively modest.

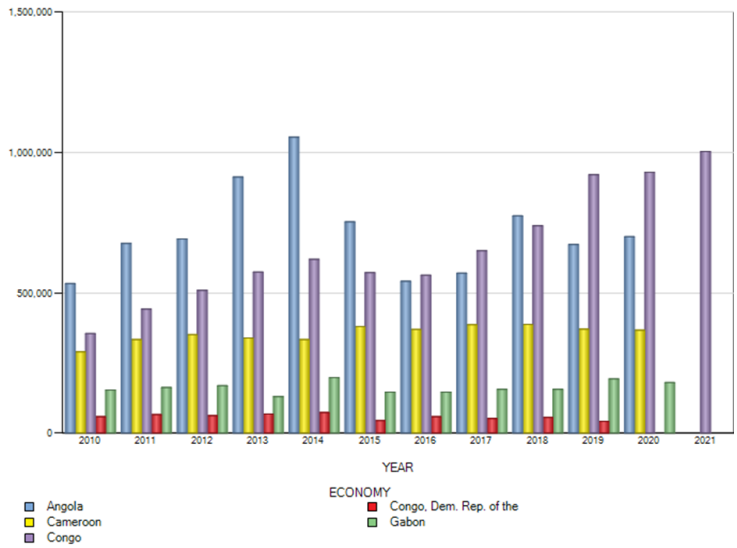



*Figure 19. Middle Africa, Container port throughput in TEU (Twenty-foot Equivalent Unit) Source: UNCTAD 2023 [55]*

## 6.4. Southern Africa

The UNCTAD statistics categorize the following countries as part of Southern Africa: Botswana (landlocked), Eswatini (landlocked), Lesotho (landlocked), Namibia, and South Africa [55, 56].

### *6.4.1. Cargo Types*

As shown in Figure 22, in Southern Africa, dry cargo handling predominates at the ports, with Durban being the largest container port and Richards Bay the largest coal port in Sub-Saharan Africa (SSA), contributing significantly to the volumes depicted in the figure below. The majority of the cargo handled is for export, as evidenced by the statistics: a total of 175 million metric tons of cargo were loaded for export, compared to only 53 million tons that were imported (Figure 20). This export dominance is attributed to the substantial quantities of dry bulk that are shipped through South African ports.

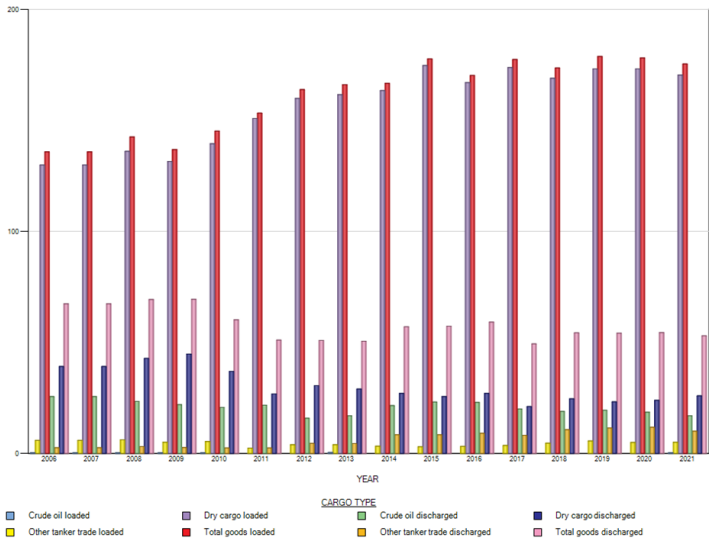



*Figure 20. Southern Africa, Cargo types loaded and discharged in million metric tons Source: UNCTAD 2023 [55]*

### *6.4.2. Container Trade*

Container trade in Southern Africa is primarily concentrated in South African ports, with Durban, the largest port in Sub-Saharan Africa, playing a pivotal role. Additionally, other container ports such as Cape Town and Ngqura also make significant contributions to the notably high container throughput figures in South African ports (Figure 21). In contrast, Namibia's container throughput is facilitated by a single port, with the Port of Walvis Bay recording a container throughput of 154,207 TEUs in 2021 [47]. Between 2014 and 2019, a new terminal was constructed to augment the capacity from 355,000 TEUs per annum to 750,000 TEUs per annum [61]. Despite projections indicating growth, the 2021 figures did not align with these forecasts. However, it is reasonable to infer that the 2021 data were still

impacted by the COVID-19 pandemic.

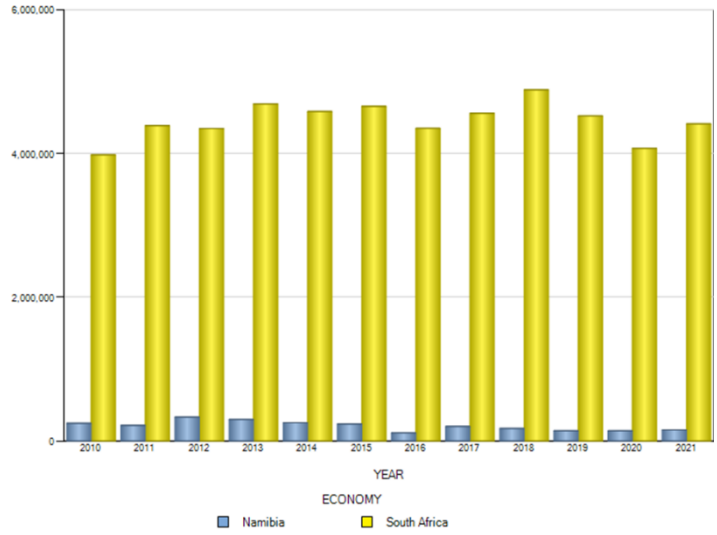



*Figure 21. Southern Africa, Container port throughput in TEU (Twenty-foot Equivalent Unit) Source: UNCTAD 2022 [47]*

# 7. Fleet DWT Requirements

To estimate and analyze the required deadweight tonnage volumes necessary to serve Africa by 2050, it is essential first to ascertain current figures. Subsequently, we will examine various growth projections put forth by analysts. Lastly, the findings will be consolidated into a comprehensive forecast.

