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Development of Angola offshore bunkering market post 2020, towards a hub for the Sub-Saharan West Africa

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DEVELOPMENT OF OFFSHORE BUNKERING MARKET IN ANGOLA POST 2020, TOWARDS A HUB FOR SUB-SAHARAN WEST AFRICA.

By

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Angola

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views and are not necessarily endorsed by the University.

(Signature): **.....**

(Date): 10/14/2019

Supervised by: **Satya Sahoo**

Supervisor’s affiliation

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Abstract

Title of Dissertation: Development of Offshore Bunkering Market in Angola, Towards a Hub for Sub-Saharan West Africa.

Degree: Master of Science

The Sub-Saharan West Africa bunker markets are affected by many negative factors. These factors include infrastructure constraints, poor practices, illicit activities, piracy, and armed robbery. In turn, the situation is hindering the growth of the bunker activity in the region. However, the new Sulphur regulation starting in January 2020 will impact the bunker fuel Markets globally. It will add more uncertainty to the Sub-Saharan West Africa region. Especially on the availability of low Sulphur fuel at offshore bunker locations. The offshore bunker locations are positively energising the region and delivering most of the bunkers volumes to ships in the area. However, by 2020, only a few offshore markets in west Africa will be able to supply compliant fuels. The Angola off port limit (OPL) market is one of the markets in the region that already supplies these types of fuels.
The Sulphur Cap regulation will change the region's bunker supply landscape. It will present challenges but also opportunities for the development of the offshore bunker locations in the region.

Hence, this research deals with the development of the Angola offshore bunkering market post-2020. It identifies the factors affecting the selection of offshore bunker locations in West Africa. It studies the implication of these factors for the development of the Angola offshore bunkering market. It analyses the leverage that Angola has by 2020 to become a bunker Hub in the region. It gives an insight into the strategies to be created to increase local bunker market shares. Also, strategies to attract vessels to buy bunkers from the Angola offshore market.

The methods chosen to evaluate the primary data are questionnaire surveys and Clarkson's Seanet. The secondary data was obtained from articles and books written by other scholars.

From the study results, it can be determined that the 2020 IMO Sulphur Cap offers positive leverage to Angola offshore fuel market. Thus, the market could increase its regional share. Also, develop its bunker industry towards a hub in the Sub-Saharan West African region.

Keywords: Sulphur, De-Bunkering, Scrubber, Compliant Fuel, Competitive Factors

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List of Abbreviations

STS - Ship to Ship transfer

IMO - International Maritime Organization

IEA - International Energy Agency

MBD - Millions of Barrels per day

LNG - Liquefied Natural Gas

RFO - Residual Fuel Oil

ISO - International Standards Organization

DM - Distillate marine fuels

RM - Residual Marine fuels

MGO - Marine gas oils

LS MGO -Low Sulphur Marine Gas Oil

HSFO - High Sulphur fuel oil

ULSFO - Ultra-low Sulphur fuel oil

ECA - Emission Control Area

SECA - Sulphur Emission Control Area

UN - United Nations

SOx - Sulphur Oxides

OPEC - The Organization of the Petroleum Exporting Countries

MARPOL - International Convention for the Prevention of Pollution from Ships

m/m - mass by mass

NM - Nautical Mile

DP1- Dynamic Positioning 1

T/C- Time Charter

DWT- Deadweight

SSA - Sub-Saharan Africa

SWOT- Strength, Weakness, Opportunity, and Threat

OPL - Off Port Limits

Chapter 1 - Introduction

1.1.Background of Study

The Shipping marine industry is responsible for about 90% of the global trade. Motor ships using fuel oil have overtaken steamships since the 1960s. Nowadays, these ships account for about 98% of the world fleet (Vermeire, 2012). The shipping industry consumes about 6 million barrels of oil every day. Also, it emits about 13 % of global Sulphur emissions (IMO, 2014). Thus, from the 1st of January of 2020, a more stringent global Sulphur Cap regulation from IMO will be in force. This regulation will limit the Sulphur emission from the shipping sector from 3.5% to 0.5 %m/m globally. It will represent a significant reduction in the Sulphur content of marine fuels. It will impact all parties in the bunker industry, and it will change the dynamics of the global bunkering market. Thus, resulting, in a global shift in bunkering locations based on compliant fuel availability. Therefore, places such as Singapore are likely to lose some of their market shares to China. Because the demand side always looks for alternative locations with a surplus on compliant fuels (Wood Mackenzie, 2018). Places such as the West Africa region, the location of the cheapest bunkers may likely change. Angola OPL is one of location in West Africa that already supplies IMO compliant fuel. Thus the 2020 Sulphur Cap regulation gives to local fuel market competitive advantage in the region. It also offers to Angola OPL fuel market positive leverage in comparison to other neighbouring markets.

Angola is strategically located to enjoy the benefits of increased regional bunker demand. However, the country is also a net exporter for fuel oil and LNG products to Europe, North America, and Asia markets. Thus, to study the development of the Angola offshore bunkering market post-2020. It is vital to identify first the factors affecting the selection of offshore bunker locations in Sub-Saharan West Africa. Then analyse the implication of the competitive regional factors to the Angola offshore fuel market in 2020. In order to conclude whether Angola OPL fuel market can develop its industry towards a bunkering hub in the Sub-Saharan West Africa region.

1.2.Problem Statement

The development of the offshore fuel market has energised the West African region. It resulted in increased competition among the local offshore fuel markets. Buxton (1985), in the eighties, reported fuel costs to be 50%. Nowadays, bunkers represent 60% to 70% of the operational costs. Shipping companies choose offshore bunkering location based on the small price differential. As a result, less competitive Offshore locations can lose market shares to an adjacent one with better attributes.

Thus, there is an urgency in tackling the negatives attributes affecting the markets in the region. Because bunker fuel in the region can be expensive, time costly, and unattractive for bunker call option from the shipping sector (IBIA, 2016). In some locations, increased regulation and restrictive licensing have halted market competitiveness. It is crucial to identify the most critical factors for the selection of offshore bunkering locations in the region. They are essential for maritime authorities and all the parties in the supply chain to develop the offshore fuel market — especially parties failing to capitalise on the domestic or regional shipping traffic.

Nevertheless, the upcoming IMO 2020 Sulphur Cap adds more uncertainty to the region. Especially on the availability of compliant fuel. These uncertainties are threats to some offshore locations in the region but opportunities to others. Angola OPL is one of the locations in the region that already supply IMO compliant fuel. So, the 2020 IMO global regulation brings opportunities for the local fuel market. Opportunities to increase its sales and, consequently, to increase its regional shares.

This research looks at factors for the selection of offshore fuel locations in West Africa. It studies the implication of these factors for the development of the Angola offshore bunkering market post-2020. It analyses if the 2020 IMO Sulphur regulation provides an opportunity for the development of the Angola offshore fuel market. It discusses the strategies to be created to increase local bunker market shares. Also, strategies to attract vessels to buy bunkers from the Angola offshore market.

However, these studies will also be looking at the offshore supply chain in its current form. Thus, identifying processes within the market that could be improved or changed.

1.3.Value of the Research

Manny factors negatively affect the competitiveness of the Offshore West Africa bunkering Markets. As such, exist an urgency in finding the factors affecting the growth of the fuel market in the region. This research can contribute to areas dealing with the strategic development of the bunkering market in the region.

Previous studies for the European region indicated fuel price and geographical location, the most critical factors for the selection of a bunkering port. However, for the Sub-Saharan West Africa region, safety and secure bunkering location and fuel quality are ranked as most important.

This study highlights that bunker factors order changes with the geographic location and targeted audience.

This research will help local maritime authorities and the parties in the bunker sector to investigate further the competitive factors affecting the selection of the offshore bunkering location. It will assist the parties in the fuel sector to work together and to improve the overall conditions and environment of the local bunker market.

This research looks at the factors affecting the selection of offshore fuel locations in West Africa. It studies the implication of these factors for the development of the Angola offshore bunkering market post-2020. It also analyses is the 2020 IMO Sulphur regulation provides an opportunity for the development of the Angola offshore fuel market. It discusses the strategies to be created to increase local bunker market shares. Also, strategies to attract vessels to buy bunkers from the Angola offshore market.

This research gives an overall view of the offshore bunker market in the region, particularly the Angola OPL bunker market. It will help, and it will provide guidance to supply chain bunker companies operating in the region. How to segment the market and how to increase market share in the Sub-Saharan West Africa region, in particular, Angola.

1.4.Research Objectives

The study objective is to evaluate if Angola can develop its offshore bunker market post-2020, considering its positive regional competitive bunker market attributes and the 2020 Sulphur Cap regulation.

This study identifies the factors affecting the selection of offshore bunker locations in West Africa. It studies the implication of these factors for the development of the Angola offshore bunkering market post-2020. It analyses the leverage that Angola has by 2020 to become a bunker Hub in the region. It gives an insight into the strategies to be created to increase local bunker market shares. Also, strategies to attract vessels to buy bunkers from the Angola offshore market.

1.5.Research Questions

- What are the most important competitive factors affecting the selection of offshore bunkering location in Sub-Saharan West Africa?
- What are the implications of those competitive factors for the development of the Angola offshore bunkering market post-2020?
- What opportunities 2020 Sulphur Cap regulation brings for the development of the Angola offshore bunkering market?
- What are the strategies to increase bunker sales at Offshore bunkering location in Angola?
- What are the recommendations to improve and develop the offshore bunkering market in Angola?

1.6.Limitations of the Research

The research focuses on the Offshore Angola bunker market. It is an exploratory study, and it is new for the country context. The study limitations are as follows:

- The scope of this study is limited only to the offshore bunker market hubs in Western Africa.
- The bunkering operations of offshore Angola took into consideration the existing market structure. The new development of the market is not accessed.
- The strategies for bunkering development are based on a distance of 12 nautical miles off Angola coast.
- The author's knowledge is limited to the local Angola fuel oil market.
- Bunker consumption figures are based on estimates and theoretical assumptions.

- The data used for the chosen corporation is limited to the corporation's websites and email exchange.
- Market Strategy is generic and based on a literature review.
- The author faced several limitations when writing the dissertation. Especially limitations linked to the location of the author (Sweden) and the physical objective study location (Sub-Saharan West Africa region, in particular, Angola).
- Interviews as a means to collect primary data were part of the Author's initial plans. However, this type of research strategy was dismissed.
- Due to the difficulties in setting and arranging for an interview appointment,
- This research focuses more on the marketing side, product adaptation to different segment markets.
- For this study, the countries in the Sub-Saharan West Africa country are shown as red on the map below. They extend from Mauritania coast to Namibia Coast. They are named as follows: Mauritania, Senegal, Gambia, Guinea-Bissau, Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, Benin, Togo, Nigeria, Cameroon, Sierra Leone, Liberia, Ivory Coast, Ghana, Equatorial Guinea, Gabon, Congo, Angola, Namibia.

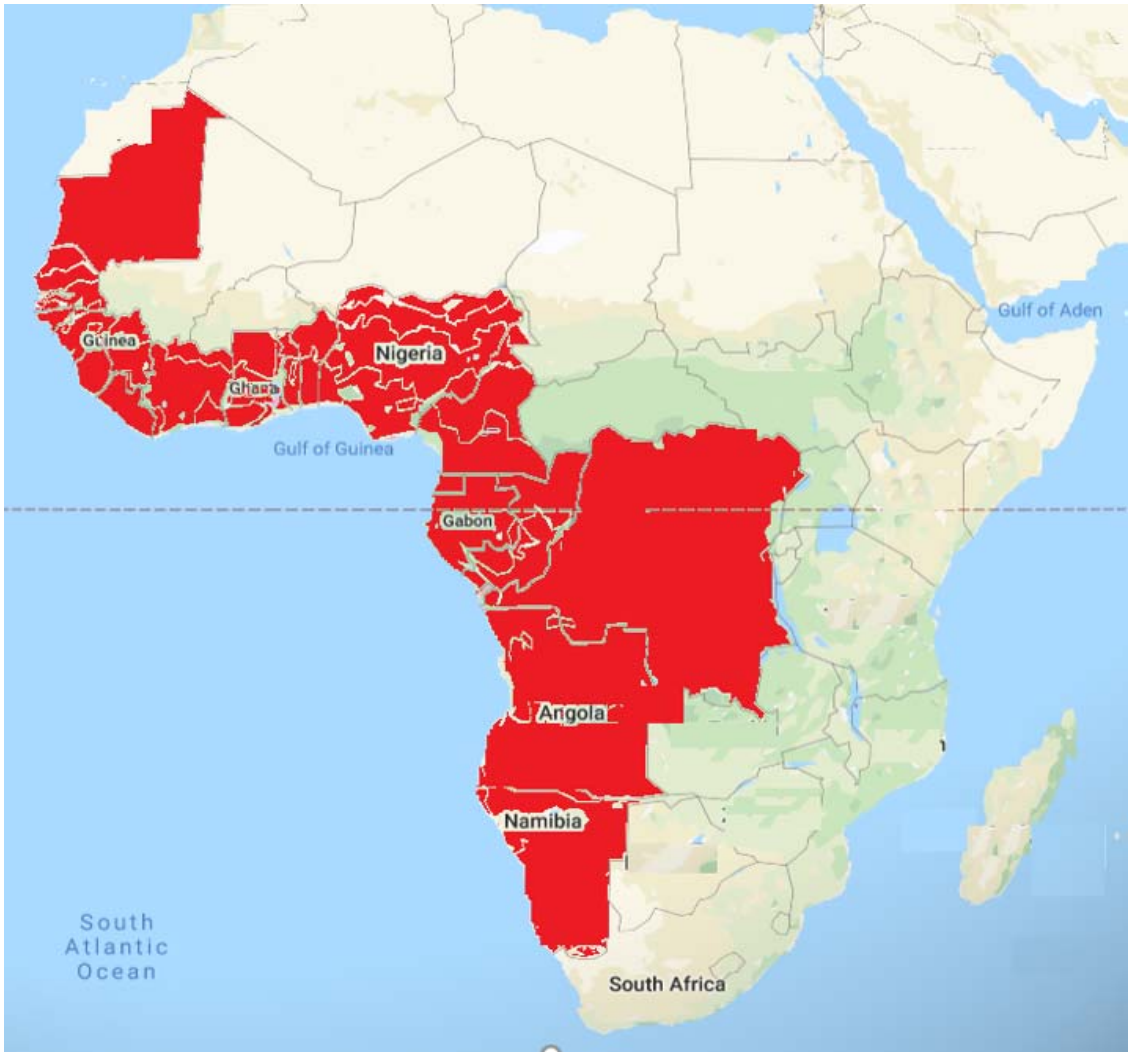


Figure 1: Sub-Saharan West Africa map.

