European Journal of Economic and Financial Research
ISSN: 2501-9430
ISSN-L: 2501-9430
Available on-line at: http://www.oapub.org/soc

DOI: 10.46827/ejefr.v7i1.1428 Volume 7 | Issue 1 | 2023

ANGOLAN PORT INFRASTRUCTURE AND THE COMPETITIVENESS IN THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY

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Abstract:
Africa has nine transit corridors, two intra-regional corridors and two main east-west corridors. Africa accounts for about 13% of the world´s population and includes 54 countries, of which 38 have coastline access along the continent´s 30,490 Km of coastline and 16 are landlocked. However, 90% of the volume of cargo between Africa and the world is transported by sea, which typifies the importance of port infrastructure in economic development. This research presents a comparative analysis of the port infrastructures in the Southern African Development Community (SADC) based on the weight capacity that the ports support, waiting time for ships in ports, the connection of infrastructure networks, the growth of GDP per capita and the entry of ships in the country during the year by type of cargo. Similarly, determinant factors of port infrastructure management were identified. The objective is to characterize the competitive position of Angolan's port infrastructure in the SADC context. The results show that Angola's port infrastructure is not the worst in SADC. However, the lack of good roads and railroads reduce its competitiveness in relation to Namibian and South African port infrastructure.

JEL: R40; R41

Keywords: Angolan port infrastructure; port infrastructure in Africa; competitiveness; economic growth and development, determinants factors

1. Introduction

Studies on the competitiveness of port infrastructure have grown significantly since the 1960s (Woo *et al.*, 2011) and (Munim & Saeed, 2019). The increasing competition between ports is focused on the logistical performance of terminals. The changing conditions of

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competition raise questions about port management policies and strategies. The term competitiveness stands for strategic development, innovation and progress in port logistics (Munim & Saeed, 2019).

Angola is located in the western region of southern Africa, south of the equator. It has an area of 1.246.700 km^2, its coastline extends for 1.650 km and has a land border of 4.837 km (ANEME, 2016). Its length from north to south is 1.277 km and its width from west to east is 1.236 km. it is bordered to the North by the Republic of Congo and Democratic Republic of Congo (DRC), to the East by the Republic of Zambia and the DRC, to the South by Namibia and to the West by the Atlantic Ocean (Portugal & Angola, 2016). The country is the seventh largest in Africa. Despite its long continental border of 84.837 km, its connections are limited by poor transport infrastructure (Haddad *et al.*, 2020). Along the coast, the lack of good port infrastructure has hindered the distribution of cement, which is one of the main components for the rebuilding of infrastructure destroyed during the civil war (Campos *et al.*, 2022) and (Campos *et al.*, 2023).

The war devastated the country and destroyed most of its economic infrastructure (Pushak & Foster, 2011). The ports of Luanda, Lobito, Cabinda, Namibe and Soyo serve the highly import-dependent economy following the collapse of domestic industry and agriculture (Porto & Clover, 2003). The reconstruction of port infrastructure began after the civil war (Jensen, 2018). However, in terms of infrastructure and logistics Angola still faces serious difficulties in achieving the levels of service delivery desired by customers. The Angolan logistics chain is composed of small players with a poor supply of customs and road transport services (Deloitte, 2014). Despite investment in transport infrastructure, the levels achieved are still far below what is needed to close the gap. The most important seaports are Luanda, Lobito, Namibe and Soyo (ANEME, 2016) and (Haddad *et al.*, 2020).

Given the importance that port infrastructure in Angola has assumed, both as a determining element in the commercial context and as the country's window to the world, it is essential to identify its competitive position in the context of SADC port infrastructure, as well as the factors that determine its competitiveness. To this end, the following questions were raised:

1) What factors determine the management of port infrastructure?
2) How competitive is Angola's port infrastructure in the SADC context?

There are very few scientific articles that address the state of Angola´s port infrastructure and its competitiveness in the SADC context. The existence of little literature signals a deficit that somewhat hinders the understanding of this situation.

This paper is organized in six sections. Section 1 presents the objectives, research questions, and the justification of the need for this research. Section 2 presents the literature review, addressing the nature of port infrastructure, its classification, and the types of terminals. Section 3 presents the research methodology. Section 4 presents the state of African port infrastructure management, and the main trans-African corridors. Section 5 presents the analysis and discussion of the results, and section 6 presents the final considerations.

2. Literature review

2.1. Port infrastructure

Port infrastructure is crucial for trade. However, its development is quite costly (Aerts *et al.*, 2014). More than 80% of international trade by volume is carried out by sea (Mokhtari *et al.*, 2011). Port activity is related to the movement of goods from port to terminals and from terminals to different destinations (Montwill, 2016).

Port are critically important nodes in the global supply chain, port authorities focus on increasing their efficiency and effectiveness (Nuzzolo *et al.*, 2013) and (Caldeirinha *et al.*, 2020). A port is a deep-water geographic area where ships dock to load and unload goods (Dwarakish & Salim, 2015) and (Alrukaibi *et al.*, 2020). The economic relevance of ports stems from the fact that most of a country's foreign trade is conducted by sea (González & Trujillo, 2008).

2.2. Classification of ports

Ports are built based on the characteristics of the soil and the depth of the water. The quay and breakwater are artificial structure erected to protect the harbor area from the waves. The breakwaters are made up of large stones to stop the sea waves. Berths, on the other hand, are structures intended directly for attracting ships and are equipped with appropriate equipment. Berths are divided into fixed and floating. Berths can be for cargo, passengers, or ship repair. In general, ports are classified as seaports and dry ports. Ports positively impact the regions in which they are located and in adjacent regions. A seaport allows landlocked regions to better engage in regional and international export and import activities (Yudhistira & Sofiyand, 2017). Seaports provide services to shipping companies and cargo owners. Ports are involved with governments, port administrations, carriers, agencies, shipping companies, and unions (Esmer *et al.*, 2016).

Dry ports, on the other hand, are based on seaports and are classified as: distant, medium, and near. This classification helps shift road freight to rail traffic modes, reduces congestion around the port, and facilitates improved logistics solutions for carriers operating within the port (Roso *et al.*, 2009). Dry ports are inland terminals that are strongly connected to seaports by road and rail. Dry ports function as extension of seaports to facilitate the movement of cargo between seaports and inland (Nguyen & Notteboom, 2016) and (Rodrigue & Notteboom, 2012). The decision where to locate a dry port requires analyzing the entire supply chain (Awad-Núñez *et al.*, 2016).

The factors that influence the location of a dry port can be economic or no-economic, quantitative or qualitative (Nguyen & Notteboom, 2016). But, are necessary:

- quality of port infrastructure and port development;
- institutions that regulate the development of infrastructure/superstructure; and
- division of tasks between the public and private sectors (Jacobs & Hall, 2007).

2.3. Types of freight terminals

Terminals are operations stations that handle two or more modes of transportation. Terminals have equipment for loading and unloading containers, the length of the port and the depth of the channels determine the size of the vessels that can operate in it (Cosco, 2017). Each port has several terminals and they are operated by one or several operators. Container terminal operators are companies that operate one or several container terminals in a port. There are two types of private investors in container terminals: pure stevedores such as, HPH, PSA and DP *World* and global shipping companies that want to integrate the terminal operation into their business activities (Yip *et al.*, 2011) and (Yeo, 2015).

The following three types of cargo terminals are distinguished: Satellite terminals (A), cargo centers (B), and transfer centers (C). For inbound or outbound cargo flows, the land terminal is the first level of a functional hierarchy that defines its fundamental (activities it serves directly) and extended (activities it serves indirectly) hinterlands. Satellite terminals tend to be set up within 100 Km of the port (Rodrigue & Notteboom, 2012). Terminal operators deal with a number of logistical problems. One such problems is the scheduling of quay cranes, which are the port´s most valuable resources. Marine container terminals are major infrastructures in global supply chains (Castilla-Rodríguez *et al.*, 2020).

Container terminals are derived into three main areas quay, yard, and gate (Ries *et al.*, 2014). One of the biggest challenges for container terminals is the modernization of cranes. As the size of ships increases, it is necessary to invest in larger cranes that can reach out to pick up the container farther from the quay. Ports are pressured by shipping companies to invest in the equipment or be excluded from major east-west trade routes (Yeo, 2015). Accessibility to seaports can be measured by the distance to the nearest port and the number of ports within a distance of no less than 200 km or more than 400 km. the hinterland is a location where a terminal offers its services to customers. The location of the dry become a strategic issue to assist the logistic system of the dry port becomes a strategic to assist the logistics system of a country or region (Awad-Núñez *et al.*, 2016).