## 7.1. Current Situation

The latest UNCTAD Review of Maritime Transport 2023 [52], utilizing data from 2021, presents the following transportation figures, categorized by cargo types: crude oil, other tanker trade, and dry cargo. In 2021, a total of 10,985.4 million tons of cargo were loaded worldwide, with 10,975.5 million tons discharged. Of this, 1,700.4 million tons were crude oil, 1,252.0 million tons were other tanker trade cargoes, and 8,033.0 million tons were dry cargo loaded. Conversely, 1,846.4 million tons of crude oil, 1,273.3 million tons of other tanker trade cargoes, and 7,855.8 million tons of dry cargo were discharged.

The same report shows that for Africa, a total of 762.4 million tons of cargo were loaded, including 226.4 million tons of crude oil, 99.8 million tons of other tanker trade cargoes, and 436.2 million tons of dry cargo in year 2022. In contrast, a total of 553.2 million tons were discharged, demonstrating that Africa exports more cargo than it imports. Of the discharged cargo, crude oil comprised 24.9 million tons, other tanker trade cargoes 118.5 million tons, and dry cargo 409.8 million tons.

Analyzing these percentages reveals that Africa accounts for only 12.6% of the total tons of goods loaded and 8.3% of the total tons of cargo discharged globally.

## 7.2. Predictions for World Trade

As global populations continue to rise, both world trade and, consequently, maritime trade are projected to expand. The classification society DNV, in its Maritime Forecast to 2050, anticipates that the total demand for transport work will increase from 65,000 billion ton-miles in 2022 to over 80,000 billion ton-miles by 2050, representing a demand growth of 29.55% over this period. The analysis of Figure 22 below reveals an expected increase in the demand for transport work by both container ships and bulk carriers. Furthermore, the demand for transport work by gas tankers is forecasted to rise, whereas the demand for liquid tankers is anticipated to decline [62].

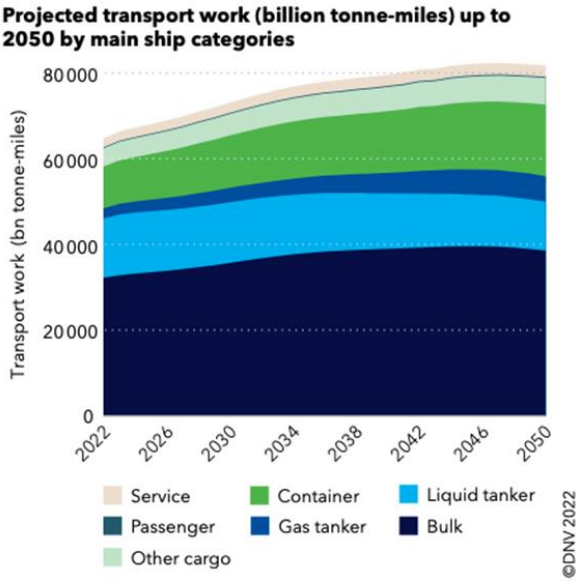



*Figure 22. Projected transport work (billion tonne-miles)*
*Source: DNV 2022 [62]*

DNV [61] further projects a total increase in demand for bulk carriers of 22.3% from 2022 to 2050. Specifically, from Table 3, an average annual growth rate of 1.4% is anticipated for the period from 2022 to 2030. Between 2031 and 2040, the growth rate is expected to remain positive but decelerate to 0.9% annually. In the final decade of the forecast period, a slight decline in growth rate is projected at -0.1%. For liquid tankers, an initial annual growth rate of 0.5% is forecasted for the period from 2022 to 2030. However, subsequent years are expected to experience progressively negative annual growth rates, culminating in an overall decrease of -15.9% from 2022 to 2050. This study suggests that the liquid tanker segment will be the only ship type to see a decline in demand, likely reflecting the anticipation that oil as an energy source may be supplanted by alternative energy sources, such as hydrogen, in alignment with global climate change objectives. This rationale is supported by the projected growth rates for gas tankers, as hydrogen or hydrogen-based gases would require transportation via gas tankers, with a predicted total demand increase of 160.2%. Additionally, the demand for container trade is expected to rise by 77.2% from 2022 to 2050.

*Table 3. Seaborne trade demand growth assumptions. Source: DNV 2022* [61].

| | Average annual change | | | |
|---|---|---|---|---|
| **Assumptions** | **2022-2030** | **2031-2040** | **2041-2050** | **Total change 2022-2050** |
| **Bulk** | 1.4 % | 0.9 % | -0.1 % | 22.3 % |
| **Liquid tank** | 0.5 % | -0.9 % | -1.3 % | -15.9 % |
| **Gas tanker** | 4.4 % | 3.6 % | 2.2 % | 160.2 % |
| **Container** | 2.9 % | 1.7 % | 1.5 % | 77.2 % |
| **Other cargo** | 2.2 % | 1.2 % | 1.0 % | 50.5 % |
| **Passenger and Service** | 1.7 % | 0.8 % | 0.3 % | 31.2 % |
| **Total growth** | 1.6 % | 0.9 % | 0.3 % | 29.5 % |

Considering these growth projections, the remaining question concerns the share of this growth that will be attributable to Sub-Saharan Africa.

## 8. Forecasts for sub-Saharan Africa

Predicting the maritime Predicting maritime trade volumes required to serve Sub-Saharan Africa (SSA) by 2050 is complex, as such projections are intricately linked to global trade developments. Global trade is influenced by a myriad of factors including political changes, shifts in demand, economic development, conflicts, and pandemics. These factors are interrelated, making precise forecasting challenging. Maritime trade fundamentally relies on the demand for sea transport, which fluctuates based on the global economy's needs. Trading patterns may evolve according to the global demand for commodities and the locations of production centers [63].

Considering the analysis presented in previous sections of this paper, we have identified the following factors that could influence the demand for maritime trade in SSA:

*Population Growth:* The population growth in SSA, observed over recent decades, coupled with demographic patterns, suggests a significant increase in the coming years. Projections indicate that the population of Sub-Saharan Africa could double by 2050 [64]. Such a demographic surge will inevitably lead to heightened demand.