Source: (Google Maps)

1.7.Summary of Findings

The results of this study revealed the following:

1. Factors affecting the selection of offshore fuel locations in the region.
   - Bunker quality and offshore location security and safety were ranked as the most critical factors.
   - Bunker quality services and bunker infrastructure were ranked as the least important factors.
2. Porter's five forces and SWOT analysis of the Angola offshore bunkering market.

- The upcoming 2020 Sulphur, the 2020 IMO Sulphur Cap, gives Angola offshore market competitive advantage in the West Africa region.
- The regulation provides to the Angola Offshore fuel industry an opportunity to increase its market share in West Africa. Since the local offshore market already delivers IMO compliant fuel.
- The product that gives a competitive advantage to Angola comparing with other offshore locations is the IFO 180 CST. The product is locally sourced, thus can be sold at a competitive price.

3. Sonangol Group Market Mix Framework.

- The offshore supplying bunker chain has the potential to increase its market shares. It can position itself as a bunker reference point in the region.

4. Case Study Market Mix.

- Target Market identification.
- Development of the strategies to increase Group Sonangol bunker market sales.

1.8.Outline of the Study

This study is structured as follows:

- Chapter 1: includes the introduction, background of the research, problem statement, value of the research objectives, research questions, and studies limitations and summary of findings.
- Chapter 2: provides a bunker market overview and literature review from different sources with a focus on market segmentation, market mix, and competitive factors affecting the selection of bunkers location.
- Chapter 3: describes the methodology used in the dissertation. It includes research, research purpose, research form, research sample, data collection, questionnaires Survey, Clarkson's Seanet, internal and external data, and Case Study selection.
- Chapter 4: includes questionnaire survey empirical results and descriptive analysis, Porter's five forces of Angola bunkering market, SWOT Analysis of Sonangol Group, Case study empirical results of the target market, and market

share by segment type. A summary of all results displayed in different forms and formats.

- Chapter 5: Discussion and Conclusion section includes factors affecting the selection of the offshore markets in West Africa, Porter five forces and SWOT analysis of Angola offshore bunkering Market, Sonangol Group market Mix, and a Case study using the IFO market product segment and three target customer segment type. The author used Porter's five forces and SWOT analysis to evaluate the Angola offshore bunker Market Structure as well as the internal and external factors affecting the market. Sonangol Group market mix was evaluated for IFO 180 CST. A case study was carried out to reveal the targeted market and the strategies to be developed post-2020 using the Market mix framework.
- Chapter 6: References
- Chapter 7: Appendices

Chapter 2 - Markets and Literature Review

2.1.Related Definitions

Marine fuels or Bunkers Oil are fuels used to power a ship, which consists of a mixture of petroleum-based oils (E.I.A, 2016).

Bunkering means replenishing a ship with bunker fuel.

De-Bunkering is the term commonly used for the process of offloading bunker poor quality fuel from ships that are unfit for use in the vessel's machinery. Such substandard bunkers occupy tank space that could otherwise be used for the right bunkers.

Bunker Supplier or Seller includes major Oil Company, large Independent Distributors, and small Independent Distributors.

Bunker End User or Consumers includes shipping industry fleet (Fishing vessels, Container vessels, Tanker vessels, General Cargo and Bulk vessels), and offshore vessels and installations.

Sulphur Dioxide is toxic, and thus, it is one of the major atmospheric pollutants. Sulphur dioxide is one of the voluminous gases emitted from a volcanic eruption. Nevertheless, around 99% of the Sulphur dioxide released atmosphere originates from anthropogenic sources (Department of the environment and energy, 2005).

The International Maritime Organization is the UN specialised agency accountable for setting worldwide standards for safety, security, and environmental pollution prevention measures, including air pollution prevention from the international shipping industry (IMO, 2014).

Sulphur Dioxide is toxic, and thus it is one of the major atmospheric pollutants. Sulphur dioxide is one of the voluminous gases emitted from a volcanic eruption.

2.2.Type of Fuels

As per the International Standards Organization (ISO) 8217, world-wide supplied for ships consumption are classified into two types:

- Distillate marine (DM) fuels
- Residual Marine (RM) fuels

The distillate fuels do not require any pre-heating for use in marine engines. They are further divided into seven fuel-grade categories. However, Residual fuels require heating for usage, and they are divided into six fuel-grade categories (ISO, 2017)

Depending upon the Sulphur content, the DM and RM fuels can be divided into two groups: Emission Control Areas (ECA) compliant (Less than 0.10%) and non-Compliant (More than 0.10%).

Marine fuel	Type	Sulphur content
Marine gas oils (MGO)	Distillate Marine fuel	0.10% min.-1.5% max.
Low Sulphur Marine Gas Oil (LS MGO)	Distillate Marine fuel	Less than 0.10%
High Sulphur fuel oil (HSFO)	Residual Marine fuel	0.10% min.- 3.5%max.
Ultra-low Sulphur fuel oil (ULSFO)	Residual Marine fuel	Less than 0.10%

Table 1: ECA/Non-ECA Compliant Fuels

Source: (The Danish Environmental Protection Agency, 2018)

2.3.Sulphur Emission from Vessels

The transportation sector is the principal consumer of oil globally, consuming about 46 MBD. The shipping sector represents 10% of the transportation sector's global oil consumption. However, the shipping industry is responsible for about 90% of global trade. Despite the industry's high transport share, the shipping industry consumes about 6 million barrels of oil every day. Also, it emits about 13 % of global Sulphur emissions (IMO, 2014).

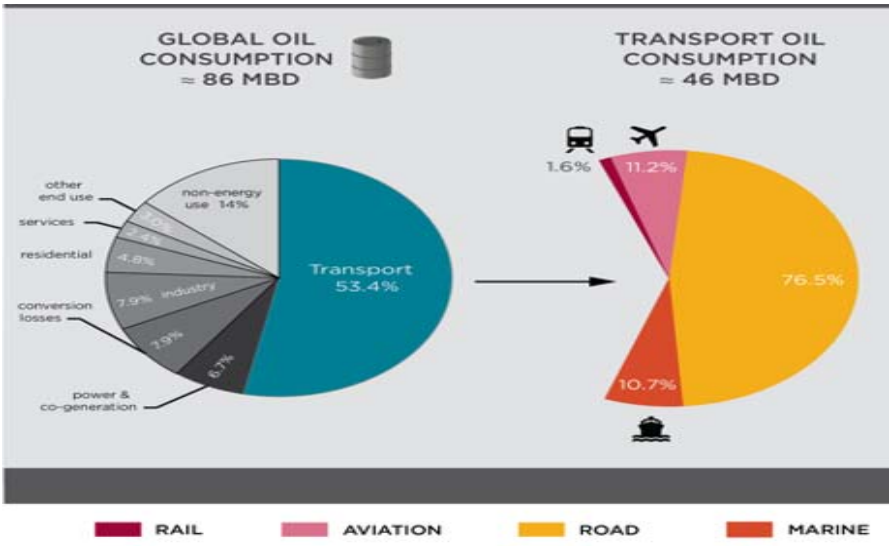


Figure 2: Transportation Sector Oil Consumption

Source: (IEA, 2011)

2.4.The IMO Fuel Sulphur Regulation

Since 1960 the IMO has been engaged in reducing harmful environmental impacts of the shipping industry.

The first IMO global Sulphur Cap regulation came into force under MARPOL Annex VI, in 2005. It consisted of decreasing the emissions of Sulphur oxides (SOx) from shipping. The regulation capped the content of Sulphur in the marine bunker's fuels to 4.5% m/m.

The second IMO global Sulphur Cap came into force in 2012. The regulation further reduced the Sulphur oxides emissions from shipping. It cut the worldwide Sulphur content from 4.5% to 3.5% m/m in the marine fuels.

The third worldwide Sulphur Cap will come into force in January 2020. The content of Sulphur in the marine fuels globally shall not surpass 0.50% m/m, for ships operating outside nominated emission control areas. This measure will dramatically decrease the quantity of Sulphur oxide from the shipping industry. It will also provide the main environmental and health benefits for the world's population, notably, for people living close to coastal areas and ports.

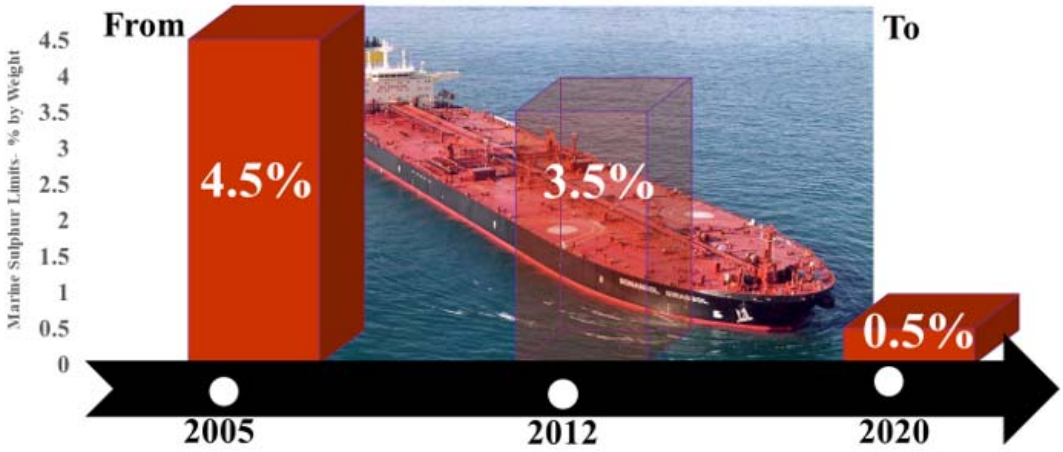


Figure 3: Global Sulphur Cap timeline

Source: (IMO, 2014)

2.5.IMO 2020 impact on Bunker Market

IMO's new regulation will have a disruptive outcome across the bunker supply chain. Some of the market participants will benefit, while others will struggle. It will impact the current global 3.5% Sulphur bunker fuel markets. The market bunker fuel mix will include the following:

- Very Low Sulphur Oil with a maximum Sulphur content of 0.5% (VLSO).
- LNG
- All the types of grades of vegetable and animal-based biofuels.
- Methanol
- Mineral oils,
- Ethane,
- Battery power,
- Hydrogen.

The number of products will increase, and it will need extra storage space. Therefore, bunkers suppliers will be required to reconfigure the existing available space or to find a new way to increase the storage area since these fuels cannot be mixed.

The regulation will affect more than 70,000 ships (DNV,2018). It will change the demand and supply balance between HSFO and VLSFO. Consequently, the price gap between the two-oil type will grow.

The new regulation is likely to change the customer's product demand profile. It will be an issue, considering that most of the sales of the bunker fuels are made on a credit basis. Consequently, the supplier's reply for credit risk may include the following:

- Reducing payment terms,
- Diversifying customer base,
- Increasing customer credit lines,
- Other credit management solutions.

The regulations will affect the profitability of the refiners; thus, the best equipped and prepared refiners will benefit from it.

2.5.1.Sulphur Cap compliance options for the Demand Side

The demand side includes Shipping companies (ship operators/owners). For the 2020 deadline, the demand side has available the following choices:

1. Using compliant blends of fuel (0.50% Sulphur) or VLSFO
2. Switching from HSFO to MGO or distillates
3. Retrofitting ships for alternative fuels (Liquified Natural Gas or other sulphur-free fuels)
4. Installation of scrubbers or systems of exhaust gas cleaning in order to use regular HSFO (KPMG, 2018).