Pier length, yard area, type of operating system, yard cranes, geographic location, connection with rail lines and road network are key elements to promote the efficiency of a port or container terminal (Fancello *et al.*, 2014) and (Ghiara & Caminati, 2017). In general, there are many factors that affect cargo flows in ports such as: (1) economic factors, (2) politics factors, (3) geographic factors, (4) industrial production factors, (5) supply chains and logistics factors, (6) port organizational factor, (7) port service factors, and (8) port competition and hinterland factors e *hinterland* (Othman *et al.*, 2020).

Containers are not commodities, they are standard-sized boxes that facilities the organization and transportation of goods to other modes of transport (González & Trujillo, 2008). The capacity of the port determines its choice by shippers. The volume of containers handled by cranes/hour in the port has grater relevance for shipping companies over geographic location (Kawasaki *et al.*, 2021). Terminal customers value

reliability, flexibility, availability, time, cost, control, and after-sales support (Wiegmans *et al.*, 2015).

2.4. The impact of port infrastructure on the economy

There is a high synergy between the port economy and the regional economy. On the one hand, the port economy has an overall effect and can effectively drive the development of the regional economy, on the other hand, the regional economy promotes the development of the port economy through its labor and resources that the port economy needs to move.

The benefits of the economic impact of a port are manifold (Wilmsmeier *et al.*, 2006) and (Wilmsmeier & Sanchez, 2017). Ports add value and generate jobs directly and indirectly. The economic benefits of port infrastructure are used by port authorities to justify raising financial resources to invest in port expansion projects. The types of port impacts are assessed in terms of output, employment, income, and value added. In general, the direct impacts correspond to the economic impacts generated by the construction and operation of the port. Indirect impacts correspond to the effects on suppliers of goods and services (Santos *et al.*, 2016) and (Jouili & Allouche, 2016).

Seaports are the main entry and exit points for bulk products (coal, ores, and crude oil) to non-bulk items (vehicles) (Michal *et al.*, 2017). With the development of international trade, more than 80% of trade in volume and more than 70% of trade in value are managed at seaports worldwide (Chenhao *et al.*, 2020). In the past the transportation of packed cargo took months to reach the destination, nowadays it takes only a few weeks (Ghiara & Caminati, 2017). Due to the loading and unloading equipment already involved in other activities at terminals, the average waiting time it takes a ship to be unloaded can range from hours to days (Rusu, 2015).

Thus, although port efficiency varies from port to port, the services required at terminal are crucial for commercial transactions. For example, according to Clark *et al.* (2004), until 2004 the most efficient ports in the world were Singapore and Hong Kong, while the most inefficient were located in Africa (Ethiopia, Nigeria, Malawi) and Latin America (Colombia, Venezuela, Ecuador). Today, seaports still face high challenges, especially in managing container ships (Hsu *et al.*, 2020).

The efficiency and effectiveness of port infrastructure significantly impacts the circulation of the economy, boosts the country's economic growth and development, and promotes the port's image. Port terminals handle hundreds of container units during the year, if the terminals are not well equipped, the volume of transacted flow can negatively affect the management services of these terminals.

3. Material and Methods

The present study used the unsystematic literature review based on the approach of Green *et al.* (2006), Yuan & Hunt (2009), Gasparyan *et al.* (2011), Hochrein & Glock (2012) and Ferrari (2016). Searches were conducted in Scopus, Web of Science, Science Direct

and Google Scholar, using the following keywords: "*Angolan port infrastructure*", "*port infrastructure*", and "*African port infrastructure*". The following filtering criteria were used: (1) p*ublication years: 1990 – 2020; (2) document type: article; (3) source type: journal; (4) language: English.* All extracted articles were manually analyzed in light of the following inclusion and exclusion criteria: title analysis, research area, keywords used, contributions, and main results.

Regarding the method, in this work was used the qualitative comparative analysis, which is an analytic technique which combines quantitative and qualitative methodologies. The technique originally focused on small samples but further development has allowed its application to broader contexts (Ragin & Rihoux, 2004) and (Roig-Tierno, 2017). The drawback to the method is the impossibility of generalizing the results to other similar cases. However, currently, in addition to being based on case studies qualitative comparative analysis of empirical data for the generalization of analyses considering possible replication in subsequent studies, and constructing logical propositions as a result of the qualitative study of the phenomenon in question (Ragin, 2008), (Woodside & Zhang, 2012) and (Roig-Tierno, 2017).

4. The development of African port infrastructure

Analyzing the efficiency and effectiveness of port terminals is key to raising port performance (Othman *et al.,* 2020). A port's operational reputation is based on objective factors (infrastructure and supply chain efficiency) as well as subjective factors (reliability and level of corruption). Currently, 80% of African trade transits via ports (Caschili & Medda, 2015). Thus, the larger the port, the higher its level of competitiveness. In general, the characteristics to be evaluated are those with depth water, berth and terminal length. Ports with better infrastructure are these with deep water, long berths and terminals (Dyck & Ismael, 2015).

4.1. The Angolan port infrastructure

There are seven seaports in Angolan, four of which are deep water (Luanda, Lobito, Amboim and Namibe) and three are shallower (Malongo, Soyo and Cabinda). According to Muzima (2019), Luanda, Cabinda, Lobito and Namibe are ports that make the country a regional transportation hub for neighboring landlocked countries.

Luanda with 11 berths is the most important port and receives 80% of imports, especially container trade. The second most important port in the country is the port of Lobito. Most of Angola's port are limited by factors such as, poor management, low container flow and poor connection with rail lines (Golub & Prasad, 2016). The capacity of the port of Lobito has been expanded, but its utilization rate is still less than 25% due to the lack of roads and railroads that would allow it to be connected to neighboring landlocked countries (in particular Zambian mining companies) (Muzima, 2019). The port of Malongo is most used for the provision of services to the *offshore* (oil and gas).

The port of Luanda is the country's main international trade route. It has 2.738 meters of quays (six berths)), 19 warehouses of 55.500 m^2, a land area of 792.219 m^2 and allows for the berthing of 17 vessels. Until 2011, the draught of the port was 10,5 meters, considerable for ship of about 30.000 deadweight tons. But the depth in Luanda Bay exceeds 20 meters, potentially allowing ships with more than 150.000 tons of deadweight to enter the day. The port is protected by the large Luanda Bay. In addition to container, bulk and general cargo berths, the national oil company Sonangol operates an oil terminal adjacent to the port (Bank, 2005) and (Pushak & Foster, 2011). In order to maintain control of container flows, the port of Luanda is assisted by the dry port of km 30 and they are connected by road and rail.

The port of Lobito was modernized and expanded with a container terminal, a mineral terminal, and an oil terminal. By 2014 the port had the capacity to handle 3.7 million tons which would be expanded to 4.1 million when the Benguela railway was operating at its full potential (Duarte *et al.,* 2014). The port of Cabinda has severe operational limitations for large ships and dredging and major rehabilitation works on berthing facilities, warehouses and sidewalks. The port of Malongo, on the other hand, supports the export of oil *offshore* Cabinda (Bank, 2005).

4.2. Competitiveness in the African port sector

Given the importance of the port of Luanda for goods from Angola, DRC, Zambia and Zimbabwe, the port of Luanda has become one of the fastest growing ports in Africa. The growth in demand in the first decade of the 21st century has generated serious congestion at the Luanda ports general cargo terminals and container traffic, with traffic volumes increasing from 30,000 to 346,000 (Pushak & Foster, 2011).

The entire Atlantic coast up to Cape Town in South African is characterized by a back of indentation, with only a few natural harbors at Dakar, Freetown, Lagos, Lobito and Walvis Bay. Modern seaports on the Atlantic coast of African can be classified into natural and man-made ports. Natural ports were dredged and expanded to accommodate larger ships, while artificial ports were built for strategic reasons. Port development was aligned with the construction of railroads and highways (Olukoju, 2020). For example, the Autonomous port of Cotonou has been the lifeblood of Benin's economy since 1910, it is a pillar of socio-economic development. Benin occupies a strategic position among the coastal countries of West Africa. It is a natural corridor for the transport of goods to and from Niger, Burkina Faso, Mali, Chad, Togo and Nigeria through the Port of Cotonou. Until 19th century, Benin´s maritime trade was conducted at two points on the coast: Grande Popo and Ouida. After the record of many losses of materials and human lives, the wharf was built in Cotonou in 1891 (Alexis *et al.,* n.d.).