*Growth of Average Income and GDP:* Beyond population growth, there is an expectation for a substantial increase in average per capita income. One scenario suggests a 600% rise in average per capita income, with an additional 1.4 billion people potentially entering the middle class. Furthermore, Africa's contribution to global GDP could see a threefold increase [65]. Given the correlation between GDP growth and maritime trade, it is reasonable to project that maritime trade in Africa could also triple. Based on the total volume of goods loaded in Africa in 2021 (762.4 million tons loaded and 553.2 million tons discharged), this projection would result in approximately 2,287.2 million tons loaded and 1,659.6 million tons discharged by 2050.

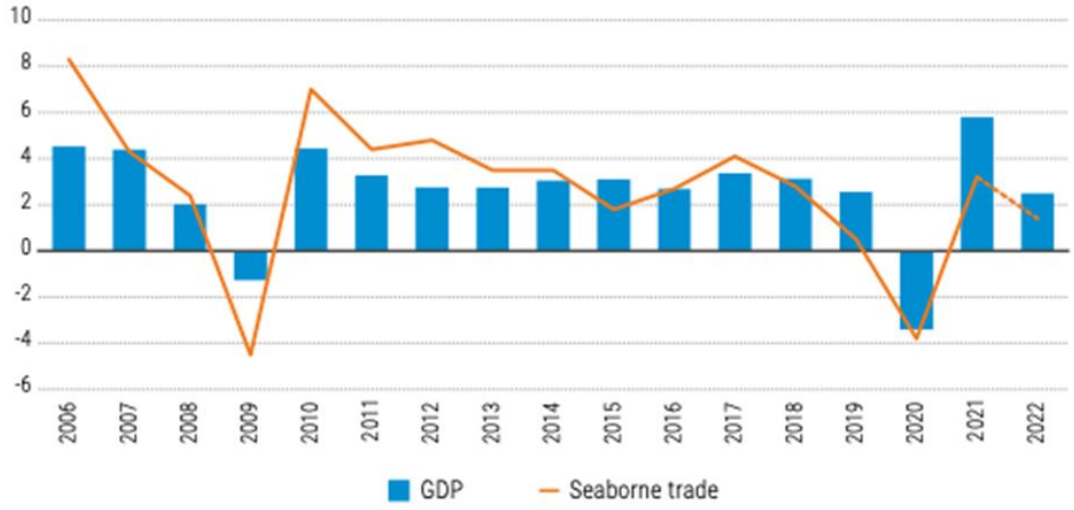



*Figure 23. International maritime trade and global output*
*Source: UNCTAD, 2022 [47]*

While the numbers in Figure 23 are speculative due to the numerous influencing factors and the extended forecast period, they are not implausible when compared with maritime trade volumes in other continents, such as Asia, where in 2021, a total of 3,889.3 million tons of

cargo were loaded and 5,492.4 million tons were discharged.

This assessment underscores the speculative nature of forecasting maritime transport volumes for SSA by 2050, acknowledging the impact of various global factors and the inherent uncertainties of long-term predictions.

*African Continental Free Trade Area (AfCFTA):* In January 2021, the AfCFTA was implemented to decrease tariff barriers in intra-African trade. UNCTAD projects that this initiative could boost intra-African trade by approximately 33% and cut Africa's trade deficit by 51%. Moreover, it is anticipated that by 2030, maritime transport could handle 132 million tons of cargo, a significant increase from the current volume of 58 million tons. In response to this growing demand, a study by the UN Economic Commission for Africa (ECA) forecasts a 188% increase in Africa's maritime fleet for bulk cargoes and a 180% rise for container cargoes [66].

*World Demand for SSA's Natural Resources:* The export profile of Sub-Saharan Africa (SSA), as detailed in the discussion on maritime and economic hotspots, is heavily reliant on commodities, given the region's wealth of natural resources like oil, coal, iron ore, timber, etc. These commodities currently dominate the demand for export maritime transportation. With the global economy moving towards reducing greenhouse gas emissions (GHG emissions), there is a visible shift from fossil-based to renewable energy sources.

Walsh et al. [63] conducted a study in 2019 (Figure 24), presenting a scenario analysis on the potential development of world trade by 2050. They proposed four scenarios, each contingent on the global economic approach towards global warming. The Green Road scenarios (GR) envisage trade under efforts to limit global warming to below 2°C, emphasizing sustainability. Additionally, two scenarios reflect current governance priorities but with different global warming thresholds (MR2C = 2°C scenario and MR4C = 4°C scenario). The High Road (HR) scenario depicts a future reliant on fossil fuels and advanced technology. This study illustrates the dependency of future maritime trade on the global capacity to reduce GHG emissions and the mindset of policymakers.

In this analysis, we focus on the 2°C scenarios. The accompanying figure illustrates maritime export trade projections under the four scenarios. It indicates that the 2°C scenarios could result in lower maritime trade growth compared to the 4°C scenarios. In the GR scenario, both container trade and the transport of wet cargoes are expected to experience slight increases, with the most significant growth projected in dry cargo trade. A similar trend is observed in the MR2C scenario, with the distinction that only container trade surpasses the levels predicted in the GR scenario, while the volumes of wet and dry cargoes are projected to be lower than those in the GR scenario.