2.5.2.Compliance Option for the Supply-side

The supply side includes refineries, oil majors, fuel traders, and resellers. For the 2020 deadline, some of the available options to comply with Sulphur Cap regulation are as follows:

1. Providing High-Sulphur fuel to vessel only installed fitted the exhaust gas cleaning systems
2. Switching to 0.5% compliant fuel or compliant fuel blends from 2020 onwards
3. Investment in new infrastructure or Infrastructure reconfiguration. It includes a refinery upgrade or building a new refinery to reduce the overall production of HSFO.
4. Investment in new storage space or reconfiguration of the existing storage space.

5. Investment in a new transportation system, including includes new barges.

2.6.Global Bunker Fuel Market

Fisher et al. (2004) estimated the global bunker market to be around 140 million tonnes per year. Different types of bunker are traded all over the world and often, sold in a country far away from their origins (Fisher et al., 2004).

The global bunker supply is dominated by fossil fuels, with oil being the most significant one. The residual high Sulphur fuel oil dominates the global oil product bunker market. It accounts for about 80% of the marine bunkers fuel mix (International Energy Agency, 2017).

2.6.1.Bunker Quality

Bunker quality depends on a variety of factors including density, water contents, carbon residue, vanadium, aluminium, silicon, total sediment, viscosity, the ash point, pour point, energy content, Sulphur (Fisher et al., 2004). Thus, the bunker fuel quality for the international shipping industry must meet the regulatory standards, including ISO 8217, MARPOL Annex VI, and other specifications.

The causes and consequences of bunker fuel of poor quality are various. Unusual non-petroleum contaminants, Poor blending practice, and deviations from specified ISO 8217 standard trigger bunker fuel defects.

A local blending of bunkers gives more room for quality discrepancies as compared to importing bunkers in finished form. Fraud and negligence also affect bunker quality.

Poor bunker quality also affects the environment due to the release of high carbon and Sulphur dioxide to the atmosphere.

2.6.2. Bunker Price

The bunker price is strongly correlated with crude oil prices. As bunker rates fluctuate as a result of crude oil price fluctuations (UNTACD, 2010). Nevertheless, the location or bunkering port also affects the bunker price. Different ports in the world have different bunker prices due to different factors. These factors include the following:

- The Market structures. Whether a monopoly or an open competition, the local bunker market structure significantly affects bunker price levels (Lam et al., 2011).

- Different fiscal policies across countries (UNTACD, 2010).
- Trading volumes as large trading volumes lower the price due to economies of scale (Lam et al., 2011).
- Storage as large storage volumes smoothes the fluctuations of price by acting as buffers to the uncertainties in demand and supply (Lam et al., 2011).
- Imported bunkers. Locally produced bunkers are cheaper than imported bunkers. Thus, the higher the volume of imported bunkers in the local market, the higher the price level (Lam et al., 2011).
- Traders and Brokers. The existence of both physical and derivatives bunker traders and brokers help make the market more efficient and increase the market size. Thus lowering the bunker price (Lam et al., 2011).

2.7.Regional Bunker Market

The worldwide bunker fuel market is fragmented into geographical regions. The regional demand for oil for marine bunkers is concentrated in a few nations. In 2012, six countries such as Singapore, the UAE, Netherlands, the US, China, and South Korea represented more than 60% of the world's bunker demand.

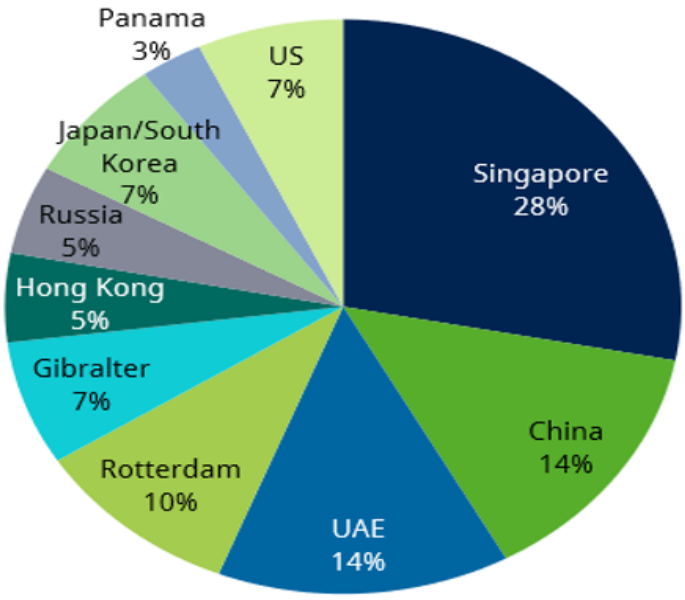


Figure 4: Global Bunker Market Supply Concentration

Source: (Schroeders, 2018)

There are approximately 400 main bunkering ports in the World. These ports are situated near high-density shipping lanes, and closer to refineries to ensure a constant supply of fuel. The port of Singapore, with total bunkers sales of 49,8 million tonnes, is the world's largest vessel refuelling centre by volume (MPA, 2019). Bunkers sales for the port of Singapore have been growing increasingly because it is suitably located along one of the major and busiest vessel routes in the world.

2.8.West Africa Bunker Market

The bunkering industry in West Africa has been developing steadily for decades due to demand from the shipping and oil and gas sectors. The West Africa region is strategically located to benefit international trade routes. The bunkers suppliers in the region can benefit from ships coming from the Northern Atlantic direction but heading East via Cape of Good Hope and vice-Versa. The region can also supply bunkers to a vessel coming from Europe and heading to South America and vice-versa. However, the locations of the bunkering area in the region vary as well as the competition levels among them. The services offered by each market varies according to the following:

- Fuel delivery location such as international waters, territorial waters, or port.
- Type of customers such as international vessels, coastal/domestic vessels, or inland vessels.

2.8.1.Refineries in West Africa

Oil refineries are responsible for converting crude oils into fuel products, lubricating oils, bitumen, and chemical feedstocks. Before 1954 there were no refineries in Africa. All refined products supplied to African came from European and American refineries. In 1958 the first Sub-Sharan Western African refineries were built in Luanda. Subsequently, refineries in Ghana and Senegal emerged in 1963.

All the refineries in the region are basically of the topping/reforming type, except for the refineries in South Africa, Nigeria, in Cote d'Ivoire, and Ghana (Mbendi, 2019)

The main refining centres in Africa are in South Africa and Nigeria (ICF, 2009) (Appendix 1: Sub-Saharan Africa Refineries).

2.9.Offshore West Africa Bunker Market

The offshore service in the West region has energised the local market. The bunker deliveries are carried out by small tankers or barge at OPL location within the nation's territorial or international water. These practices have enabled bunkers suppliers to offer significantly lower calling costs. It also has enabled them to sell an imported product rather than locally sourced products. The offshore bunker markets in West Africa are estimated to sell around 120,000-150,000 tonnes per month to vessels in the region (IBIA, 2016).

2.10.Offshore West Africa Bunker Suppliers

The market has an oligopoly structure, dominated by a small number of firms. Most of the bunkers sold at west Africa offshore locations are not produced in the regions. The bunker products are sourced from the East and the European markets. The local bunker market requires massive capital investment, experience, and professionalism. In that context, local companies have been displaced by international operators. Therefore, the offshore bunker market in Sub-Saharan West Africa is dominated by offshore European. These operators are delivering higher standards of service.

The offshore bunker market very dynamic, with constant changes in suppliers' companies. Several companies have exited the bunker market in West Africa. Mainly due to increased levels of piracy, hijackings, and cargo theft in the area.

Monjasa is currently the leading physical supplier for end-users in the region, delivering around 120,000 MT of bunkers every month (Monjasa, 2016). The company has a contract with Geneva-based trading house Trafigura (Shipping watch, 2014). Other companies operating the market include Trafigura, Addax & SK B&T, Vitol, Total, and Minerva Bunkers.

2.11.Angola Offshore Bunker Market Overview

Angolan bunker industry is a Monopoly Market dominated by the oil State company "Group Sonangol." Around 43,000 tons of bunker fuel are monthly delivered locally to commercial ships, ships servicing the offshore industry, and fishing fleet. The bunker market is divided into two segments: residual fuel and distillates. The residual

fuel oil market is denoted by one grade, the IFO 180 CST, while the distillate also has one grade, the MGO.

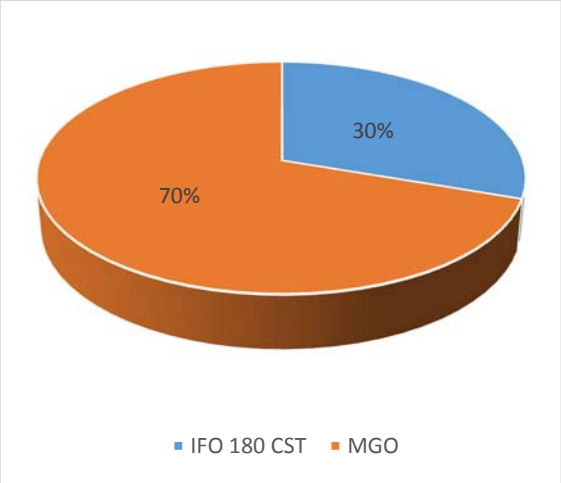


Figure 5: Angolan Bunker Products

Source: (Sonangol Distribution, 2019)

2.11.1. Group Sonangol

The Group Sonangol is a state-owned enterprise that oversees petroleum and natural gas production in Angola. The Group has over 30 subsidiaries. Each subsidiary is an independent business unit with its management. However, Sonangol E.P. The holding company has ultimate control over all the subsidiaries. Some of the principal subsidiaries are Sonangol refinery, Sonangol Distribution, and Sonangol Shipping. The Group maintains overseas facilities in cities such as:

- London, UK
- Houston, US
- Brazzaville, Congo
- Hong Kong
- Singapore.

Sonangol Group is one of the principal shareholders of the Portuguese energy company (Galp Energia), holding one-third of the company's shares.

In 2012 Sonangol won the right to develop Iraq's Najmah oilfield. In 2018, Sonangol announced the reactivation of the Iraqi oil exploration fields in Najma and Qayara after years of closure due to armed conflicts.

2.11.2. Angola OPL Locations

The bunkering delivery in Angola for the offshore market takes mainly place at the following offshore location:

- Cabinda
- Soyo
- Block 17
- Luanda Bay
- Lobito Bay
- Namibe

Figure 6: Angola OPL Distribution Map

As per Angola Law, bunker delivery can take place anywhere within the country's territorial waters up to EEZ (Diario da Republica No. 72, 2017). However, due to operational challenges and conditions of the sea state, the bunkering deliver happens

only within 12 miles of the coast. The only exception is the bunker delivery at block 17, where bunkering takes place more than 12 miles from shore. However, for that, the bunker delivery is done by a vessel with DP 1 feature.

2.11.3. Operational Model of the Offshore Bunkering System

The offshore bunker operation is done within 12 nautical miles from the Shore. This due to the condition of the sea state and other operational challenges. The bunkering supplying fleet of the Group Sonangol comprises of the following:

- Four chemical tankers, ranging between 5, 000 to 17,000 deadweight
- A floating Storage with a capacity of 130,000 MT.

The entire bunkering operation is controlled from Luanda (operation & scheduling, sales, and inventory management). The mother vessel of 130, 000 MT deadweight is kept in Luanda as floating storage. The rest of the fleet units are used to deliver bunkers to all offshore location in the country as follows:

Node L1 (Luanda - Cabinda): A mobile supplying unit does all the bunkers delivery. The unit supplies offshore Cabinda as well as the Luanda Bay. The mobile unit resupplies in Luanda from time to time.

Node L2 (Luanda - Soyo): two units are used for bunkering delivery. One is kept as temporary Storage off Soyo, while the other unit with DP1 capability is kept as a mobile unit. Thus, supplying vessels at the offshore Block 17 area and Soyo. Both bunkers units take their resupplies in Luanda from time to time.

Node L3 (Luanda -Lobito-Namibe): A unit mobile unit is used to deliver bunkers in Lobito bay, Namibe offshore, and Luanda Bay. The resupply of the unit is done in Luanda from time to time.

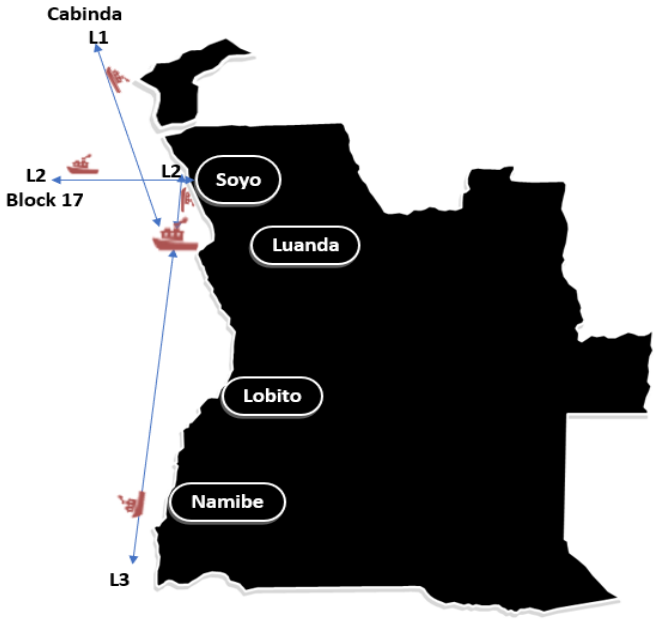


Figure 7: Angola bunkering Supply Structure

2.11.4. Current Perspectives of the Angola Offshore bunker Market

Sonangol Group is the only company allowed to import and export fuels for the bunker market in Angola. The Group acts as suppliers for both local bunkers' distributors companies and end-users or vessels. The market Structure has prevented international trading and physical bunkering companies from entering the market. Thus, as a result, some of the international leading bunker trading company such as Trafigura, Vitol, Mercuria, and physical bunker suppliers such as Monjasa, and Addax, have set up business in other sub-Saharan countries.