Dyck & Ismael (2015) evaluated the competitiveness of major West African ports (Abidjan, Cotonou, Dakar, Lagos, Lomé and Tema), using the Analytic Hierarchy Process. The results show that the port of Abidjan is the most competitive due to its efficiency and performance, infrastructure and political stability. The Lagos Port Complex, the largest port in West Africa in terms of Scale and throughput, ranked fifth

behind the ports of Lomé, Tema and Dakar due to political instability. The port of Cotonou in Benin, on the other hand, was the least competitive because port competitive in West Africa excels in door-to-door delivery. According Malchow & Kanafani (2004), location, port characteristics and ship characteristics determine the selection of a port in port competitiveness.

The port of Luanda had long delays and poor performance relative to other African ports. Container dwell time (12 days) was twice as long as Durban, the best performing port in Africa and rivaled only the underperforming ports of Mozambique. Truck delays (14 hours) were more than twice as long as other SADC ports. Crane productivity was lower than other Southern African ports. The handling rate at the port of Luanda was among the higher than that charged at the port of Mombasa (Kenya) and 25% higher than that charged at Durban (South Africa). The bulk cargo handling fee was also high compared to other African ports (Pushak & Foster, 2011). But after some years, Caschili & Medda (2015) analyzed the attractiveness Index of 41 container ports in 23 African countries with data from the period 2006 to 2010. Their results show that the port of Luanda is not among the worst on the African continent.

Namibia has two ports (Walvis Bay and Lüderitz) which handle over 6.5 million metric tons of cargo. Walvis Bay is Namibia´s main port and the only deep-water port, its depth is 12.8 meters and can accommodate container ships with a maximum capacity of 2.400 tons. Walvis Bay Harbor has a new cargo and container quay wall that is 500 meters long and the channel has a draft of 8.15 meters, which can accommodate ships up to 150 meters long. This port handles over five million tonnids of cargo per year, 20% of which is containerized. The port of Walvis Bay is one of the preferred entries into SADC because of its accessibility and agility, it offers less time. Namibia is connected to Botswana, Angola, South Africa, Zambia, Zimbabwe and DRC (Namakalu *et al.,* 2014).
Dyck & Ismael (2015) when conducting their study of the port sector on the west coast of Africa, observed that competition and port selection are closely related to port location and throughput, which in turn affects the direct port calls of shipping lines. According to Clark *et al.* (2004), the African ports that had severe delays at las until 2004 were: Ethiopia (30 days), Kenya, Tanzania and Uganda (14 days each), Cameroon (20 days), Nigeria (18 days) and Malawi (17 days).

Cargo dwell time (the time between the arrival of the ship and the container leaving the port facility) exceeds 20 days on average for ports on the African continent, making them the most time inefficient. Companies that rely on just-in-time shipments are less likely to development in this environment (Refas & Cantens, 2018).

The time delays in African ports are due to the lack of modern equipment capable of handling cargo quickly and the lack of administrative efficiency. Bureaucracy in the handling of customs documents generates high transaction costs for companies and wastes time. Thus, the more red tape there is at customs, the less competitive they become for shipping companies.

According to Cullinane *et al.* (2005), the efficiency of port is characterized by quay length, ship turnaround time, ship stowage, crane throughput, and yard operations.

These authors evaluated the efficiency of the world´s most important ports and container terminal throughput is a determining factor in the contemporary global economy.

Omoke & Onwuegbuchunam (2018) analyzed costs per ship time in port, ship turnaround time, crane efficiency, and frequency of ship call as determinants of port competition in West Africa. The authors concluded that ports operating in the same geographic range compete with each other, leading the less efficient ones to lose customers to the more efficient ones. In the same vein, Kaliszewski *et al. (*2020) analyzed the global competitiveness factors of container ports and highlighted three factors: quality of container terminal service, manpower, and adequate nautical accessibility. This corresponds to the increasing size of container ships, which require Deepwater container terminals and reliable port services. The shipping lines need high standard services and low risk of labor-related disruptions to maintain the high level of service quality.

Today, ports can lose important customers if they have inefficient port infrastructure (Notteboom & Winkelmans, 2001a). The market environment in the port sphere is changing significantly (Notteboom & Winkelmans, 2001b). In this vein, Goss (1990) identified five distinct forms of port competition: between port clusters; between ports in different countries; between ports within a country; between terminals within a port; and between modes of transport.

Currently, research on port competition is focused on these five categories (Munim & Saeed, 2019). Research indicates that the most important elements in port selection are the number of trips, internal transportation rates, the port´s internal intermodal connectivity, and the existence of container terminal (Dyck & Ismael, 2015). The determinants in the port industry can be qualitative and quantitative (D´Este & Meyrick, 1992). Quantitative factors include route and cost factors and service factors, while qualitative factors include flexibility and ease of use, port management, contacts, and the level of cooperation between the shipper and the port (Rimmer, 1998).

Analyzed the competitiveness of port infrastructure necessarily implies charactering the main competitiveness factors, since the relevance of a port depends on its location, the market situation, and is perceived different by stakeholders (shippers, forwarders, shipping companies, shipping agents, carriers, and logistics operators). The stakeholders exert influence on the choice of the terminal and are guided by the different competitiveness factors (Kaliszewski *et al.,* 2020).

4.3. Determinant factors in port competitiveness

Ship waiting time, container dwell time in port, ship turnaround time, and crane productivity are factors that represent a port´s efficiency and directly influence the efficiency of shipping companies and other ports users (Dyck & Ismael, 2015). Three factors characterize the productivity of port terminals (Trujillo *et al.,* 2018):

- the berths needed to berth the ships (measured in linear meters);
- the cranes used to load and unload the containers; and
- the surface area of the terminal which is measured in m^2.

Cargo volume is also a determining factor, it measures the actual amount of cargo handled at a port (Hales *et al.*, 2017). As a rule, cargo volume is measured by the movement of containers in Twenty-foot Equivalent Units (TEUs). In turn, the input factors (the terminal´s quay cranes) affect the efficiency of the container terminal. Thus, a terminal is efficient if it moves high amounts of cargo (container traffic in TEUs) in the terminal. As a rule, the efficiency of port terminals is measured in TEUs per crane. But, this measure does not evaluate the overall efficiency of the terminal, as it focuses only on a specific aspect of the terminal (Notteboom *et al.*, 2000).

Several authors have identified different determinants factors that affect port competitiveness. To organize them, a filtering methodology was used, that is, several articles were analyzed and only those that cited certain elements as determining factors in port competitiveness were extracted. Subsequently, the determining factor, author and year of publication were transcribed in Table 1.

Table 1: Determining factors of port competitiveness

Determining factors	**Authors**
Geographic location of the port	Starr (1994), Ha (2003), Song & Yeo (2004), Yuen *et al.* (2012), Malchow & Kanafani (2004), Dyck & Ismael (2015), Hales *et al.* (2017)
Connection between transport infrastructures	Starr (1994), Yuen *et al.* (2012), Parola *et al.* (2017), Tongzon & Heng (2005)
Development of port infrastructure	Starr (1994), Ha (2003), Song & Yeo (2004), Yuen *et al.*(2012), Dyck & Ismael (2015), Parola *et al.* (2017)
Workforce stability	Starr (1994), Yuen *et al.* (2012)
Port handling charges and/or fees (costs)	Song & Yeo (2004), Yuen *et al.* (2012), Dyck & Ismael (2015), Hales *et al.* (2017)
Volume of the load handled safely	Song & Yeo (2004), Yuen *et al.* (2012), Dyck & Ismael (2015)
Efficiency and effectiveness in the delivery of port services (transit time, frankness, capacity and reliability), strategic management of the port	Bennett & Gabriel (2001), Ha (2003), Malchow & Kanafani (2004), Song & Yeo (2004), Teng *et al.* (2004), Tongzon & Heng (2005), Yuen *et al.* (2012), Dyck & Ismael (2015), Hales *et al.* (2017)
Wharf depth	Tongzon & Heng (2005), Yuen *et al.* (2012)
Adapting the port to the current market	Tongzon & Heng (2005)
Product differentiation	Tongzon & Heng (2005)
Capacity and size availability	Yuen *et al.* (2012)
Connectivity with the interior	Yuen *et al.* (2012)
Maritime transport services	Yuen *et al.* (2012)
Terminal operators	Yuen *et al.* (2012)
Personalized service	Yuen *et al.* (2012)
Document simplification at the port	Yuen *et al.* (2012)
Damage to cargo and port skills	Yuen *et al.* (2012)
Port Information Systems	Yuen *et al.* (2012)
Government policies	Teng *et al.* (2004), Yuen *et al.* (2012)
Information about the port´s activities	Ha (2003), Yuen *et al.* (2012)
Port response time	Ha (2003), Hales *et al.* (2017)
Vessel characteristics	Malchow & Kanafani (2004)

Sustainability policy	Dyck & Ismael (2015)

Source: Elaborated by the author.