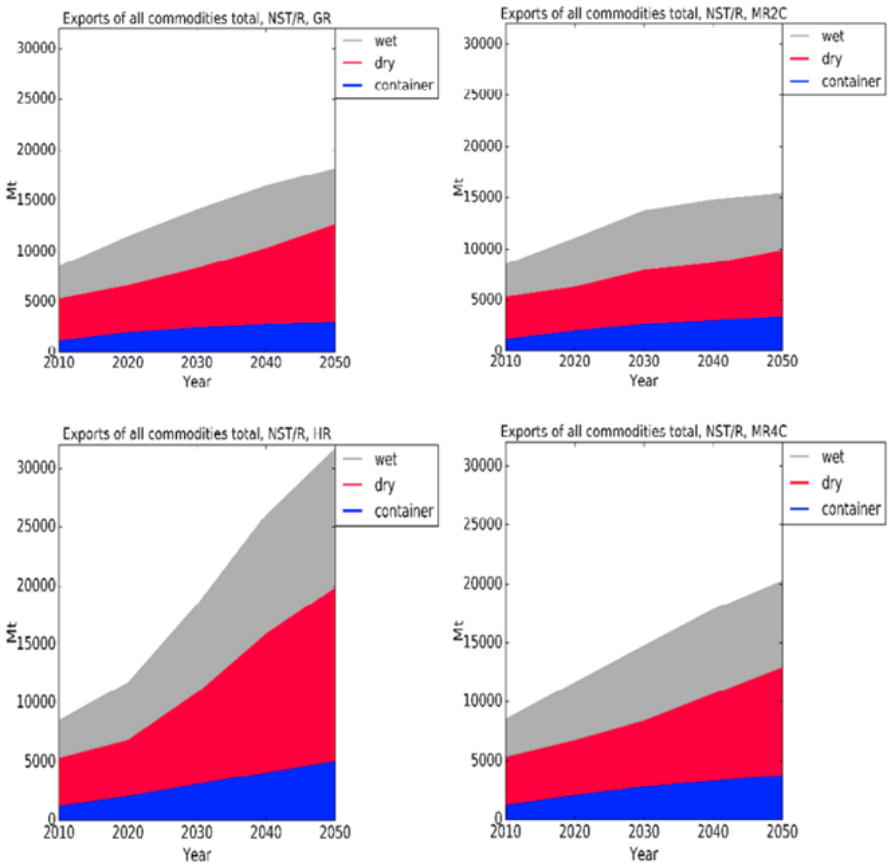



*Figure 24. World sea trade according to the 4 scenarios*
*Source: Walsh et. al. 2019 [63]*

The anticipated greater growth in the dry bulk sector is attributed to a shift in commodities for energy production, moving from coal and crude petroleum to bioenergy commodities such as wood and cork (Figure 25), in efforts to meet climate objectives. The study suggests that Africa holds the most significant potential for fulfilling global demand for bioenergy commodities, given its ample available land.

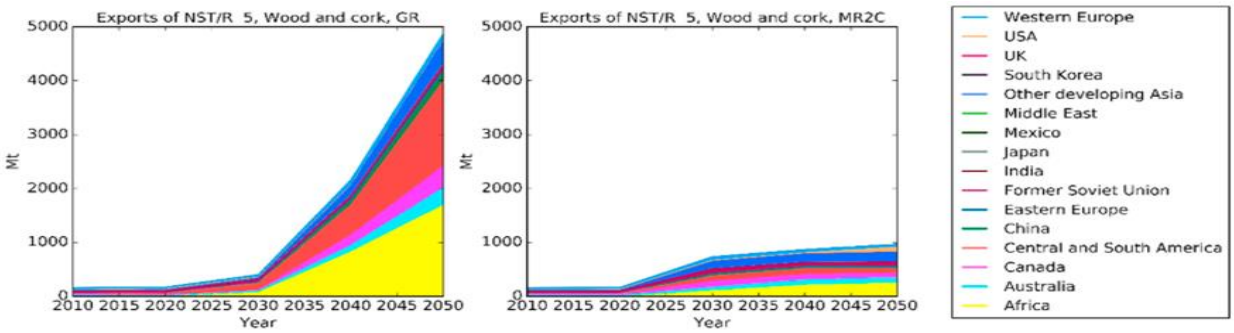



*Figure 25. Export of wood and cork*
*Source: Conor Walsh et. al. 2019 [63]*

This shift is expected to enhance Africa's maritime export trade significantly. Conversely, commodities that currently constitute a substantial portion of Africa's exports, like oil and coal, are projected to decline. This trend will largely depend on the extent of transport electrification and the methods of electricity generation by 2050. Thus, the study anticipates a shift in the commodity landscape, alongside forecasting Africa as a major exporter of iron ore by 2050 (Figure 26).

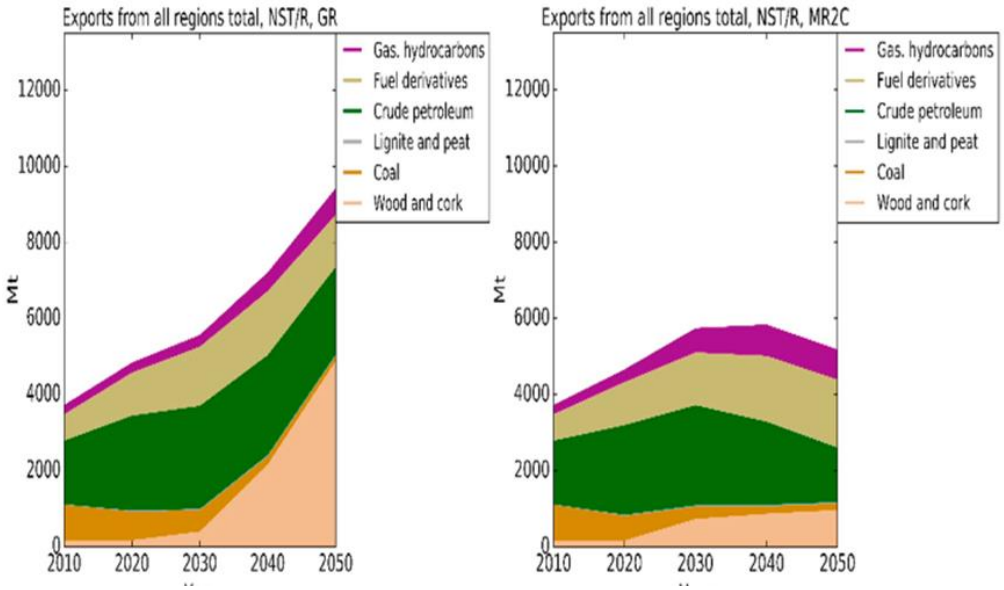



*Figure 26. Exports of energy commodities from all regions*
*Source: Conor Walsh et. al. 2019 [63]*

*Diversification in Cargo and Vessel Types:* African nations are experiencing an increasing requirement for diverse vehicle types to bolster sectors such as agriculture, mining, construction, and logistics. Vehicles are essential for transporting goods, reaching remote locations, and facilitating economic activities. Furthermore, the demand for passenger vehicles in urban centers is surging, catering to both personal and public transportation needs. As urban populations expand, the necessity for efficient and dependable transportation systems intensifies.