2.11.5. Maritime Indicators-Merchant Fleet & National Flag

In terms of Merchant fleet, national flag (thousands of DWT) among 20 Western countries, Angola ranks a number 7 (UNTACD, 2017).

(Annex 2- West Africa Merchant Fleet and National Flag per country)

Source: (UNTACD, Countries profile 2017)

2.11.6. Liner shipping connectivity index

Regarding the Liner shipping connectivity index, Angola ranks as a second country (UNTACD, 2017).

(Annex 3- West Africa liner Shipping index per country)

2.12.Maritime Security

Maritime security includes several interconnected sub-fields. One of the subfields deals with maritime security piracy. Modern-day piracy includes armed robbery, hijacking of ships, with a focus on kidnapping and ransom payments. Currently, two regions in the word that troubled by maritime piracy are as follows:

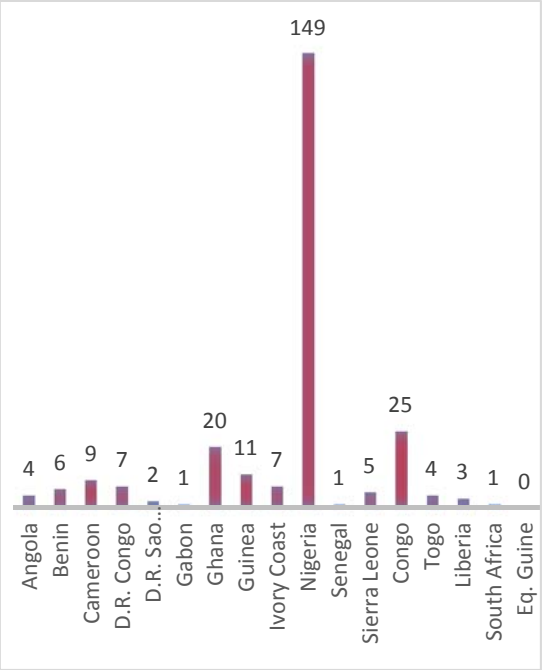
- The Gulf of Aden to East Africa
- The Gulf of Guinea to the West.

Piracy affects national and regional and international waters. It is a threat to the regional and global economy.

2.12.1. Sub-Saharan West Africa Maritime Security

The Sub-Saharan West Africa region is adversely by piracy. The offshore bunker market in the Africa region struggles with security issues, including piracy and armed robbery. The West Africa prone areas for piracy and armed robbery include Benin, Cameroon, Equatorial Guinea, Ghana, Guinea, Ivory Coast, Nigeria, Togo, and Congo (ICC IMB, 2019).

Period 2014-2018



Period 2019 Jan-June

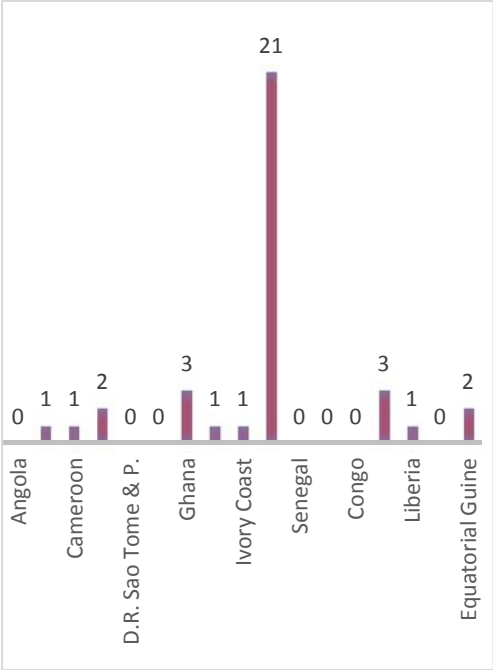


Figure 8: South and West Africa-Piracy and armed robbery by number

Source: (ICC IMB, 2019)

2.13. Framework Theories.

2.13.1. Porter Five Forces

It helps to understand the competitive environment of an industry.

- The power and numbers of competitive business rivals
- The potential new market entrants,
- The suppliers in the industry
- The customers in the industry
- Substitute products that influence business profitability.

Michael Porter first introduced this concept in 1979. It consists of five forces analysis. These forces help businesses to assess industry attractiveness. To understand how trends affect industry competition, in and finally, how a firm can position itself to succeed in the market (HBS, 2018).

2.13.2. SWOT Analysis

It is an analytical and strategic tool that allows the assessment of business strengths and weaknesses. Also, it allows analysing the business opportunities available and the threats the business faces.

2.13.3. Market Mix

It helps to understand what the product or service can be offered and how to plan for a successful product offering. The marketing mix is implemented through the use of 4 P of marketing: Price, Product, Promotion, and Place.

2.13.3.1. Product

It involves an offering of any item to buyers for consumption.

Three crucial as an aspect needs to be considered when placing a product on the market:

- Product design
- Product quality
- Product features (Szwejkowska et al., 2007).

2.13.3.2. Price

It is the only part of the mix, which generates a turnover for the organisation.

Pricing strategies include the following:

- Penetration pricing
- Skimming pricing
- Competition pricing
- Product Line.
- Bundle Pricing
- Psychological pricing
- Premium pricing
- Optional pricing
- Geographical pricing (Szwejkowska et al., 2007).

2.13.3.3. Promotion

It involves various delivery mechanisms for advertisement. It includes banners, billboards, internet websites, logos on clothing, magazines, newspapers, radio spots, and television commercials. It also includes direct response, public relations, and personal selling (Szwejkowska et al., 2007).

2.13.3.4. Place

It includes two types of distribution, indirect distribution, and direct distribution (Szwejkowska et al., 2007).

2.14. Literature Review

Market segmentation has been discussed by scholars such as Kotler & Armstrong (2001). They highlighted that business markets could be segmented geographically or demographically (Industry, company size). Market segmentation allows the marketer to understand the unique needs of customer segments. In turn, it allows the business to focus on product development efforts such as:

- Product pricing
- Selection of appropriate distribution channels
- Develop advertising messages that will appeal to the target market.

Brassington and Pettitt (1997), studies discussed two growth strategies, namely market penetration and market development. These two strategies can be used to increase market share for the same product. Market penetration is increasing sales volume to current markets using more aggressive marketing. It is done by using the marketing mix to achieve higher volumes of sales. Market development is selling more of existing products to new markets, and this could be geographical or opening more use of the same products but for different use.

Other Scholars wrote literature on bunkering ports and discussed competitive factors that determine bunkering port selection. Acosta et al. (2011) explored twenty factors affecting bunkering competitiveness of the ports of Gibraltar, Ceuta, and Algeciras. From their analysis, it was determined the fuel prices, together with geographical advantage, were the most critical factors. Aronietis et al. (2017), studies for the port of Antwerp, evaluated shipping lines bunkering preferences by using a discrete choice experiment. The author concluded that the essential attributes of the bunkering choice are the fuel price and the trust for the correct bunker quality and quantity. Lam et al. (2011) identified ten attributes for the selection of a bunkering port when assessing the competitiveness of ports of Singapore and Shanghai as a bunker Hub. From their analysis, the three most important attributes are bunker quality, market transparency, and bunker price.

A set of market-related factors also influences the choice of where to bunker along the route. These factors include the diversion distance from the main shipping route, the nautical accessibility of the port and the ship cargo intake maximisation.

Yao et al. (2011), when studying the bunker fuel management strategy for a single shipping line company, concluded that all these three elements (where to bunker, how much and speed adjustment along the service route) are interrelated. Thus, the development of bunker fuel management strategy such as where to bunker, how much and speed adjustment is vital for a shipping company.

According to the International Energy Agency (2014), the global bunker market is distributed as follows: Europe 34%, Asia 31%, America 22%, Middle East 8%, and Africa 5%. Thus, the distribution of the bunker's ports varies per region around the

world. In fact, as per OPEC (2014), the three largest bunkering ports in the world, Singapore, Fujairah (UAE), and Rotterdam (Netherlands), account for around one-third of the total marine bunker fuel consumed in the world (WOO, 2014). Africa and West Africa region struggles with bunker delivery infrastructures, which are often underdeveloped. In turn, the Western Africa market has become Unattractive for bunker call (IBIA, 2016). Volkering et al. (2015), studies for the port of Rotterdam concluded that the bunkering at sea concept is a valid concept, and it is already applied worldwide. Particularly in sheltered waters, such as anchorage at Singapore; port of Gibraltar in; and the Panama Canal. Notteboom & Rodrigues (2005) highlighted that regionalisation is an essential concept for ports that traditionally have been focusing on themselves. They stated that regionalisation represents a new stage of port system development. This concept is also valid for the offshore bunker market; thus, regionalisation is beneficial for bunker market growth.

2.15. Research Gap and Contribution

For the studies on the feasibility of the Hub and spoke principle for the LNG supply Northwest Europe Kajal Festen (2009) concluded that offshore installation could serve as an alternative to overcome infrastructure underdevelopment or geographical constraint. Whereas per Volkering et al. (2015), for the port of Rotterdam, studies, highlighted that the offshore bunkering supply area is an adopted concept worldwide, and it is mainly applied in sheltered waters.

Scholars have not addressed offshore bunkering, bunkering at sea, or development of marine bunkering systems in Western Africa.

Shipping chooses their bunker ports basis on small price differentials. For instance, the effect of increased bunker costs on liner services has been investigated by Notteboom and Vernimmen (2008). The competitive factors affecting bunker, port selection have been studied by many scholars in regards to Europe and Asia regions. Acosta et al. (2011), focused on the supply side of the bunkering operations southern part of Spain. Aronietis et al. (2017), focused on demand-side regarding the Port of Antwerp. Lam et al. (2011), focused on the demand side in South East Asia and far east regions. Wang et al. (2014), focused on the container industry for the Eastern

Asian regions. Although most of the factors on bunkering choice factors are common, however, the order changes vary as per the geographic location, and the targeted audience. Thus, Africa or the West Africa region has not been included in the studies. From the literature review, it can be concluded that former bunker's studies do not include Africa or West Africa region.

This research gives an overall view of the offshore bunker market in Sub-Saharan West Africa, particularly Angola OPL. It focuses on identifying competitive factors for the selection of the offshore location in West Africa. It discusses the importance of the bunker factors for the development of the Offshore bunkering Market in Angola, market towards a hub in the West Africa region.

Chapter 3 – Methodology

3.1.Introduction

This chapter covers research design, population sample, data collection, and research analysis.

3.2.Research Design

It includes the research purpose, research form, and the research sample.

3.2.1.Research Purpose.

A research purpose can be classified as exploratory, descriptive, and explanatory (Saunders et al., 2009).

- The exploratory study seeks for new insights and approaches the phenomena or problem from a new perspective. It asks the question of what is happening, evaluating the problem in a new light (Saunders et al., 2009).
- The descriptive study, when applied, portrays the phenomena or problem accurately. It requires extensive previous knowledge of the problem to be described or researched. It could be an extension of or a piece of exploratory research (Robson, 2002).
- The explanatory study seeks an explanation of the situation or problem traditionally. It identifies the relationship between aspects of the phenomenon. It explains patterns relating to the phenomenon being researched (Robson, 2002).

This thesis uses two approaches, exploratory and descriptive. Both categories will ensure the capture of all the relevant factors about the development of the offshore bunkering market in Angola post-2020.

3.2.2.Research form.

Exploratory and descriptive approaches designs are supported by qualitative and quantitative research form.

Qualitative research offers understanding and insights into the problem setting (Malhotra, 1999). The approach is characterised by its unstructured form of data collection. It also characterised by maintaining close contact with the source of

information gathered. The approach is useful when the researcher is looking for an understanding of the phenomenon. Thus, by asking questions such as how and why. In opposite, quantitative research is well structured and formalised. The approach seeks to quantify the data and applies some form of statistical analysis (Malhotra, 1999). It is a useful approach as it provides answers to questions such as when, who, how much.

Development of the offshore bunkering market in Angola involves the following:

- Understanding the factors affecting market growth locally and regionally.
- Development of strategies in order to increase market shares, both locally and regionally.

This thesis uses qualitative and quantitative approaches. The aim of using them both types is to ensure the research questions are answered.

3.2.3.Research Sample

Sampling comes in two forms, namely, probability or representative sampling, and non-probability, or judgmental sampling.

For probability samples, the chance of each case being selected from the population is known and is usually equal for all cases.

For non-probability samples, the chances of each case being selected from the total population are not known (Saunders at al., 2009).