Port facilities refer to all tangible assets used to serve maritime cargo (Hales *et al.*, 2017). In this context, the capacity and efficiency of port infrastructure, the quality of roads, railroads, cost, services, geographical location, and easy access to the interior of the country or continent play an important role in making decisions regarding the choice of port (Cullinane *et al.*, 2005) and (Guy & Urli, 2006).

4.4. Africa's main ports corridors

African ports are vital to the African economy, they facilitate Africa's integration into the international trade arena, enabling over 90% of the continent's imports and exports (Refas & Cantens, 2018). A report on transport corridors in West Africa identified nine transit corridors (Figure 1), two intra-regional corridors (Bamako, Mali-Ouagadougou, Burkina Faso and Ouagadougou-Niamey, Niger) and two main east-west corridors (Dakar-Niamey) and (Abidjan- Lagos) (Olukoju, 2020).

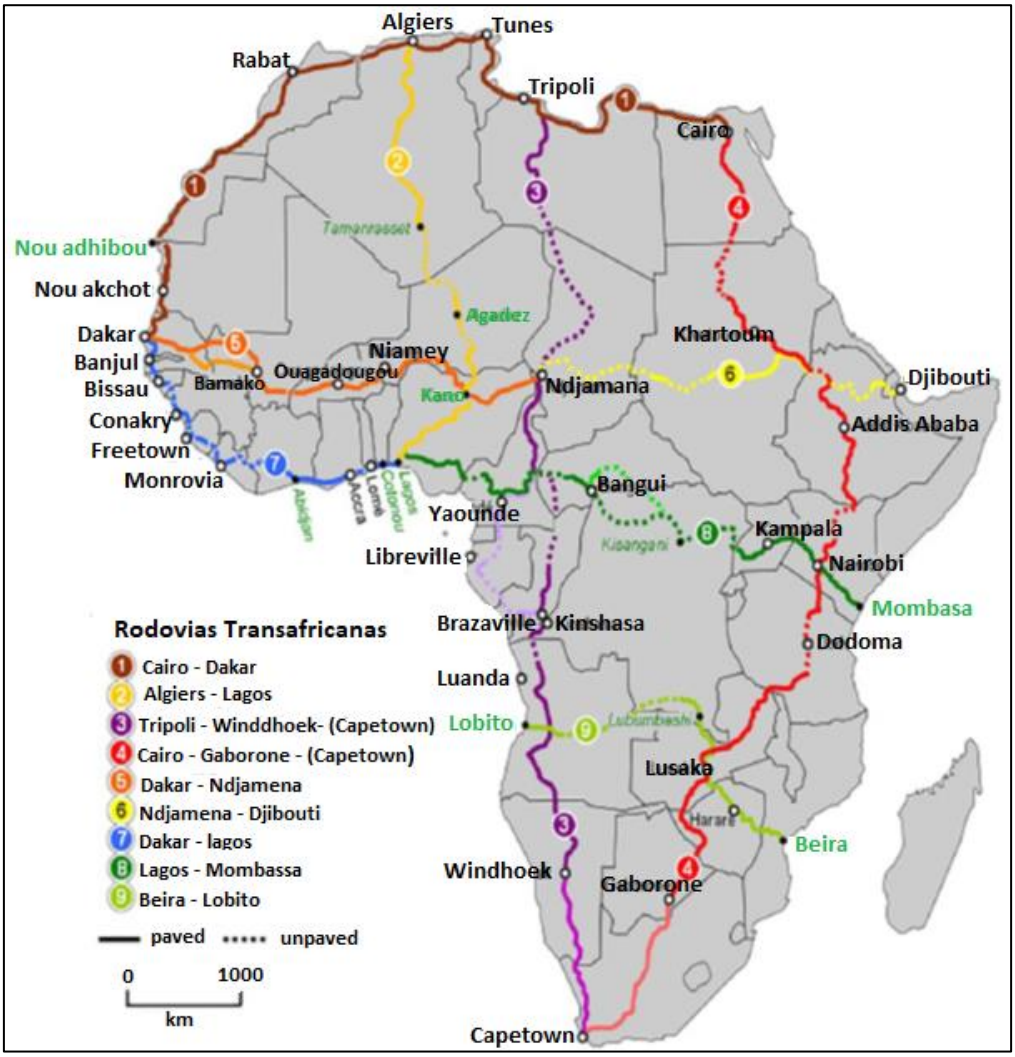

Figure 1: Trans-African corridors. Source: adapted from Olukoju (2020).

Africa accounts for about 13% of the world's population, 38 countries have access to the coast along the continent's 30.490 km of coastline and 15 are landlocked. 33 African countries are classified as least developed, 21 of them have access to the sea and 12 have no access to the sea. The GDP of African countries is relatively low (Trujillo *et al.,* 2013). West Africa is characterized by a number of relatively small ports that spread along the Atlantic coast of West Africa and compete fiercely for cargo destined for the landlocked West African hinterland (Dyck & Ismael, 2015).

Opened in 1866, the port of Dakar was the main port in French West Africa, its annual throughput in 2006 was 9,9 million tons. The port was served by a major railway line opened in 1885, running north to the port of Saint Louis and east to Bamako in Mali. After the completion of the Cana Vridi in 1951, the Porto of Abidjan became the main seaport on the Côte d'Ivoire, leading to the closure of the canals at Porto-Bouet and Grand Bassam. A one-meter narrow gauge railway line from Abidjan a Azaguié was opened in 1905 over a distance of about 70 km (Olukoju, 1992) and (Olukoju, 2020).

In the same vein, Ghana´s first major seaport was opened in 1928. It was proceeded by an eastern railroad built in 1923 to move minerals and cocoa from the interior. After independence, a new port was built in Tema as an outlet for the country´s aluminum smelting plant. In the Republic of Benin, the port of Cotonou was inaugurated in 1965. It has been operational since the era of French colonial rule. A railway line was inaugurated in 1906 to connect Cotonou in Ouidah to the capital of the pre-colonial Kingdom of Daomé (Olukoju, 2020).

In Nigeria, seaport and railroad construction began in the 1890s. the Lagos railroad had reached Ibada in 1901 and Minna in 1911. Meanwhile, the Baro-Kano railroad was built by the northern Nigerian government between 1907 and 1911. Both lines were integrated when northern and southern Nigeria unified in 1914 (Olukoju, 1992; Olukoju, 2020). The port of Douala, on the other landlocked countries to the north since the 19h century. Construction of the railroad and port occurred during German colonial rule until 1914 (Olukoju, 2020).

The port of Dakar has the best crane productivity and one of the cheapest handling costs, its main disadvantage being the distance from the port to the landlocked West African hinterland. Its port technical efficiency is also quite low, with a rather average throughput for a port of its scale. Lagos is the largest port in West Africa, serving Africa's largest economy (Nigeria). In terms of port infrastructure, Lagos port's quay has the largest berth and terminal area, which is comfortable to accommodate larger ships and more containers, but the water depth of the port is comparatively the most (9m), which leads the port to accommodate only ships of up 2.000 TEUs. That is its major disadvantage. The port changes the lowest handling cost, but has the worst crane productivity compared to the port of Abidjan, Lomé, Tema, Dakar and Cotonou (Dyck & Ismael, 2015).

The most important corridors from the point of view of seaport-hinterland development are Lagos-Kano-Jibiya, Cotonou-Niamey, Lomé-Ouagadougou, Tema-Ouagadougou, Abidjan- Ouagadougou, Abidjan-Bamako and Dakar-Bamako. These

transit corridors are differentiated by certain characteristics. First of all, two of them (Dakar-Bamako and Abidjan-Ouagadougou) have dual rail and road connections. Others are based on road transport services. Second, Dakar and Abidjan serve multiple corridors with Bamako and Ouagadougou being the inland terminals of these links. Third, Dakar, Abidjan and Lomé, unlike Lagos and Tema, profit from their common affiliation with the extinct French empire in west Africa and with rail links across their modern borders (Olukoju, 2020).