The reefer container trade, particularly for pharmaceuticals and medical supplies, warrants attention due to its high demand. A variety of temperature-sensitive pharmaceutical products and medical supplies, such as vaccines, insulin, biological materials, and certain diagnostic equipment, need specific temperature conditions for preservation of their efficacy and integrity. Refrigerated containers offer an appropriate solution for the safe transport of these sensitive items.

The requirement for specialized vessels is influenced by regional developments and specific trade needs. This could encompass LNG carriers for LNG transport, offshore support vessels for the oil and gas sector, and reefers for the shipment of perishable commodities [67].

# 9. Alternative Fuels and African Maritime Prospect

The exploration of alternative fuels across various African countries highlights a critical component for the future of maritime development and the construction of vessels that utilize these fuels.

## 9.1. Ammonia

Given Africa's significant engagement in agriculture, ammonia, predominantly used in fertilizers, emerges as a key resource with potential benefits for the shipbuilding industry. According to Prause et al. and Gerlitz et al. [43, 45] ammonia is the most cost-effective carbon-free fuel. The physical properties and economic, technological, and social factors appear to be superior to those of other fuels. This is why in Egypt for instance, ammonia production, gauged by nitrogen content, saw an increase to approximately 3.7 million metric tons in 2018 from 2.8 million metric tons in 2016, indicating growth in this sector [68]. Further progress includes the authorization to build a green ammonia facility in the Ain Sokhna industrial zone. Spearheaded by Egypt's Green Ammonia Company, this project is set to produce 1 million tonnes annually at an estimated cost of $5.5 billion, generating approximately 10,600 jobs during its construction and operational phases [69].

Morocco's OCP Group, renowned for phosphate exportation, plans to start an ammonia production facility in Nigeria by late 2023. This facility is expected to have an annual capacity of 750,000 tons of ammonia and 1 million tons of fertilizers, facilitating exports to Morocco's Jorf Lasfar plant. This initiative is part of OCP's strategy to boost production across Africa, aiming to triple Nigeria's fertilizer supply to 3 million tons within five years, thereby supporting sustainable agriculture and improving food security [70].

Algeria was recognized as the world's fifth-largest ammonia exporter in 2021, with exports totaling $714 million, showcasing the commodity's significance in Algeria's export portfolio [71]. This abundance in North African countries suggests a readiness to incorporate ammonia in shipbuilding due to its plentiful availability.

Namibia has embarked on a collaboration with German investors on a $10 billion green hydrogen project, anticipated to be Sub-Saharan Africa's largest. The project aims to generate green ammonia through wind and solar power, targeting an annual production of 2 million tonnes for regional and global markets. This venture is seen as a major step forward for sustainable energy projects, expected to create 15,000 jobs during construction and 3,000 permanent positions thereafter [72].

These developments in ammonia production and green hydrogen projects underscore the potential for alternative fuels to reshape Africa's maritime industry and support global sustainability efforts.

## 9.2. LNG

Nigeria, a prominent hydrocarbons producer in Africa, relies heavily on revenue from oil and

natural gas, which are critical to its economy. The nation boasts the largest natural gas reserves on the continent and holds the sixth position globally in liquefied natural gas (LNG) exports [73]. It has constructed an extensive LNG export facility with a 22.5 million tonnes per annum (mtpa) capacity. Despite previously lacking a domestic LNG market, recent efforts by the government and private sector investment in virtual gas pipelines are changing this. The development of small-scale LNG facilities aims to provide flexible energy solutions across Nigeria. Greenville LNG leads this initiative, distributing LNG nationwide via LNG-fueled trucks, with additional companies investing to enhance Nigeria's LNG infrastructure. This expansion into the domestic market creates attractive investment opportunities that support industrial growth and Nigeria's energy transition [74].

However, the sector faces challenges, including disruptions that diminish production. Specifically, in the third quarter of 2022, Nigeria saw a notable decrease in crude oil production, falling below one million barrels per day, primarily due to crude oil theft and pipeline vandalism. This significantly affected the output of major crude oil grades like Bonny Light, Brass River, and Forcados [73].

In Equatorial Guinea, the Alen gas project has initiated feed gas flows to its LNG plant, signaling new opportunities for companies to transport cargoes from the region. This project aims to mitigate output declines from the Alba field and challenge Shell's dominance in LNG volumes. Chevron's participation, demonstrated by lifting its first cargo, suggests potential shifts in LNG pricing strategies, diverging from the traditional US Henry Hub index [75].

The Rovuma LNG project in Mozambique's Rovuma Basin, particularly in the Area 4 block, represents a significant endeavor. Operated by Mozambique Rovuma Venture (MRV), a consortium of ExxonMobil, Eni, and CNPC, this project aims to establish a 15.2 million tonnes per annum LNG export facility. It seeks to utilize gas from three reservoirs to solidify Mozambique's status as a major LNG exporter in Africa. The infrastructure for the project includes liquefaction trains, gas turbines, compression units, subsea pipelines, marine facilities, and airstrips, with contractors like JFT, Mitsubishi Heavy Industries, and Bonatti International playing vital roles [76].

In 2021, Algeria achieved a historic peak in natural gas production, the highest since 1980, producing 9.9 billion cubic feet per day (Bcf/d). This marked a significant increase from the 8.0 Bcf/d recorded in 2011, despite a decrease in the percentage of gas exported. Algeria, with substantial reserves of both crude oil and natural gas, is a key producer in Africa. Plans to enhance the Skikda LNG terminal, including increased storage capacity and improved export facilities, are underway. Algeria has established major pipelines like Transmed, Medgaz, and MEG for gas transport to Italy and Spain, though political tensions have occasionally disrupted gas trade [77].

Algeria anticipates a gradual increase in gas exports, especially from 2026 onwards, as new gas fields begin production. This growth is expected to be supported by increased foreign investment, potentially adding 27 billion cubic meters annually to Algeria's gas output in the medium term [78].

Egypt has seen rapid growth as an LNG exporter among Arab countries, exporting 1.4 million tons of LNG in the second quarter of 2021, a significant rise from the previous year. Accounting for 5% of Arab LNG exports, Egypt's strategic location, untapped liquefaction potential, and connections with the EU position it as a key player in the LNG market. With

existing capacity, Egypt can produce 12 million tons of LNG annually, potentially covering about 15% of the EU's LNG demand [79].