For this thesis, the probability or representative sampling was chosen as the sampling technique. The author used stratified random sampling to form the population sample of the research. The stratified random sampling divides the population into two or more relevant and significant strata based on one or several attributes (Saunders et al., 2009).

The sampling frame of the primary data consisted of bunker demand-side companies. The categories of the companies surveyed were as follows:

- Ship-Owner
- Commercial Manager
- Technical Manager
- Ship Operator

- Bunker Broker

The population sample for secondary data consisted of a company in the bunker supply chain. The company studied is a multi-national enterprise with different business segmentation.

3.3.Data Collection

Primary and secondary data are two kinds of data used in research work (Malhotra, 1999).

Primary data are created by a researcher to be used for a specific purpose. This kind of data is time-consuming and often expensive. According to Ghauri et al. (1995), surveys and questionnaires are the most popular method of collecting primary data in business studies.

Secondary are data that have previously been gathered and can be accessed by researchers. The data may serve other purposes rather than merely answering the researcher's problem. However, secondary data can sometimes answer or partially answer the research questions (Saunders et al., 2009). This kind of data can be easily obtained and are not expensive.

This thesis uses both types of data, primary and secondary. The strategies used to obtain both data are described below.

3.3.1.Questionnaire Survey

The questionnaire survey is one of the collections techniques used to extract primary data from the population sample. To collect the information from the companies in the survey, the author used Microsoft 365 form survey. The Microsoft form survey is a free online survey service provided by Microsoft. The created structured questionnaire was written in the English language. The questionnaire consisted of one question with eight factors affecting the selection of offshore locations in West Africa using a five-point Likert scale (Appendix 5:Microsoft 365 Survey Form). A link to the questionnaire survey was sent out by emails to thirty selected companies. The thirty companies surveyed were from different sizes and nature but operating ships of various types and sizes in the WAF region.

The participants on the survey were asked to rate the importance of the factors on a magnitude of 1 (not important at all) to 5 (very important). Successful completion of the questionnaire by responded updated the original questionnaire automatically.

3.3.2.Clarkson Seanet.

Clarkson's Seanet was the other strategy used to collect primary. The tool is an online ship tracking system. With the help of a username and a password, the author was able to obtain the following information:

- Vessel counts (all/each type) in Angola national waters up to 36 months period
- Vessel counts (all/each type) in the West Africa region up to 36 months period
- Vessel counts (all/each type) in each of countries national waters of Sub-Saharan West Africa up to 36 months.
- Top 10 top owners for the vessel counts in Angola national waters up to 36 months period.
- Top 10 top owners for the vessel counts in each of the country's national waters of Sub-Saharan West Africa up to 36 months.

From the Database, it was possible to obtain information regarding the total number of vessels by type globally.

3.3.3. Internal and External Data

Churchill and Iacobucci (2005), divide secondary data into two types, namely, internal and external data. Internal data is originated within the firm, and external outside the company.

In this dissertation, the internal data consists of the company’s annual report, emails, operational documents, presentations, and data obtained from the company’s web sites.

The external consisted of documentation from third-party and legal institutions in the country. The author also used the Google search engine to find related publications of interest.

3.4.Case Study Selection

The case study is limited to one product supplied at Angola offshore bunkering market and to three targeted shipping groups (Appendix 6- Targeted Vessels Group Count).

Primary data used for the case study was obtained from Clarkson's Seanet. Secondary data used includes consisted of internal data from the Group Sonangol.

3.5.Data Analysis

The data analysis for the primary and secondary data was carried as follows:

3.5.1.Questionnaire survey

Survey and questionnaire tools enable researchers to collect and analyse data quantitatively. Especially when using descriptive and inferential statistics (Saunders, Lewis, and Thornhill, 2009).

The author used Microsoft 365 survey form to analyse the primary data. The data consisted of factors affecting the selection of offshore bunkering location in WAF.

The created Microsoft 365 survey questionnaire carried out two functions:

It automatically analysed the data on the received questionnaire from the respondents.

It automatically displayed the average number of each factor surveyed. However, the data were also analysed further by using descriptive statistics such as mean and standard deviation. Then, analyses result presented through charts and tables.

3.5.2.Framework Analysis

The secondary data analysis was done with the help of frameworks such as Porter 5 forces and SWOT analysis and Market Mix framework. These theories allowed the author to identify the structure of the market, the internal and external factors, and the market mix of the Angola offshore bunkering market.

3.5.3.Case Study Analysis

A researcher preparing a case study can choose between two general analytical strategies:

- Theoretical propositions
- A case description.

The theoretical propositions are the most commonly used strategy. It is based on research questions taken from previous studies. A case description is less common and is used when little of the previous research has been done (Yin, 1994).

The data analysis for the case study was made using a case description. The primary data was obtained from Clarkson's Seanet database. The secondary data was obtained from external documents, books, publications from other authors.

Chapter 4 – Findings

This chapter covers the following:

- Empirical Results and descriptive Analysis of the Questionnaire survey for the factors affecting the selection of offshore bunker locations in Sub-Saharan West Africa.
- Porter Five Forces - Angola Bunker Industry
- SWOT Analysis Sonangol Group (Bunkering)
- Market Mix of the Sonangol Group (Bunkering)

4.1.Empirical Results and descriptive Analysis of the Questionnaire Survey

Factors	**Average Score Ranking**	**Standard Deviation**	**Mean**
Offshore or Anchorage Location Security and Safety.	1	0.65	4.56
Bunker Quality.	2	0.71	4.48
Bunker Price.	3	0.76	4.4
Reliability and Punctuality of Bunker Suppliers	3	0.71	4.4
Availability of Low-Sulphur Bunkers or other IMO 2020 Compliant Fuels	4	1.01	4.24
Geographical Location.	5	0.71	4.2
Quality of Bunkering Services	6	0.95	4.08
Bunker Infrastructure	7	0.73	3.96

Table 2: Factors Scores and Ranking of WAF Offshore Bunkering Location.

4.2. Porter Five Forces - Angola Bunker Industry

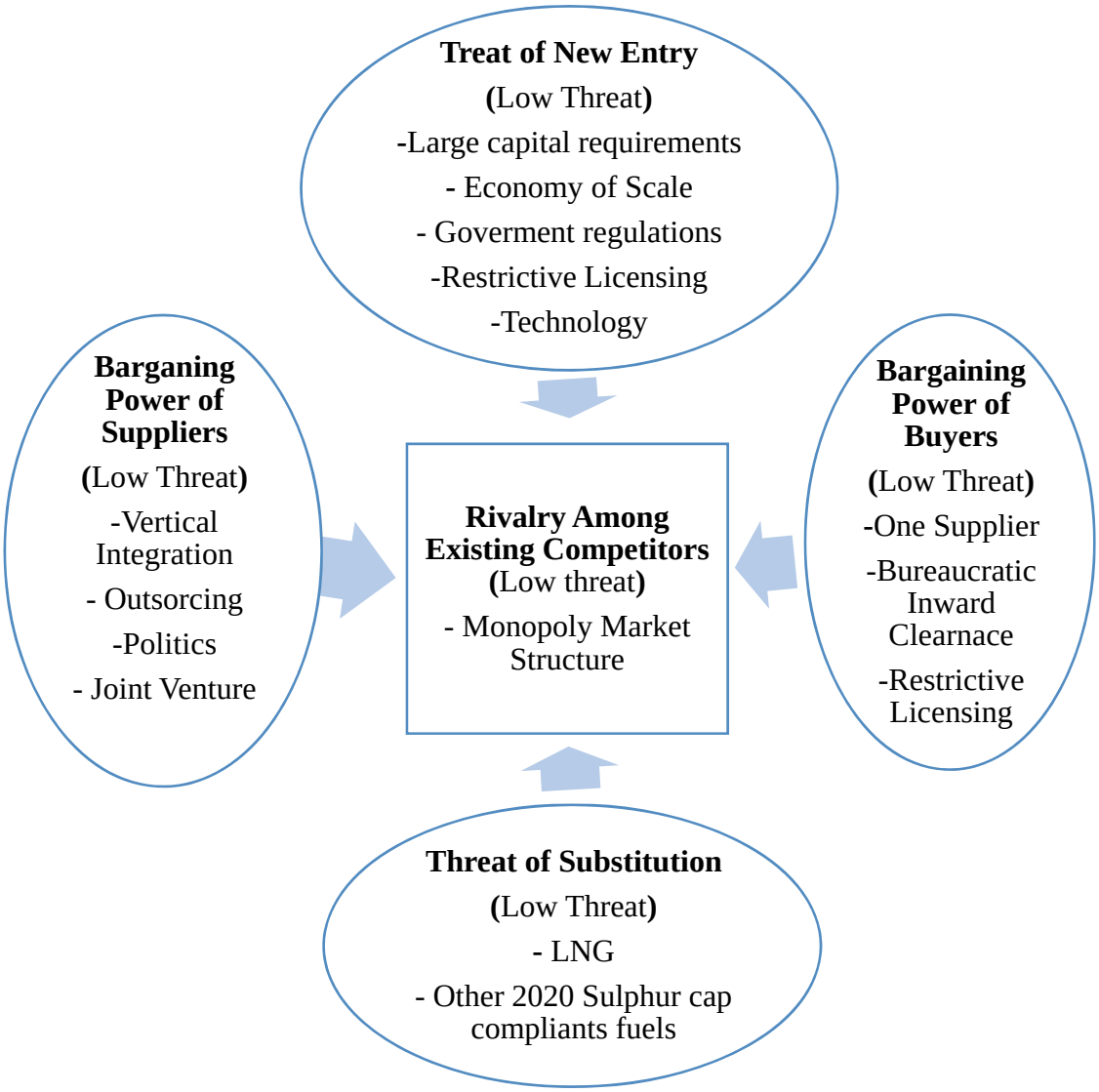


Figure 9: Porter Five Forces

Source: (Porter, 1985)

4.3. SWOT Analysis- Sonangol Group (Bunkering)

Strengths
• Geographical position • Refinery (Luanda refinery) • Bunker Fuels ISO 8217 Compliant • Integrated Operations • Availability of Sulphur fuel less than 0.5% m/m • Secure and Safe OPL bunkering location • Huge brand and good reputation
Weaknesses
• High bunkering fuel prices. • Limited diversity of Bunker Products • Limited storage capacity • Monopolistic Market • Selling of Sulphur fuel less than 0.5% m/m as cargo to international markets
Opportunities
• 2020 IMO Sulphur Cap • Angola oil Sector Reform Process • Construction of New Refinery
Threats
• Government and Environmental regulations • Market Liberalization • Global economy Slowdown

Table 3: SWOT Analysis

4.4. Market Mix- Sonangol Group (Bunkering)

Figure 10: 4 P Market Mix

4.5. Case Study

4.5.1.Target Audience by Vessel group type

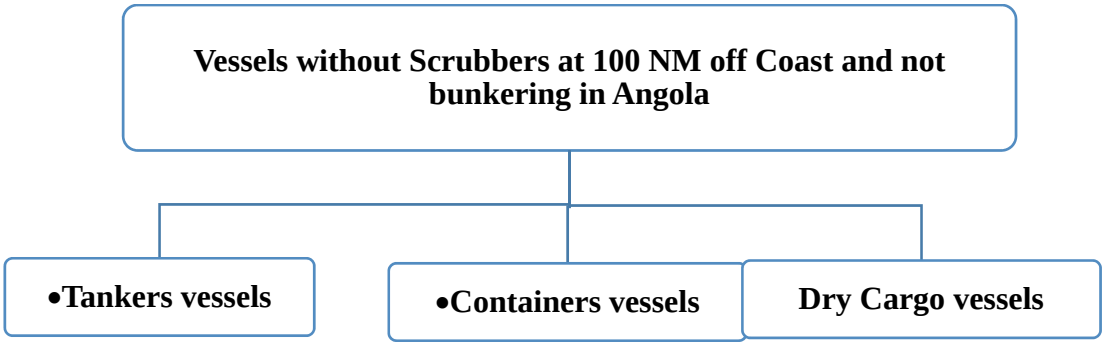


Figure 11:Target Audience by Group Type

4.5.2.Market Mix Post 2020- Sonangol Group (Bunkering)