In the Gulf of Africa, the port of Lomé is the smallest port in terms of all, but it can accommodate large ships due to its large draught (14m). The port's efficiency and performance in vessel handling is good, but handling cost are relatively high. Its crane productivity is also relatively high (Dyck & Ismael, 2015). In recent decades, due to port costs, shipping companies are choosing efficient and less expensive ports (Munim & Saeed, 2019).

In the same vein, the port of Abidjan is the best in West Africa, offers the best level of service to shipping lines, provides quick access to berths upon ship arrival and a fast ship response time. This allows container ships to spent little time in port and reduce their operating costs. However, the productivity of its crane is relatively very poor, compared only to the one in Lagos. Relatively the average distance from the port of Abidjan to landlocked West African countries is the second best after Tema port. The productivity of the Tema is high and compares only favorably with Dakar. In terms of location, Tema is best suited to serve landlocked West African countries (Dyck & Ismael, 2015).

The Cotonou-Niamey corridor is the busiest in West Africa. A portion of this corridor passes through northern Nigeria, thus diminishing the advantages of Lagos which is Nigeria's main seaport. Cotonou's competitiveness over Lagos can be attributed to two factors (Olukoju, 2020):

- it is the least expensive corridor in West Africa at $3.938 compared to $4.552 for Lagos-Jibiya or $5.095 for the Abidjan-Ouagadougou corridor.
- delays at border checkpoints averaging 98 minutes, were the shortest in the region.

Walvis Bay, Namibia's largest port, was built in 1840. Originally developed by the Germans, it came under South African control as a League of Nations territory that South Africa annexed before Namibia became independent. The Germans began construction of the railroad from Swakopmund to Windhoek in 1897. The Walvis Bay railroad was completed in 1899 (Olukoju, 2020). The port of Luanda, on the other hand, was opened in 1844, but railroad construction did not begin until 1887. However, deterred by the long delays and high prices, Angolan traffic began to use the port of Walvis Bay more as the main gateway to the sea. Walvis Bay is located 2.100 km south of Luanda, but improvements in road rail infrastructure connecting the two cities have made the port more accessible to the Angolan market (Pushak & Foster, 2011).

In general, the quality of port infrastructure differs from country to country and region within the same country and terminal to terminal within the same port, these differences significantly affect logistics performance (Munim & Schramm, 2018).

In addition to the corridors in Figure 1, SADC has other internal corridors that facilities the movement of goods (Figure 2). Despite the differences between gauges, the SADC region has a strong connectivity between different rail lines and road lines, which together connect the ports on the Atlantic coast to the ports on the Indian coast. Among them, the following multimodal (road-rail) corridors can be distinguished:

A. Lobito Corridor – constitutes the shortest route from mineral-rich areas of DRC and Zambia to a port (Duarte *et al.*, 2014). It is estimated that in Katanga alone the copper and cobalt deposits account for 40% and 50% respectively, of the world's total reserves. The need to allocated these resources to the coast makes the Lobito corridor a very important line, as it represents the shortest and fastest line to the European and American markets from the Port of Lobito. However, the inefficiency of the rail and road infrastructure causes these resources to be transported to South African ports (Mouzinho, 2016).

The railway infrastructure is a major component in the Lobito corridor. It runs from the port of Lobito to the Luau-Dilolo border crossing between Angola and the DRC, over a stretch of 1.344 km, includes rails, locomotives, wagons, 70 railway stations and warehouses. Until 2014 the railroad was not operational in the DRC. Zambia had started planning work on a new railway from the copper belt crossing the border post of Jimbe and connecting to the CFB at Luena (Duarte, 2014).

Figure 2: SADC multimodal corridors and major ports. Source: Parida (2014).

B. Trans-Kalahari Corridor – officially opened in 1998, is a paved road that stretches more than 1900 km from the port of Walvis Bay through Botswana to Johannesburg. Together with the Maputo corridor, it connects east to west in four countries (Namibia, Botswana, South Africa and Mozambique). The railway line along the corridor runs from port of Walvis Bay to Gobabis (via Windhoek) and continues on from Lobatse in Botswana. Currently, cargo from the Port of Walvis Bay is mainly transported by road from the Port of Walvis Bay to Gaborone and Gauteng. Cargo can also be transported by rail from the port of Walvis Bay to Gobabis and then offloaded from the train onto a truck,

with the remainder of the trip made by road to Gaborone or Gauteng, as the rail link ends at Gobabis. Okahandja, Gobabis, Karibib, Usakos, Walvis Bay and Swakopmund are some of the tows located along the Trans-Kalahari corridor (Parida, 2014).

The Trans-Kalahari highway connects the port of Walvis Bay with Botswana and the province of Gauteng (South Africa's industrial heartland). Similarly, the Trans-Caprivi highway connects Namibia (Zambia and Zimbabwe) to the port of Walvis Bay. The Trans-Cunene also connects the port of Walvis Bay to neighboring Angola (Namakalu *et al.*, 2014).

C. Beira-Harare Corridor – Mozambique is the gateway for international trade to landlocked countries such as Zimbabwe, Zambia, DRC, Malawi and Botswana, it has the shortest distance to the seaports of Beira, Nacala and Maputo. In this corridor, the Sena railway line (575 Km) is the only existing export corridor, connecting the city of Moatize to the port of Beira. On this line, the section from Beira to Dondo is in poor condition, leading to a single line speed restriction of 20 Km/h (Parida, 2014).

5. Results and discussion

Africa's port infrastructure, particularly that of SADC is developing. For example, the port of Dar es Salaam is one of the largest in Africa with a presence in the global arena. According to Trujillo *et al.* (2013), only East African ports are characterized by first generation port systems, in most African countries port are management by Ministries of Transport. Until 2013 the largest ports in Africa were in Egypt, Morocco, Algeria, Djibouti, Mauritius, Togo and South African. These countries have implemented port reforms.

For years poor management and investment in transport infrastructure have elevated the port of Luanda to the status of the most expensive and inefficient port in SADC, with has negatively influence the port's image and the flow of goods between landlocked SADC countries and the port of Luanda. In general, shipping companies find it attractive to move to a particular port if it offers lower costs, cargo handling efficiency, and routes for the allocation of goods.

The comparative evaluation of terminals and cranes is increasingly pronounced. Thus, to identify the competitiveness of Angola's port infrastructure in SADC, we proceeded to analyze the growth of GDP per capita of each SADC country that has access to the sea (Figure 3). GDP data (total and per capita, current and constant prices, annual) are taken from UNCTADState.

Analyzing the growth dynamics of GDP per capita of the SADC countries that have access to the sea, it is observed that during the period from 2000 to 2021 South Africa showed the highest economic growth, which may mean that South Africa invests heavily in its port infrastructure, because the greater the investment in transport infrastructure, the higher the GDP per capita. Angola's GDP per capita, on the other hand, began growing in 2001, peaking in 2014.

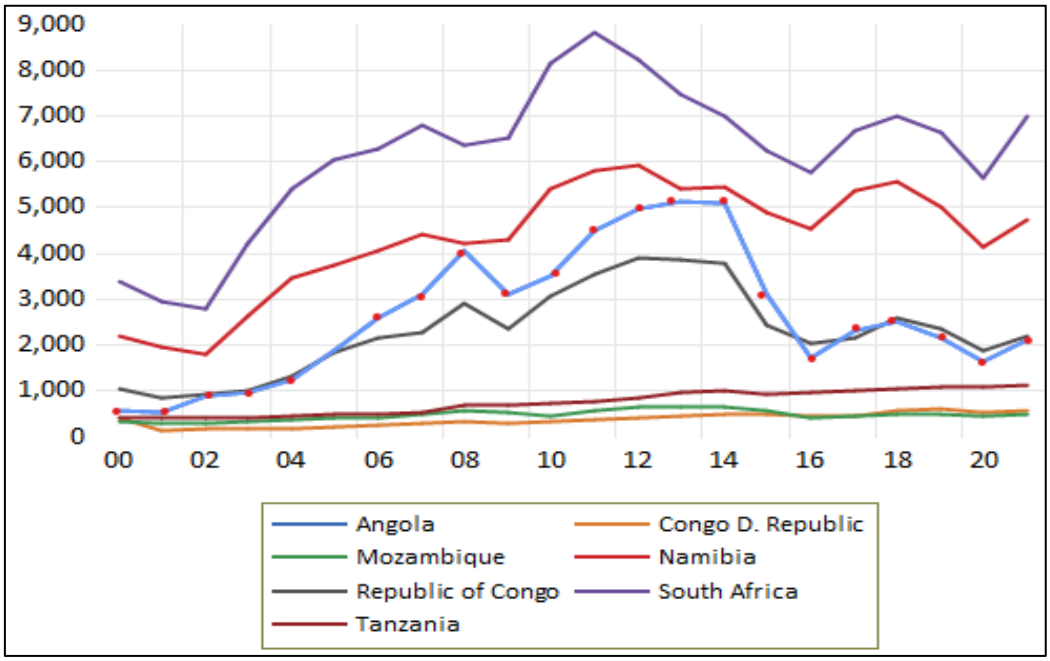

Figure 3: GDP per capita of the SADC countries with access to the sea between 2000 – 2021. (Source: the authors)

This growth reflects investment in transportation infrastructure and the oil boom in the international market. In general, South Africa, Namibia, Angola and the Republic of Congo show the same growth trend. Similarly, the Democratic Republic of Congo, Mozambique and Tanzania show the same growth trend.