A memorandum of understanding between the EU, Israel, and Egypt aims to boost natural gas exports from the East Mediterranean to Europe, reducing reliance on Russian energy imports. This agreement encourages European companies to engage in exploration tenders in Israel and Egypt, with expectations for a significant increase in LNG shipments from Egypt to Europe in the coming years [80].

### 9.3. Methanol

Nigeria's collaboration with the Nigerian National Petroleum Corporation (NNPC) and its partners on a $3 billion methanol processing plant marks a strategic move to tap into new investment opportunities and bolster its position in the global methanol market. This initiative is poised to produce 10,000 tons of methanol daily, reducing the country's reliance on methanol imports [81]. Methanol is a major non-fossil fuel that will play a vital role in the energy mix for the shipping industry [82].

With oil revenues on the decline, Nigeria is leveraging its vast gas resources to gain a competitive edge in methanol production. The global methanol market is expected to reach $26.6 billion by 2025, with significant capacity additions from Russia, Iran, and the United States. The Brass Fertilizer and Petrochemical Company Limited (BFPCL) project, which is set to be completed in 2024, will significantly enhance Nigeria's methanol production capabilities. By tapping into its extensive natural gas reserves, Nigeria aims to develop the chemical industry's value chain and foster a robust methanol fuel sector [83].

A consortium consisting of Earth and Wire, ENERTRAG South Africa, and 24Solutions plans to establish an e-methanol production facility in Humansdorp, South Africa. This facility, aimed at producing environmentally friendly e-methanol, will utilize renewable electricity, desalinated seawater, biomass, and municipal waste to produce green hydrogen and synthesis gas. Feasibility studies are underway, with construction expected to begin in 2025 if the project is feasible. The consortium's goal is to encourage the adoption of fuel-cell systems and the use of zero-emission e-methanol, targeting demand in both the European and South African markets [84].

Egypt's Damietta Port is poised to host the nation's first green methanol project, with an estimated investment of $450 million. The initiative aims to produce 40,000 tons of green methanol annually at the outset, with the potential to increase production to 200,000 tons per year. This project underscores Egypt's commitment to transitioning towards environmentally sustainable manufacturing practices [85].

In Namibia, the exploration of biomass feedstocks, particularly encroacher bush types, presents significant opportunities for methanol production. Research has confirmed the feasibility of using biomass as an alternative feedstock for producing high-quality methanol. This leverages Namibia's abundant and readily available biomass resources for energy applications, highlighting the potential for sustainable methanol production [86].

## 9.4. Hydrogen

VNG AG, a leading German gas group, and Sonatrach, the Algerian state-owned energy company, have entered into a Memorandum of Understanding (MoU) to assess the development of a German-Algerian green hydrogen value chain. This collaboration seeks to explore the viability of long-term hydrogen and ammonia initiatives, aiming to facilitate the import of green hydrogen from Algeria to Germany. Both entities recognize hydrogen's critical role in the future energy mix and believe Algeria's abundant solar energy potential and established infrastructure could enable cost-efficient green hydrogen production. The partnership initially focuses on financial and technical considerations, including hydrogen infrastructure development and joint commercial ventures. With VNG's subsidiaries, ONTRAS Gastransport GmbH and VNG Gasspeicher GmbH, offering significant contributions to the expansion of hydrogen infrastructure in Eastern Germany, this initiative marks a significant step towards sustainable energy collaboration [87].

The Moroccan Ministry of Energy, Mines, and Environment, in partnership with the National Hydrogen Commission, has crafted a comprehensive roadmap for green hydrogen development. Anticipating a surge in green hydrogen demand—up to 30 TWh by 2030 and 307 TWh by 2050—Morocco plans to leverage 2GW from renewable energy sources to meet this need. The strategy is anchored in three pillars: market and demand enhancement, technological advancements for cost reduction and local integration, and investment strategies, including cluster identification and financing avenues. Morocco's strategic advantages in renewable energy, geographical positioning, and energy infrastructure set a strong foundation for becoming a leader in green hydrogen production. The roadmap outlines a phased development approach: pilot projects and targeted exports in the short term (2020-2030), local usage and cost reduction in the medium term (2030-2040), and broader application across various sectors by 2050, including ammonia production to decrease reliance on imports [88].

South Africa has positioned itself on a hydrogen-driven path towards decarbonization, economic growth, and enhanced export potential. The Hydrogen Society Roadmap (HSRM) outlines ambitious goals for 2050, including the deployment of 10 gigawatts (GW) of electrolysis capacity and the production of 500 kilotons of hydrogen annually by 2030. Achieving these targets is expected to create a substantial number of jobs. South Africa's proficiency in the Fischer-Tropsch process, access to essential minerals for hydrogen production, and robust infrastructure, coupled with its abundant renewable resources, pave the way for efficient green hydrogen production. This initiative underpins South Africa's commitment to transitioning to a net-zero economy by 2050 and mitigating its substantial greenhouse gas emissions, thereby securing a competitive position in the global green hydrogen market [89].

## 9.5. Biofuel

Countries in Sub-Saharan Africa, including Ghana, Mozambique, Nigeria, South Africa, and Uganda, possess significant opportunities to enhance their sustainable liquid biofuel production. This can be achieved through systematic collection of agricultural residues, expanded

cultivation of crops like sugarcane, grasses, and trees, and minimizing food waste. The integration of conventional and innovative biofuel technologies could substantially replace petroleum-based fuels used in transportation. Key to this bioenergy production are efficient land management, improved agricultural techniques, and optimized food chain management. Additionally, the region's forests provide residual woods that could be transformed into bioenergy [90].

Since 2004, Mozambique's biofuel sector has evolved from small-scale domestic production to attract foreign investment aimed at international markets. Site selection for projects often prioritizes infrastructure, labor, and service availability over natural resource potential or government incentives. While many projects are situated in less remote areas, operational ones have demonstrated socio-economic benefits. Nonetheless, the predominant focus on external markets could impede national goals for energy diversification. Monitoring and policy adjustments are essential to ensure the sector's alignment with national objectives. Prominent initiatives in Mozambique include the Beira Agricultural Growth Corridor Initiative, ProCana Mozambique, Mozambique Bioenergy, the Limpopo Valley Sugarcane Development Project, and the SAIL Ventures Jatropha Project [91].