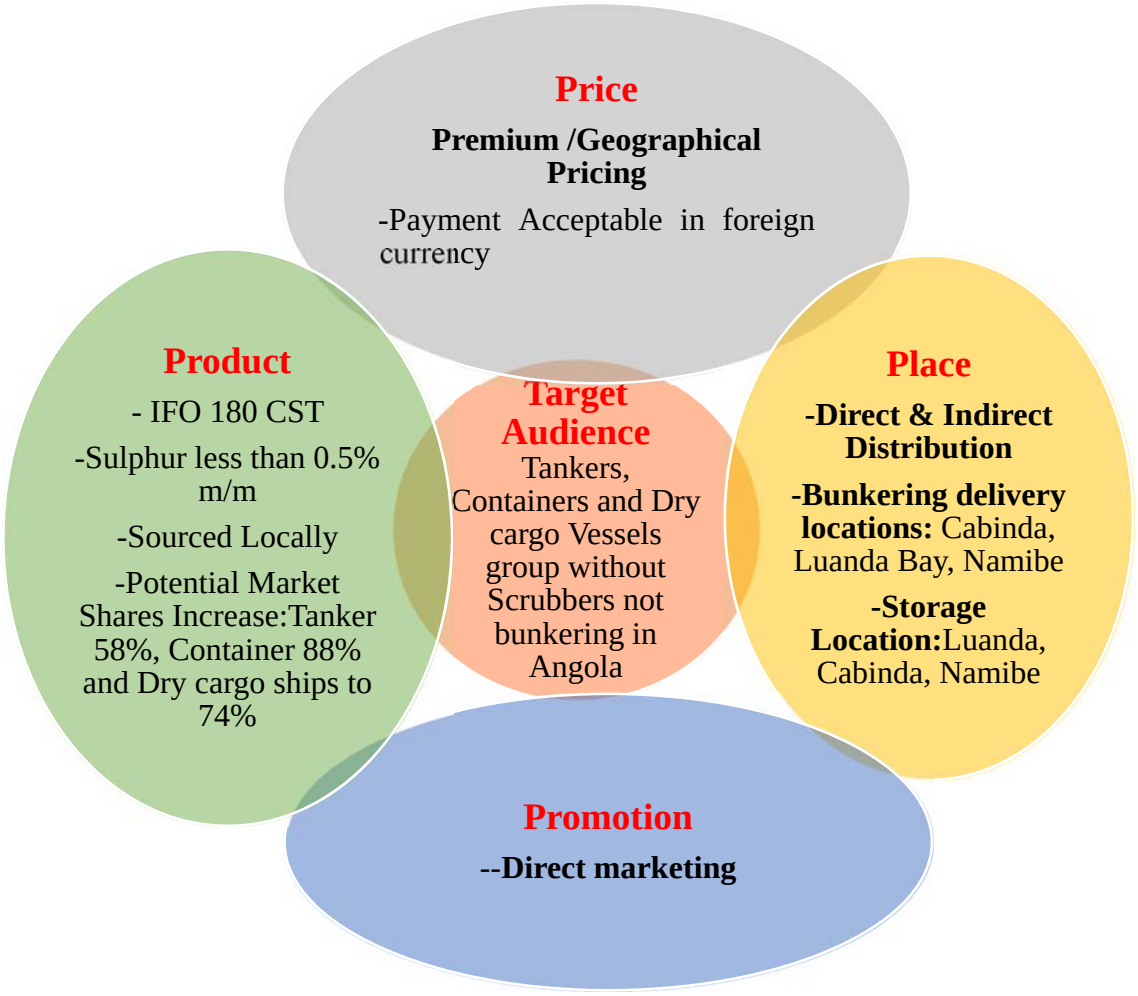


Figure 12: 4 P Market Mix Post 2020

Chapter 5 – Discussion and Conclusion

5.1.Discussion

5.1.1.Factors affecting the selection of Offshore Location in Sub- Saharan WAF

The descriptive analysis of the questionnaire survey showed the significance of the factors affecting the selection of offshore bunkering location in Sub-Saharan West Africa. The mean of the Likert- scale scores presented in the last column of Table 2 showed that Offshore or Anchorage Location Security and Safety, and Bunker Quality are the top factors. Their mean score values were 4.56 and 4.48, respectively. The Bunker Price and Reliability and Punctuality of Bunker Suppliers with a mean score of 4.4 for both were also major factors. Availability of Low-Sulphur Bunkers or other IMO 2020 Compliant Fuels and Geographical Location with a mean score value of 4.24 and 4.2 were also significant factors for the respondents. Quality of Bunkering Services and Bunker Infrastructure, although influential, were ranked with a slightly lower mean score of 4.08 and 3.09, respectively. On the other hand, the Availability of Low-Sulphur Bunkers or Other IMO 2020 Compliant Fuels and Quality of Bunkering Services have relatively high standard deviations, reflecting diversity in opinions.

From the eight factors, Offshore or Anchorage Location Security and Safety were ranked as first, while Bunker Quality as the second most competitive factors affecting the selection of an offshore location in Sub-Saharan West Africa.

Offshore or Anchorage Location Security as the first factor is mainly because of the increased numbers of piracy and armed robbery incidents in the area. As a result, it increases costs for the shipping companies bunkering in West Africa. The extra costs can be related to additional insurance premiums and employment of the local security team or an armed guard. As per ICC IMB (2019), the West Africa prone areas for piracy and armed robbery include Benin, Cameroon, Equatorial Guinea, Ghana, Guinea, Ivory Coast, Nigeria, Togo, and Congo. Consequently, vessel calling those locations are prone to an additional insurance premium. As per Energypost (2018), the Nigerian maritime industry and dealers in bunker fuels are losing out on an estimated $20 billion because vessels calling at Nigeria’s ports choose to procure their bunkers

from sources outside the country. Angola However, offer notably better prospects in regards to maritime security. From the period between 2014-2018, the piracy and army robbery (actual and attempted), Angola represented only 2 % of the total incidents in South and West Africa. Since the beginning of 2018 until June this year, no single has occurred in the country. It shows strong commitment from the Angolan government in providing maritime safety to the shipping industry. Angola is not part of the piracy and armed robbery watch list. Thus, this factor alone can attract vessels in the region to call Angola offshore ports for bunker call, instead of other regions struggling with the maritime security issues.

Quality is the second-most important factor for two main reasons, first is the Sulphur Cap and second is related to operational and technical issues if the ships use substandard fuel.

From the first of January of 2020, ships without scrubber have no option than buying compliant fuel. The fuel availability is uncertain in a particular region in the world, including West Africa. Angola already sells low Sulphur fuel IMO compliant. The fuel sold in Angola is of good quality, and it is sourced from the local refinery and supplied by a reputable international company. Therefore, Angola has significant leverage comparing with most of the African countries. Nevertheless, the low Sulphur compliance fuel that will be supplied Lomé post-2020 is sourced outside the region. In general terms, Angola can provide a better price than Lomé since the compliant fuel is sourced locally.

Besides, poor bunker quality results in high costs for all the parties in the bunker industry. The complexity of the bunker supply chain, in addition to potential discrepancies of the bunker quality supplied, results in lengthy and costly disputes. Poor fuel quality for the demand side may result in financial and technical issues such as:

- Ship’s engine damage
- De-bunkering costs
- Lost value of the removed bunkers
- Lost time

- Port dues
- Surveyor’s fees
- Vessel deviation costs (ExxonMobil, 2019)

The 2020 Sulphur Cap brings much uncertainty about fuel availability, but Angola OPL already supplies this type of product. The IFO 180 CST is produced at the local refinery and supplied by a reliable and reputable company, the Sonangol Group.

5.1.2.Porter Five Forces - Angola Bunker Industry

This framework analysed the Angola industry's competitive environment.

5.1.2.1.Rivalry among existing Competitors

Angolan bunker industry is a Monopoly market dominated by the oil State company “Sonangol Group.” The group is the only institution in the country allowed to import, export fuel products, including bunkers as per the law. Thus, rivalry among competitors is non-existing in the local bunker industry.

The Government intervention in the bunker market inadvertently benefits the Group Sonangol, rather than the broader consumer base due to lack of competition. The absence of competition promotes inefficiency and underestimates the role of the consumers (Blommestein, 2010).

5.1.2.2.Bargaining Power of Suppliers

Porter (2008), illustrates that powerful suppliers can affect the market by charging higher prices, limiting production, and integration. The Sonangol Group controls the entire bunkering supply chain for the residual fuel. This, from the extraction of crude oil, refining to the distribution of the product in the market. For the distillate, the grade is sourced from different global markets. The group uses a third-party international company such as Trafigura, Vitol, and Total through a public tender. However, Sonangol is a multinational oil company and is financially stable. Therefore, as a buyer of the distillate from the third party, the companies are in a dominant position to bargain prices, and to demand better quality or additional service. Distillates suppliers cannot overpower the group as the Sonangol as the ability to rely less on the third-party. Indeed, the Sonangol Group has the option to acquire the distillate product more cheaply as follows:

- Creating a joint venture to import the product
- Importing the product themselves directly from the source
- Invest in a new refinery in the country.

5.1.2.3.Bargaining Power of Buyers

Porter (2008), illustrated that powerful buyers can reduce prices, demand better quality or more service. The clients of the offshore bunkering market are commercial vessels bounds/outbound to Angolan Ports and offshore destinations, vessels servicing the offshore and local fishing fleet.

The local market only has one supplier, and the purchase of bunker is restricted to national companies or companies registered on the group's database. The bunker purchase payment is made only in the local currency, thus subjected to inflation and exchange rate fluctuation. Due to market structure, the bargaining power of buyers is low as buyers have no other options than taking the price if bunkering in Angola. Fishing vessels and vessels servicing the offshore industry have no other choice than buying locally due to the nature of their work. Commercial ships engaged in the international voyage, have the option to bunkers at SSA Area in Congo, or any other international location within the ship's route. The costs of changing markets vary; it depends on different factors such as:

- Whether the ships have enough bunker to reach other bunker ports
- How close is the alternative bunker location to the ship's route
- The price of and availability of the bunkers of the alternative bunker market

Due to the market structure, the end-users have no other options than accepting the price of the bunkers fuels offered at Angola OPL. Even when the bunker prices are attractive locally, the bureaucratic inward clearance makes it unattractive for the end-users.

5.1.2.4.Threat of Substitution

The threat of other substitutes has in the past played a low role, but with IMO 2020, Sulphur Cap LNG fuel or another type of Low Sulphur fuel may disrupt the market soon. LNG has the potential to be trend fuel in the long term since the country exports already LNG to European and Asian Market.

LNG fuel-supplying, as a bunker product locally will require a massive investment in infrastructure. Within Sonangol Group, there is already an initiative to sell LNG as a bunker; thus, the 2020 regulation and the market demand will influence even more the group to make LNG as bunker fuel grade in the local market. However, the substitution depends on the relative cost/benefit profile of other types of fuels. So the threat of substitution is low due to the required massive investment in LNG infrastructure.

5.1.2.5.The threat of New Entry

Porter (2008), indicated that new entrants bring with them a new capacity and the desire to gain market share. This desire puts pressure on costs, prices, and the rate of investment that is necessary to compete. Thus, the threat of entry depends on two factors: the height of entry barriers and the incumbent's reaction to new entrants.

The bunker industry is a capital-intensive industry. It takes upfront investments to start a bunkering distribution company. Moreover, to operate in Angola, new entrants need licenses, insurances, distribution channels and other qualifications that are not easy to obtain. Additionally, it can be expected that existing players have built up a broad base of experience over the years to cut costs and increase service levels. Considering that the liberalisation of the market is not an option for the Angolan bunker market, then the threat of new entry is very low due to the monopoly structure of the market.

5.1.2.6.Summary

Porter's Five Forces framework identified and analysed the five competitive forces that shape the Angola OPL bunker industry.

The results showed the following:

- Due to the market structure, the Group Sonangol is in a dominant position to bargain prices and to demand better quality or additional service from the distillates suppliers.
- The company can rely less on the third-party by creating a joint venture to import the product, importing the product themselves directly from the source, or invest in a new refinery in the country.

- The competitive rivalry in the bunker industry is low due to the structure of the market (Monopoly). Therefore the Sonangol has greater power to charge higher prices and set the terms of deals to achieve higher sales and profits.
- Since the company database only comprises many smaller, independent customers, then it is easier for the group to charge higher prices to increase profitability.
- The company produces the market supplied IFO 180 CST compliant with 2020 Sulphur, thus with no close substitutes; then, the company has more power to increase prices and to increase profitability in the market.

5.1.3.SWOT Analysis

This framework was used to evaluate the Sonangol Group's competitive position in the bunkering sector and to develop strategic planning. The analytical tool assessed the internal and external factors of the market.

5.1.3.1.Strength

- Geographical Location

The country has coastal access to the vessel traffic in the region. Particularly traffic access of vessels from the region bound/outbound to Eastern destinations (East/Middle East/Far East) and vice-versa. Similarly, access to vessel traffic coming from Northern Atlantic direction destined to Congo and the Democratic Congo Republic.

- Luanda Refinery

The Luanda has one of the existing refineries in operation in the region. Country-category is the fourth largest in the West and South Africa Region (Appendix 1). The Luanda refinery produces 100% of the residual bunkers sold in Angola.

- ISO Compliant

The bunker industry in Angola complies with ISO 8217 quality standards and the IMO MARPOL Annex VI (Diario da Republica No. 72, 2017). The residual fuel produced by the refinery is of good quality, and there are seldom disputes as to the quantity supplied.

- Very Low Sulphur Fuel Availability

The Sulphur content produced by the Luanda refinery complies with the 2020 IMO Sulphur Cap. The Sulphur content is less than 0.5% m/m due to the quality of the crude used. The IMO Cap starting in January 2020 requires the shipping industry to use compliant fuel if not fitted with a scrubber. Thus, the Angola offshore bunker marked can answer a question about the availability of such fuel in the region.

- Secure and Safe offshore bunkering location

Angola provides a secure and safe offshore location for bunkering operations. There are no dangers of illicit activities, including piracy or armed robbery. Since 2018, the country has not registered single piracy or armed robbery incident (Fig 6). The Angola government is very committed to providing maritime safety and economic development for the entire region. Nevertheless, the bunkering operations in Angola waters are supervised by the navy.