Regarding the entry of ships in SADC between 2018 and 2021, the results in Figure 4 illustrate that Angola was on equal footing with Mozambique and Tanzania and they all only below South Africa which had the highest number of registrations in the region.

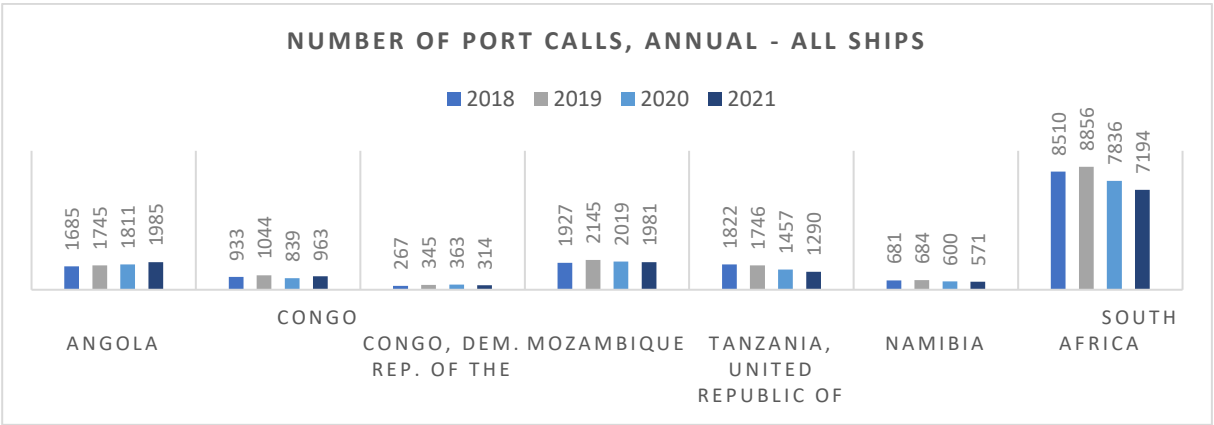

Figure 4: Port calls recorded in the SADC countries between 2018 and 2021 (Source: the authors)

Regarding the number of port calls of liquid bulk carriers among SADC countries, the results in Figure 5 illustrate that Angola was below only South Africa which has the best developed port infrastructure in the region.

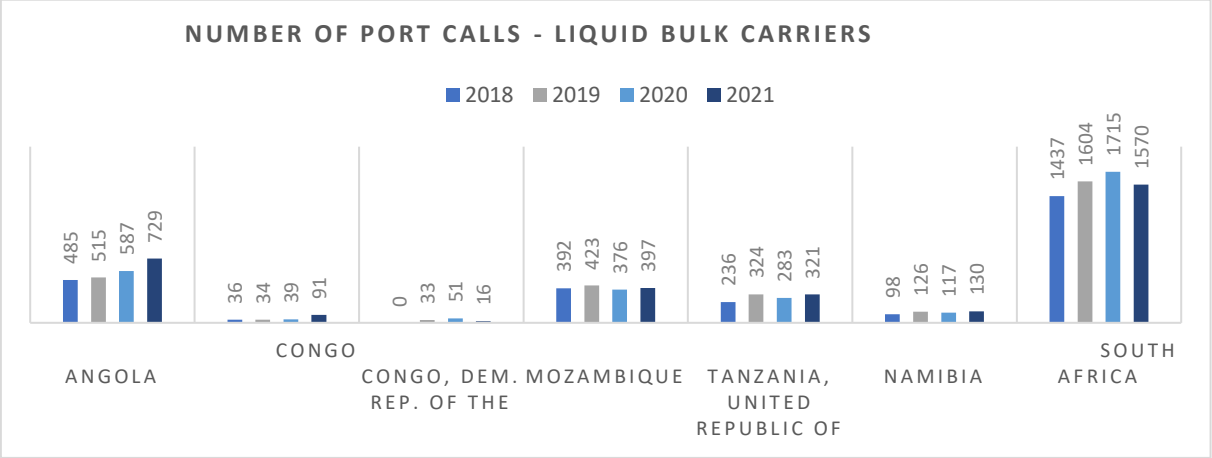

Figure Error! No text of specified style in document.**:** Number of port calls – liquid bulk carriers between 2018 – 2021
(Source: the authors)

Regarding the number of dry bulk carriers registered in SADC countries between 2018 and 2021, the results in Figure 6 illustrate that Angola had the worst results. Only South Africa and Mozambique had a good result.

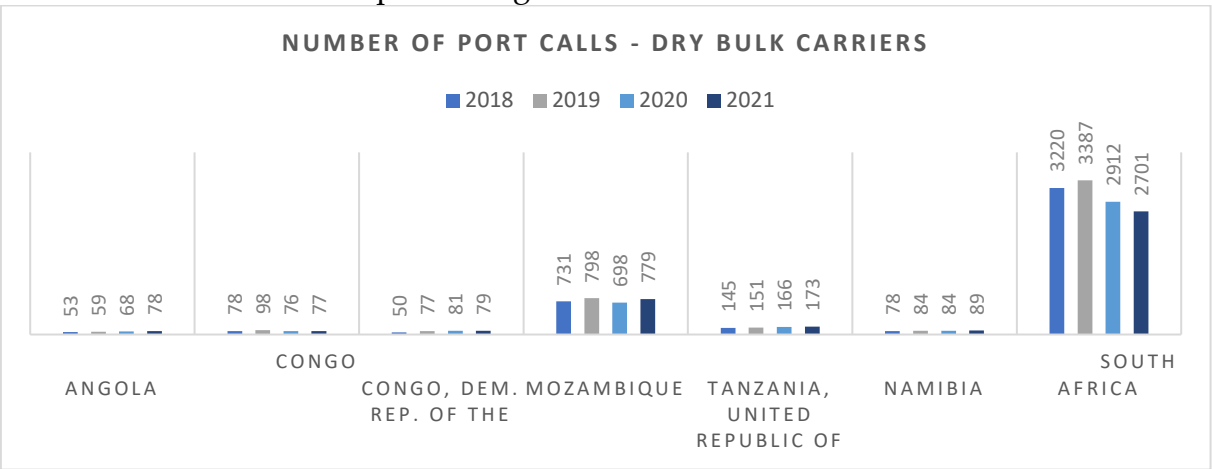

Figure 6: Number of port calls – dry bulk carriers between 2018 – 2021
(Source: the authors)

Regarding the number of dry breakbulk carriers registered in SADC countries between 2018 and 2021, the results in Figure 7 illustrate that Angola performed better relative to Namibia, Tanzania, Mozambique, and the DRC.