South Africa shows considerable promise for biogas production, with over 300 biodigesters providing decentralized energy solutions, particularly beneficial in rural areas. These biodigesters, capable of offsetting up to 2,500 MW of electricity currently supplied by the national grid, present a sustainable alternative to fossil fuel-based energy sources. The Bio2Watt 5 MW biogas plant in Bronkhorstspruit exemplifies the potential within South Africa's biogas sector. The planned expansion by companies such as New Horizons and Anaergia, aiming to build three commercial biogas plants each year, underscores the increasing relevance of biogas technology in the nation's energy landscape. In Tanzania, the Tanzania Domestic Biogas Program has led to the installation of over 12,000 biodigesters, with support from the Tanzanian Government and the Norwegian Embassy. This initiative has directly benefited around 70,000 Tanzanians, marking a pivotal shift towards reducing reliance on fossil fuels and improving living standards, employment prospects, energy sustainability, and socio-economic growth in rural and peri-urban communities [92].

# 10. Development Roadmap

## 10.1. Current State Assessment

In preceding chapters, we have analyzed the contemporary landscape of Africa, highlighting demographic trends, anticipated demand, the strategic locations of maritime and economic hubs, the dynamics of the shipyard industry, maritime trade projections, and future fuel technologies for propulsion systems.

## 10.2. Setting Vision and Objectives

- By 2050, the population is projected to have doubled, with average per capita income having tripled. This growth signifies a substantial increase in economic power and consumer demand within the continent and consistent with the IMO 2050 vision [34].
- Africa is envisioned to emerge as a leading producer of renewable energy, capitalizing on its advantageous solar and wind conditions. The continent is expected not only to meet its own energy needs but also to contribute significantly to the global energy demand through the export of renewable energy, particularly in the form of hydrogen stored in ammonia. Additionally, the demand for biofuels is anticipated to surge, with Africa positioned as a key supplier, thanks to its capability to sustainably cultivate the necessary biomass.
- A notable shift in global production patterns is expected, with Africa becoming a crucial hub as economies from Asia, Europe, and America diversify their production centers to enhance resilience against crises such as wars and pandemics. Africa's youthful workforce and the lower cost of renewable energy, compared to other regions, are pivotal factors in this transformation.
- African ports are set to become essential transshipment hubs for the export of energy commodities, precious metals, and locally produced goods. Furthermore, these ports will play a critical role in importing merchandise from other production locations and food supplies to meet the needs of a population that has doubled in size.

## 10.3. Identifying Priority Areas

To realize the vision outlined previously, a thorough assessment of the requisite infrastructure is essential. In this context, "infrastructure" encompasses ports, hinterland connections, shipyards, bunker facilities, and production plants, with an additional focus on the standardization of regulations.

1. *Ports as Economic Catalysts:* Ports are crucial for Africa's economic expansion, serving as primary entry and exit points for the continent. However, the current infrastructure is inadequate to manage the anticipated volumes if the envisioned developments materialize. African ports, often hindered by draft and size restrictions, exhibit performance that is below global standards, resulting in elevated shipping costs. Significant investments

are thus imperative. Notably, China, as part of its Belt and Road Initiative, is investing billions in African port infrastructure, solidifying its position as sub-Saharan Africa's largest trading partner. While such investments are beneficial for Africa's development and prospects, they also heighten the continent's dependency on a single foreign economy.

2. *Hinterland Connectivity:* Equally crucial are the connections between ports and the hinterland, especially for land-locked countries within Africa. These connections, whether by road or rail, are vital for accessing global markets, affecting the profitability of exports and the cost of imports.

3. *Shipyards and Maritime Services*: The presence of shipyards for maintenance and repair becomes essential as maritime traffic to the continent increases. However, shipbuilding is expected to remain predominantly in Asia, where the requisite infrastructure and expertise are already established. Despite being relatively new compared with global giants, Africa's shipbuilding sector has a lot of promise because of its advantageous coastline locations and the need for marine trade. The industry's capacity is progressively growing as a result of expenditures made to improve workforce skill development, infrastructure, and technology adoption. But there are drawbacks to this expansion as well, chiefly the effects of climate change. Coastal infrastructure is under threat from rising sea levels and a rise in the frequency of extreme weather events. As a result, adaptive measures are required to enhance the resilience of shipbuilding facilities and maritime activities.

4. *Production Plants and Economic Growth:* The establishment of production plants is vital for fostering economic growth and reducing unemployment. The shift towards renewable energy commodities, such as hydrogen-based gases like ammonia, is particularly crucial for Africa as the global community seeks to reduce greenhouse gas emissions. This shift away from fossil fuels, traditionally major export commodities for Africa, necessitates alternative sources of energy and income, including the manufacturing of merchandise products.

5. *Bunker Facilities:* The availability of bunker facilities is crucial for supporting the numerous vessels participating in global maritime trade. A significant challenge will be ensuring access to alternative fuel types, in line with evolving global energy trends.

6. *Standardization of Regulations:* Achieving efficient collaboration across diverse economies necessitates the standardization of regulations, which is paramount for facilitating seamless trade and investment activities.

In summary, advancing Africa's infrastructure in these key areas is imperative for achieving the continent's developmental vision, requiring both domestic initiative and international collaboration to ensure sustainable growth and reduced dependency on external entities.