- Huge brand and a good reputation

Multi-national Oil Company Group Sonangol dominates the bunker industry. It is a huge brand and has a good reputation. The company is stable financially. In 2018 the Group Sonangol had a turnover of US$17.7 billion.

5.1.3.2.Weakness

- Expensive Bunker Prices.

The MGO is imported, thus expensive. However, the IFO 180 CST is also expensive when compared with HFO 380. The IFO 180 is expensive due to its quality. In general, it is priced higher than the HFO 380. Since the Angola bunker market only offers IFO 180 CST, then HFO 380 has been cheaper at Lomé and Pointe Noire.

- Limited storage capacity

The country has limited storage capacity due to infrastructure constraints. Sonangol Group, total storage capacity in 2017, was 698.680 cubic meters (Sonangol Annual report, 2017).

- Limited Products Offering

The market cannot offer different bunker products such as HFO 380, MDO and LNG bunkers. Non-Availability in the local market of HFO and MDO implies importation, thus reduce the ability to offer competitive prices. The country owns LNG plant and

import products to the European and Asia markets; However, LNG bunkering would require massive investment.

- Monopolistic Market

The market is highly regulated, and the absence of competition affects the bunker price. Nevertheless, licensing for bunker supplying services is restricted to Angola company only. In general, a licensed company in the country has strong ties to the government or public authorities.

- IFO 180 CST sold as cargo

Due to its quality, 80% of the IFO produced in Angola is sold as cargo to the international market. About 65,000 MT of fuel oil is sold monthly, mainly to the USA or European market (Sonangol Annual report, 2017).

5.1.3.3.Opportunities

- IMO 2020 Sulphur Cap Regulation

The upcoming Sulphur Cap will change the bunker landscape and offer an excellent opportunity to Angola offshore supplying market to sell and to increase its market share in the region. Especially regarding the IFO Sulphur fuel, which is locally produced. It will also provide a chance to offer different grades of bunkers product, including LNG grade.

- Angola oil Sector Reform Process

The country is going to reform period in the oil sector. It may impact the bunker market structure. Recent development indicated that a starting of a joint venture between Sonangol and Total. The joint-venture will be responsible for the distribution of derivatives and the possible participation in the importation of refined petroleum products, which may force Group Sonangol to redesign its organisational structure and to consider its strategic repositioning in the market.

- New Refinery of the capacity of 200,000 barrels of oil per day by 2022

Angola imports 80% of the refined oil products. Therefore, there is an urgent need to construct an oil refinery in the country. The projects consist of the construction of a refinery in Lobito by 2022, with a capacity to process up to 200,000 barrels of oil per day. Also another in Cabinda with an as-yet-unspecified capacity.

5.1.3.4.Threats

- A stricter Governmental or environmental regulation. It can be locally, regionally, or globally.
- Global economic slowdown due to protectionism, or a trade war.
- Market Liberalization, this would lead to increased market competition as results this would affect the Group Sonangol market shares and profit.

5.1.3.5.Summary

The results showed the IMO 2020 Sulphur Cap Regulation presents an opportunity for the Angola OPL industry to increase sell of IFO 180 CST in the local market. Since Angola OPL offers better security than OPL markets in the region, then this factor will attract vessels to the local market for buying the compliant fuel. The increase in sales could be achieved by increasing the storage capacity, bunker fleet, and selling locally as bunker product to end-user, the remaining IFO 180 CST sold as cargo to international markets.

5.1.4.Market Mix

This framework was used to evaluate the Group Sonangol Market mix for the IFO 180 CST since the product is locally produced. The use of the marketing mix ensures that the Group Sonangol is putting the right product in the right place and at the right price.

5.1.4.1.Product

The product is the IFO 180 CST because of its Sulphur content, which below 0.5% m/m. This product sourced from the local by the refinery and has better quality than HFO 380 supplied on other neighbouring markets. The IFO 180 CST also complies with ISO 8217 quality standards and the IMO MARPOL Annex VI (Diario da Republica No. 72, 2017). The product is 2020 IMO Sulphur Cap compliant as the Sulphur content is less than 0.5% m/m. The fuel supplied at the Angola market is a better alternative than HFO 380, which is the most common fuel for the global shipping fleet. Unfortunately, the global shipping fleet has been running on heavy fuel oil with high Sulphur content since the early 1970s. The HSFO is the bottom of the oil barrel, the residue of simple refining. It is the dirtiest and heaviest product produced by refineries worldwide. However, the IFO 180 CST supplied in the Angola offshore

market is produced locally, and the Group Sonangol has complete control of the entire process. From the extraction of the crude, refining, and distribution to the end-users. Sonangol Group is an integrated energy company and controls the whole supply chain of the IFO 180 supplied in Angola. Thus, are seldom disputes as to the quality supplied. By segment, the tanker group is the largest consumer of the IFO 180 CST sold at as shown below:

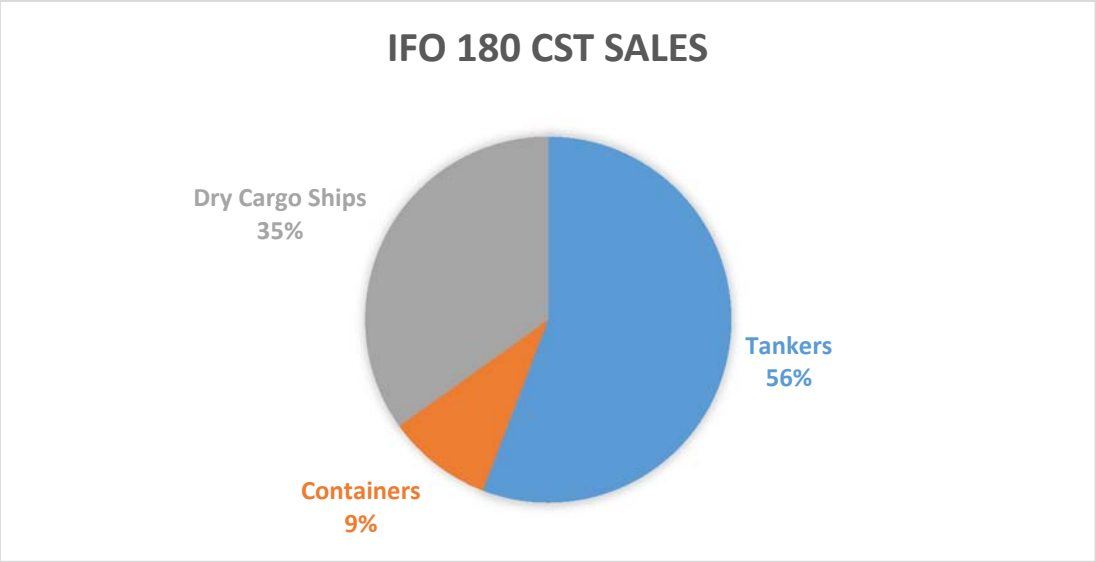


Figure 13: IFO 180 CST Sales by Segment

5.1.4.2.Price

Due to its quality, the IFO 180 worldwide have been priced higher than HFO 380, as shown in the graph below:

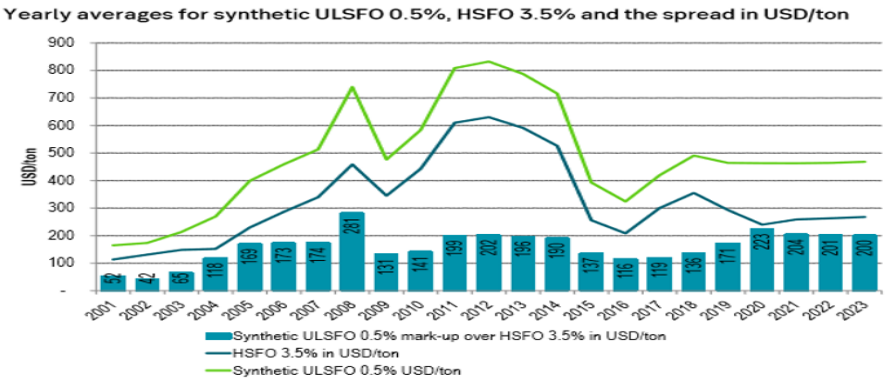


Figure 14: IFO price spread

Source: (SEB, 2019)

Thus, the IFO 180 CST at Angola OPL bunker market has always been priced higher than HFO 380 offered by location in the region. The IFO cost was as much as twice of HFO380 price in WAF during the period December 2015 to June 2016, as shown on the table below:

	Off. WAF (HFO 380 in USD)	Offshore Angola (IFO 180 in USD)
Dec-15	298	595
Jan-16	304.5	595
Feb-16	308	595
Mar-16	312.8	595
Apr-16	317.5	595
May-16	322	595
Jun-16	326	595

Table 4: IFO 180 vs 380

Source: (Minerva and Group Sonangol)

The current pricing strategy of the Sonangol Group has been charging a premium on the IFO 180 CST due to the quality of the fuel.

5.1.4.3.Promotion

To promote the product, the group uses various delivery mechanisms for advertising include banners at sporting events, internet websites, magazines, newspapers, radio, and television commercials.

5.1.4.4.Place

Sonangol Group uses mainly indirect distribution methods for IFO sales. This due to Angola law that requires companies to be registered into the company database and payment made in local currency only. In indirect distribution, the final price of the product can be higher for the end-user.

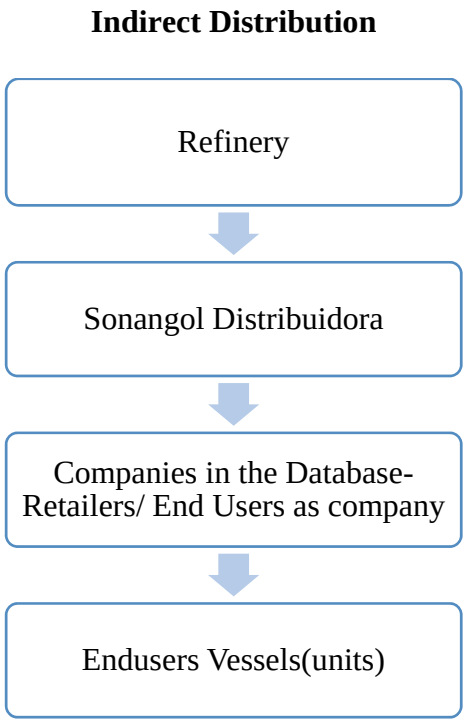


Figure 15: Indirect Distribution

5.1.5.Case Study

The case study is limited to one of the products supplied at the Angola OPL bunkering market and to three targeted shipping groups.

5.1.5.1.Target Market

The bunkering product is the IFO 180 CST. The targeted shipping groups involves vessels at 100 nautical miles off the coast that do not purchase bunker from Angola OPL, namely:

- Tankers vessels without a scrubber
- Dry Cargo vessels without a scrubber
- Containers vessels without a scrubber

Why IFO 180 CST

The bunker product IFO 180 CST sold in the Angola OPL bunkering market complies with the upcoming 2020 IMO Sulphur Cap regulation. The product is sourced from the local refinery in Luanda. The Sonangol Group has complete control of the entire supply chain process of the product. From extraction of the crude from the field, refining, and to the distribution of the product to the end-users.

Why Vessels without a Scrubber

After January 1st of 2020, this group of vessels will no longer have options to buy the cheaper HFO 380 due to its high Sulphur content above 0.5% m/m.

Why Vessels within 100 Nautical miles (regardless of Port of origin or destination)

Bunkering at sea concept is a valid concept applied worldwide, particularly in sheltered waters. The areas where bunkering at sea is taking place are areas where the seas are quiet. The waves are not very high, and the wind and currents are not strong. These are perfect circumstances for bunkering (Volkering et al., 2015). The current Angola bunkering supplying structure can only deliver bunkers products to a maximum distance of 12 NM from shore, depending on the sea condition and state. An exception applies when using DP featured vessels.

However, the decision to change or deviate from the shipping route by ship-owners is generally driven by economics (Tikkelman et al., 2010). Also, Shipping chooses their bunker ports basis on small price differentials. Therefore deviation for bunkering call needs to be economically justifiable. Nevertheless, busy schedules and inflexibility on a charter party may also prevent commercial ships from deviating their passage just for a bunker call.

For this particular study, the author decided to use 100 NM distance from shore as the reasonable distance that shipping users may be willing to deviate. Longer distance deviation for bunkering is not economically feasible and consequently makes the bunker to be purchased more expensive. The table below shows that a 6 hours deviation on an Aframax vessel cost around 5,000 USD in bunker costs. For such time the vessel would have travelled around 90 NM at a speed of 15 knots.

Speed (Kts)	Deviation Time (hours) 6.0	Bunker Cost (USD) $365	Total Distance (NM)	Angola OPL Maximum Delivery distance from Shore (NM)
15	6.0	$5,886	90	12
14	6.0	$4,882	84	12
13	6.0	$3,787	78	12

Table 5: Bunker Deviation Costs based on Aframax Oil Tanker

Source: (Appendix 1: Kalahari Speed and Consumption)

Vessels bound or outbound Angola ports, and the terminal can bunker when they are loading/discharging, or they can call Angola OPL as bunker call option only. However, since not, all the vessels within 100 NM miles from Angola coast are bound to or outbound from Angola ports and terminals. Then, it is essential as well to attract these vessels passing through up to distance of 100 NM off the coast to make a bunker call at Angola OPL locations.