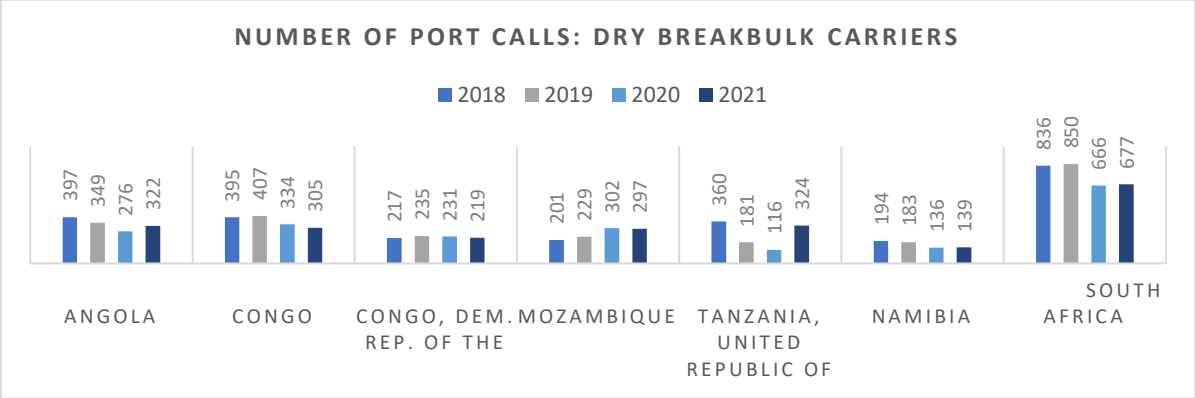

Figure 7: Number of port calls – dry breakbulk carriers between 2018 – 2021
(Source: the authors)

Regarding the number of Roll-On/Roll-Off ships, the results in Figure 8 illustrate that Angola was in the fourth position. It was not a strong competitor in the region.

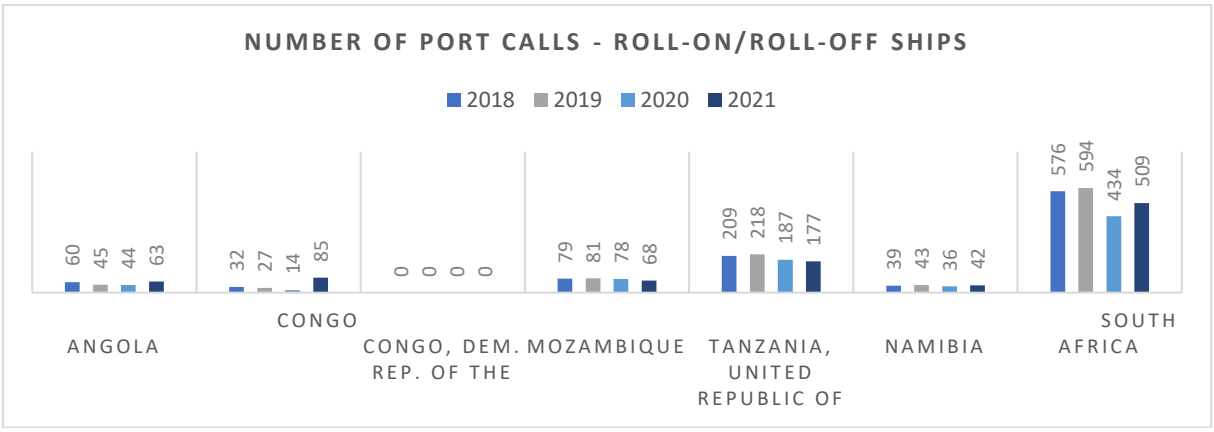

Figure 8: Number of port calls – Roll-On/Roll-Off between 2018 – 2021
(Source: the authors)

Regarding the number of container ships registered in SADC countries between 2018 and 2021, the results in Figure 9 illustrate that Angola was in third place.

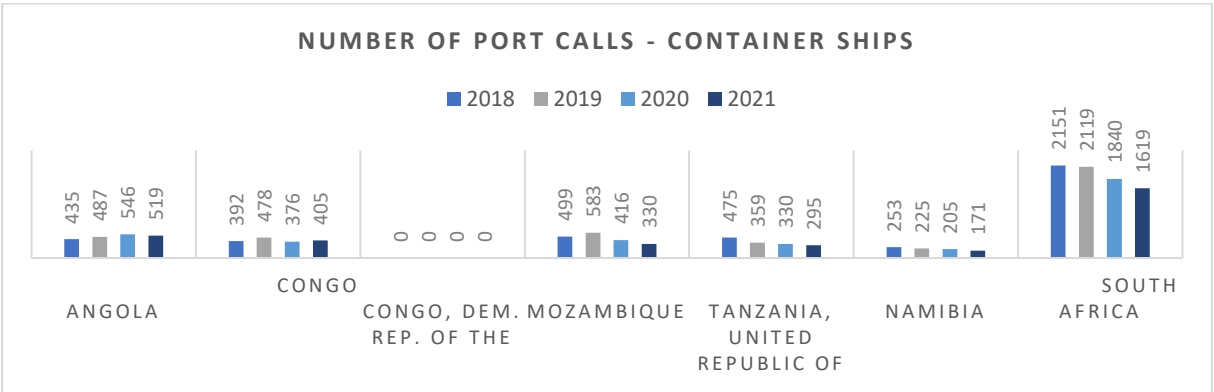

Figure 9: Number of port calls – container ships between 2018 – 2021
(Source: the authors)

Regarding the waiting time of container ships at SADC ports during the year 2021, the results in figure 10 illustrate that Namibian ports had the best performance at the SADC level with almost two days, while the worst performance was at Tanzanian ports, with 3 days.

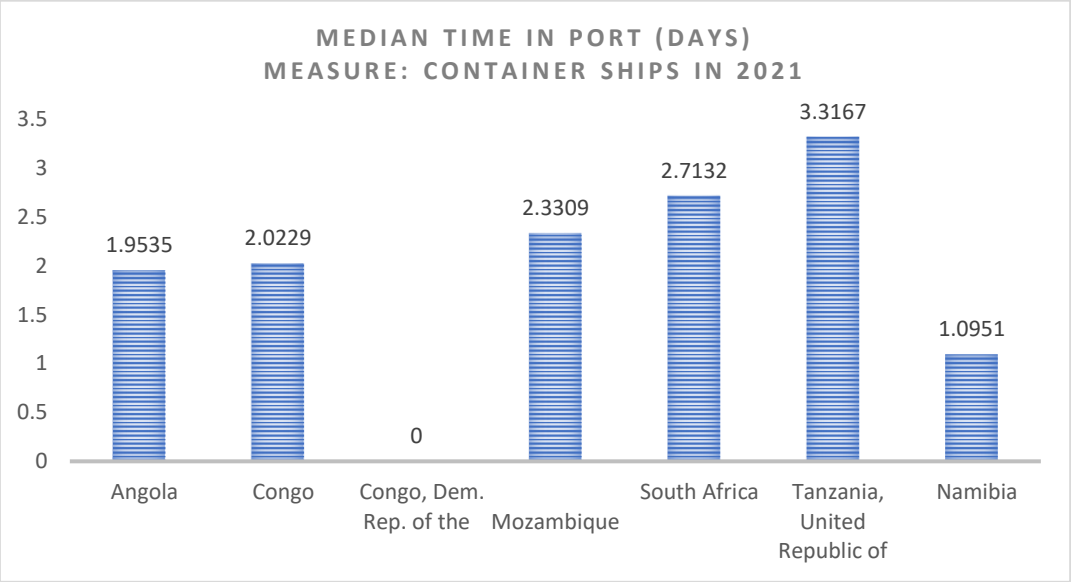

Figure 10: Median time in port in 2021
(Source: the authors)

Regarding the maximum capacity supported by ports in the SADC region during the year 2021, the results in Figure 11 illustrate that South African ports have the highest capacity, while the lowest capacity was recorded at Tanzania ports.

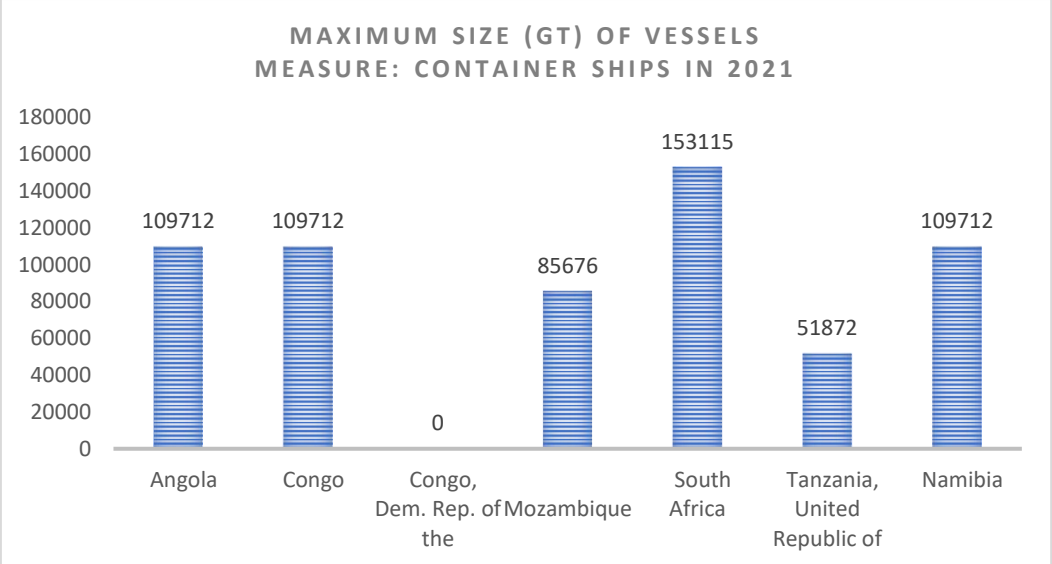

Figure 11: Maximum size of vessels
(Source: the authors)

Regarding the *Average container carrying capacity (TEU) per container ship* registered in SADC during the year 2021, the results in Figure 12 illustrate that the South African ports have the highest average capacity in SADC, while the lowest average capacities were registered in Mozambique and Tanzania.