10.4. Developing Action Plans for each Priority Area

1. *Enhancement of Port Infrastructure:* For Africa to achieve its 2050 objectives, ports must expand and enhance their efficiency through increased and diversified investments. Modernizing terminal infrastructure is crucial for reducing port costs [94] and, by extension, the costs of imports and exports [95], and allowing African ports to compete globally. The capacity of these ports must grow to accommodate the needs of a population projected to double by 2050. Overcoming current limitations due to draft and size restrictions is essential for accommodating larger vessels, thereby leveraging economies of scale to lower shipping costs. Investment should prioritize potential hub ports, with Durban currently serving as the primary hub in South Africa. Future strategies should include the development of additional hubs on both the east and west coasts, with Mombasa being a promising candidate for the East Coast. In West Africa, collaboration among countries could enhance the region's competitiveness. Diversifying investment sources beyond the current primary investor, China, could mitigate risks associated with dependency on a single economy and foster more equitable agreements benefiting African nations.
2. *Hinterland Connectivity Enhancement:* With the anticipated increase in port activities, hinterland connections, including roads and railways, must be expanded and strengthened as commonly seen in other parts of the world [i.e. 96]. Completing the Trans-African Highway system and bridging existing gaps are essential. Diversifying funding sources for these projects can enhance resilience and reduce dependency on single investors.
3. *Focus on Shipyards:* Shipyards in Africa should concentrate on repair and maintenance to meet the growing demands of increased vessel traffic by 2050. Competing with Asian shipbuilding markets may not be feasible due to the high investment and expertise required; thus, prioritizing repair and maintenance is advisable. Furthermore, the African shipbuilding sector should take a holistic approach to sustainability that takes into account social and economic factors in addition to environmental ones. The marine industry can support regional economies, generate employment opportunities, and guarantee the long-term sustainability of maritime operations by emphasizing sustainable practices [95].
4. *Development of Production Plants:* Production facilities are crucial for economic growth, generating export revenue and facilitating a shift from fossil fuels to renewable energy sources like green ammonia or methanol. Africa's advantageous renewable energy potential positions it as a significant player in the global energy market. Ensuring that profits from these ventures contribute to regional development is essential for stimulating economic growth. Economic development will, in turn, drive maritime trade [47].
5. *Alternative Energy Bunkering Infrastructure:* Establishing bunkering facilities for alternative fuels such as ammonia, methanol, and LNG is vital, given Africa's capacity to produce these fuels. This infrastructure will support the transition to cleaner shipping fuels, aligning with global maritime environmental goals. Disruptions brought on by climate change also highlight how important it is for business to embrace sustainable practices and technology [42]. A greater focus is being placed on creating ships with energy-efficient engines and

environmentally acceptable materials, in addition to being commercially and environmentally sustainable [97]. The marine industry's ability to meet the growing demand for maritime services and transportation while navigating the problems posed by climate change depends on this shift towards sustainability.

6. *Regulation Standardization:* The enforcement of intelligent IMO regulations, aimed at mitigating the consequences of shipping activities, requires concerted efforts from international organizations, governments, shipping companies, and the wider public. This involves implementing stringent environmental regulations, adopting cleaner technologies, improving waste management practices, and promoting sustainable shipping initiatives to foster a more ecologically and socially responsible maritime sector [98]. Just like is seen in the EU for example [99]. harmonizing regulations is crucial for fostering trade and reducing conflicts within Africa. Advancing initiatives like the African Continental Free Trade Area is key to standardizing norms and facilitating economic growth, as demonstrated by European Union's success with free trade agreements. Standardizing trade practices can significantly contribute to the continent's economic expansion.

# APPENDIX I

Port development in Africa 2013-2021 by Reboredo & Gambino 2023 [27]

| Region | Country | Project | Location | Years | Reported cost (USD) | Primary Developer |
|---|---|---|---|---|---|---|
| Cental Africa | Sengeal | New port terminal | Dakar | 2013 (Completed) | 132 million | Ballore Group |
| | Sierra Leone | New deepwater port | Bonthe | 2021 (Agreement signed) | 1.4 billion | Strong Hold Finance Group |
| | Togo | Port expansion | Lome | 2011-16 (Completed) | 380 million | Grupo Cyes; Somague |
| | Gabon | Port expansion | Owendo | 2019 (In progress) | 341 million | Afcons Infrastructure |
| East Africa | Kenya | New deepwater expansion | Lamu | 2016 (In progress) | 480 million | China Road Bridge Corporation (CRBC) |
| | Kenya | Port modernization | Mombasa | 2018 (In progress) | 293 million | Toyo Construction Co. |
| | Somaliland | New container terminal | Berbera | 2018-21 (Completed) | 442 million | DP World |
| | Tanzania | New deepwater port | Bagamoyo | 2015 (Renegotiation) | 10 billion | China Merchants Port (CMPort) |
| | Tanzania | Port modernization and expansion | Dar es Salam | 2017 (In progress) | 593 million | CHEC |
| Southern Africa | Mozambique | LNG terminal | Matola Harbour | 2020 (In progress) | 350 million | Total, Gigajoule |
| | Mozambique | Port modernization | Maputo | 2013 (Completed) | 80 million | DP World |
| | Namibia | New container terminal | Walvis Bay | 2014-19 (Completed) | 300 million | CHEC |
| | South Africa | Port modernization | Durban | 2021 (Planning stage) | 7 billion | Transnet |

| Region | Country | Project | Location | Years | Reported cost (USD) | Primary Developer |
|---|---|---|---|---|---|---|
| North Africa | Algeria | New deepwater port | El Hamdania Industrial Zone | 2021 (Agreement signed) | 3.3 billion | China Harbour Engineering Co. (CHEC) China State Construction Engineering Corporation |
| | Egypt | New container terminal | Abu Qir | 2021 (Agreement signed) | 730 million | Hutchison Ports |
| | Morocco | New container terminal | Tanger-Med Complex | 2019 (In progress) | 1.3 billion | Tanger Mediterranean Special Agnecy (TMSA) |
| West Africa | Benin | Port modernization | Contonou | 2017-20 (Completed) | 450 million | Port of Antwerp International (PAI) |
| | Cameroon | New deepwater port | Kribi | 2015-20 (Completed) | 704 million (Phase 1) 608 million (Phase 2) | Bollore Africa Logistics, CMA CGM, and CHEC |
| | Cote D'lvoire | Port expansion | Abidjan | 2020-21 (In process) | 933.4 million | CHEC |
| | Ghana | Port expansion | Terna | 2016-20 (Phase 1 Completed) | 1.5 billion | Ghana Ports, Harbour Authority (GPHA), APM terminal, Bollore |
| | Ghana | Port expansion | Takoradi | 2019 (In progress) | 475 million | Ibistek GPHA |
| | Guinea | Port expansion | Conakry | 2016 | 774 million | CHEC |
| | Mauritania | Port modernization | Nauakchott | 2019 (In progress) | 390 million | ARISE Maurtanie |
| | Nigeria | New deepwater port | Lekki | 2017 (In progress) | 1.6 billion | Lekki Port LFTZ Enterprise |
| | Nigeria | New port facility | Rivers State | 2013-16 (Completed) | 3.7 billion | Deep Offshore Services Nigeria Ltd |

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