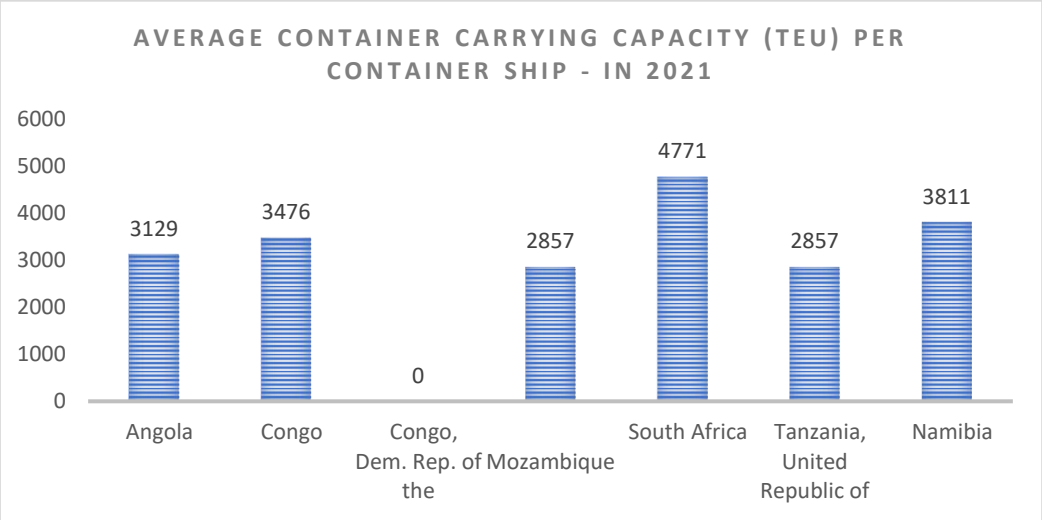

Figure 12: Average container carrying capacity per container ships
(Source: the authors)

Regarding the *maximum container carrying capacity (TEU) of container ship* of container ship supported by the ports in the SADC region during the year 2021, the results in Figure 13 illustrate that the South African ports have the highest capacity in SADC, while the lowest maximum capacities are in Mozambique and Tanzania.

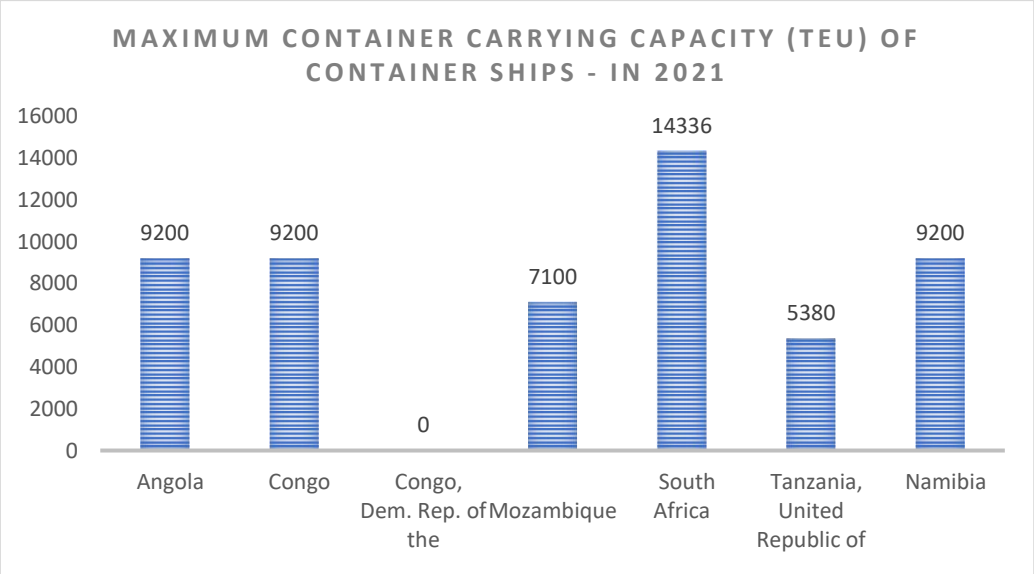

Figure 13: Maximum container carrying capacity of container ships
(Source: the authors)

Based on these comparative analyses, it can be concluded that the Angolan port infrastructure has undergone some improvements that have allowed it to correct the inefficiencies presented until then. Currently, the port of Luanda is neither the best nor the worst in the SADC region. It is believed that if there is strong investment in road and rail infrastructure, the Angolan port infrastructure will each higher level.

Angola´s weak investment in its transport infrastructure is reflected in the weak competitiveness of the Angolan economy vis-à-vis the other SADC economies, the country presents a weak logistical development. The lack of a railway network in the country is undermining the potential of the port of Luanda, which served as a strategic port for Zambia and the DRC. If the country´s road and rail infrastructure were in full operation, the country would have collected a lot of revenue from container allocation in the landlocked countries of the region. According to Deloitte (2014), the poor development of the logistics sector in the country has limited the efficient movement of people and goods, thus compromising Angola´s development. Given the situation, one of the mechanisms to reverse this situation is the rehabilitation of transport infrastructure so that the ports of Angola provide better service, because the price, time and quality reflect significant impact on port competitiveness.

6. Conclusion

Port infrastructure is a fundamental pillar for the Angolan economy, it is the gateway for more than 80% of the products traded in the country. Its management presents complex and hermetic trade-offs, mainly due to the lack of investments and the underdevelopment that the country presents. Although Angola´s port infrastructure has benefited from some improvements, the inefficiency of road and rail infrastructure continues to hold back the performance of Angolan ports in SADC. Currently, Angolan ports have not only become uncompetitive with the Port of Walvis Bay in Namibia, but have also lost domestic clients to this port.

Thus, this study, in addition to allowing the identification of the determining factors, also allowed us to understand the importance that the Angolan port infrastructure represents for the mining regions of the DRC, Zambia, Zimbabwe and Angola itself, which makes the rehabilitation of rail and road infrastructure necessary, since the poor performance of the Angolan port infrastructure is mainly associated with the poor development of road, rail and logistics infrastructure. Without good transport infrastructure, it will be difficult to make the Angolan port infrastructure competitive in the African arena, as other countries have invested heavily in their transport infrastructure. Thus, this study can help decision-makers to develop management strategies that enable efficient and effective investment in Angola´s port infrastructure in the short, medium, and long term.

This study is one of the first to be conducted in a comprehensive manner on Angolan port infrastructure, which, in a way, brings contributions that can help managers make decisions aimed at improving Angola´s port infrastructure. In terms of

limitations, this study was limited to the analysis of comparative results, which to some extent limits in-depth knowledge of the nature of each port infrastructure discussed here. Regarding future studies, we intend to develop work to characterize the state and impact of Angola´s road and rail infrastructure on the development of the Angola economy, as well as on the integration of supply chains at the SADC level. The current context of Angola shows that as long as the country does not have good road and rail infrastructure, the Angolan port infrastructure will not be competitive enough in SADC. The outflow routes must be improved to enable an efficient and effective supply of goods in the short, medium and long term.

7. Recommendations

Therefore, to increase the volume of national trade and increase the level of growth of the Angolan economy, it is essential that the Angolan government invest heavily in transport infrastructure. We believe that without good transport infrastructure there are no conditions to boost logistics, the agricultural sector, local industry, regional trade, and supply chain.

Declaration of Conflicting Interests
The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
This research received no funding.

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