Why Group Tankers, Dry Cargo Ships, and Containers

In general, offshore vessels and fishing vessels consume distillate fuels. As per Sonangol Group, there no records for IFO 180 CST sold to such vessels. Regarding passengers' vessels, they very unlikely to stop in Angola ports as part of their destination, and also they are very unlikely to deviate from their busy schedule for a bunker call only at Angola OPL. However, tankers, dry cargo ships, and containers are part of the Sonangol Group statistics regarding bunkers purchase (Figure 12: IFO 180 CST Sales by Segment).

5.1.5.2.Four P Market Mix Post 2020

This framework is used to evaluate the Group Sonangol Market mix for the IFO 180 CST since the product will meet customers' needs and expectations for the 2020 Sulphur Cap.

5.1.5.2.1.Product

The product quality complies with IMO 2020 Sulphur Cap. Vessels without a scrubber will have to use the compliant fuel only. Therefore the IFO 180 CST produced in Angola could be sold to this group of vessels. As per the author's interpretation of Clarkson's Seanet data, the IFO 180 CST potential expansion market is 71%, as shown below:

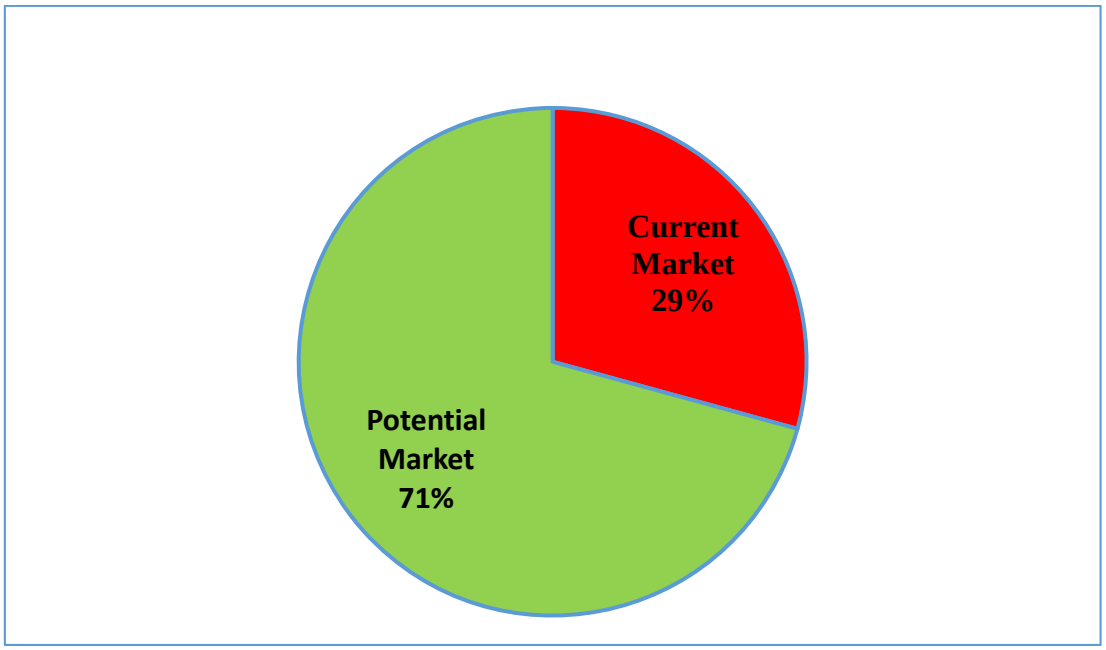


Figure 16: Overall Potential Market Shares Increase

The company IFO market shares could be increased by segment as per the figures below. The Tanker segment shares could be increased by 58%, Container 88%, and Dry cargo ships to 74%.

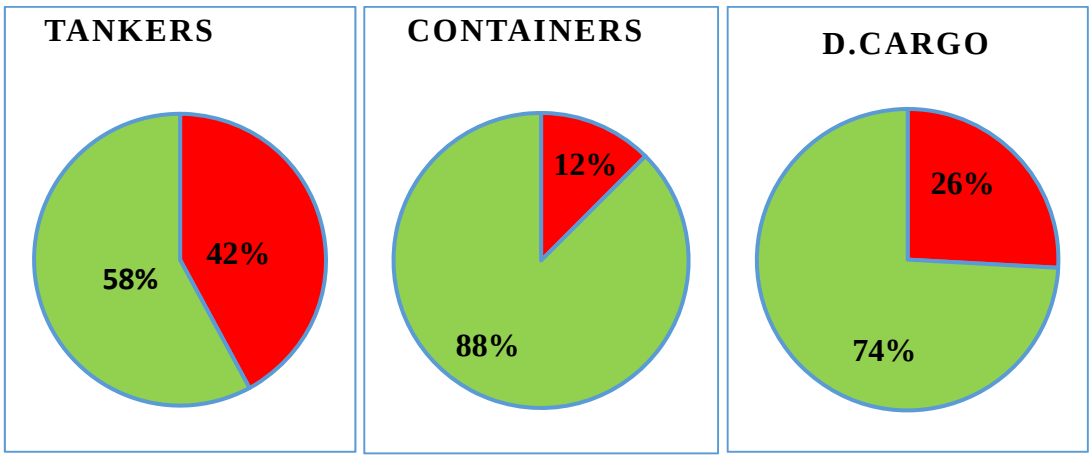


Figure 17: Potential Market Shares Increase by Vessel Segment

5.1.5.2.2.Price

The 2020 Sulphur Cap offers an opportunity to group Sonangol to target vessels that do not bunker in Angola without a scrubber locally or regionally. The group to be targeted are tankers, containers, and dry cargo group vessels. Premium price and the geographical price will be the most appropriate as strategy pricing.

Geographic pricing is a technique of charging customers based on the location where the bunker is supplied (1,2,3..12 miles from shore). This pricing strategy passes the transportation cost of goods to buyers.

5.1.5.2.3.Promotion

For post-2020, direct response and direct marketing will be the preferred method for promotion. It would ensure that bunker fuel purchased from the website or via other salespeople could be done without the middle man.

Direct mail permits an organisation to use its resources more effectively. It would allow the Sonangol Group to send publicity material to the targeted group of vessels.

5.1.5.2.4.Place

For 2020 the use of direct distribution methods for IFO sales will make the price cheaper for the end-users (Fig. 18). The possibility of making a payment at other types of currency would make life a bit easier for customers.

Direct Distribution

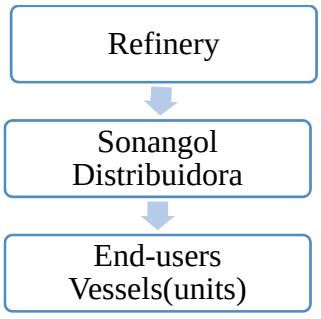


Figure 18: Direct Distribution

The distribution networks of the group need to be reconfigured as per the following:

- Cabinda (Permanent Storage)
- Luanda Bay (Permanent Storage)

- Namibe (Permanent Storage)

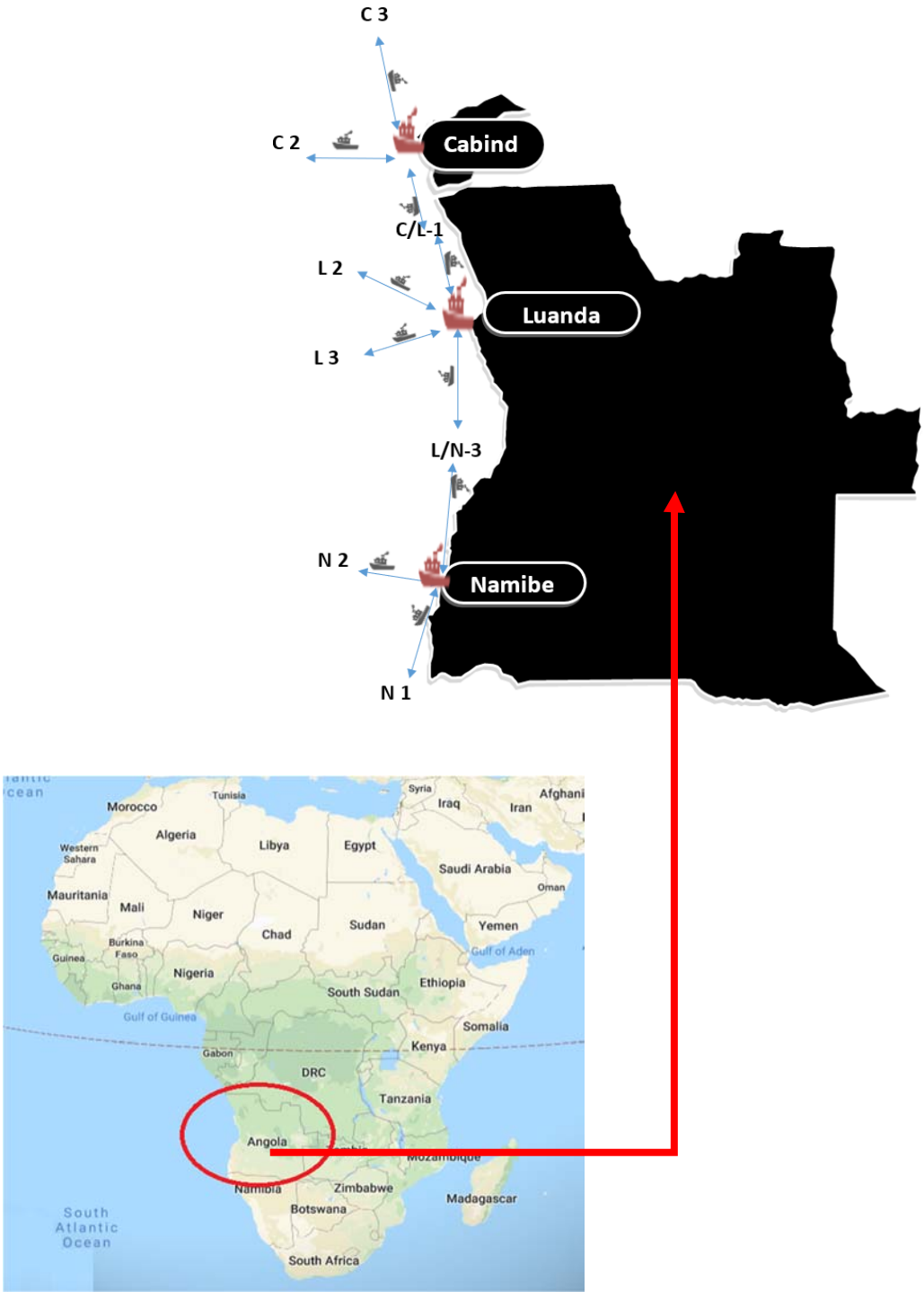


Figure 19: Storage Distribution Map Post-2020

As per Angola Law, bunker delivery can take place anywhere within the country's territorial waters up to EEZ (Diario da Republica No. 72, 2017). However, due to operational challenges and conditions of the sea state, the bunkering delivery happens only within 12 miles of the coast. However, the potential clients will be targeted from a distance up to 100 NM miles from the shore.

5.2.Conclusion

The final ranking of the most important competitive factors affecting the selection of offshore bunkering location in Sub-Saharan West Africa are as per below:

1. Offshore or Anchorage Location Security and Safety.
2. Bunker Quality
3. Bunker Price
3. Reliability and Punctuality of Bunker Suppliers
4. Availability of Low-Sulphur Bunkers or other IMO 2020 Compliant Fuels
5. Geographical Location.
6. Quality of Bunkering Services
7. Bunker Infrastructure

The results above illustrate that the order of factors can be used as a benchmark to improve the competitiveness of any offshore location in WAF or to develop the offshore bunker market in the region. The above benchmark rule is appropriate and helpful to local authorities and parties in the bunker supply chain in the sub-Saharan West Africa region.

The five competitive forces shaping Angola OPL bunker industry are summarised as follows:

- The industry has a monopoly structure
- The Group Sonangol is in an excellent position to increase sales and market shares locally or regionally.
- The company has more power to increase prices and to increase profitability in the market of the IFO 180 CST bunker product. Since it is produced locally, and there are no close substitutes in the short term.

- The geographical location of the country offers access to the vessels traffic in the region

The SWOT analysis indicated that the Group Sonangol could increase sell of IFO 180 CST in the local market post-2020. The sales increase could be achieved by increasing the storage capacity, increasing the bunkering fleet and increasing sales volumes of IFO 180 CST to end-users. The company can opt to sell locally to end-users as bunker products; the IFO 180 CST product sold as cargo to the international markets. Nevertheless, the positives attribute that the Angola OPL market has got can be used to attract vessels in the area. These positives attributes are resumed into the following:

- No single piracy and army robbery incident since the beginning of 2018 until June this year(Fig. 7).
- Good regional liner shipping connectivity index, as the country, ranks as a second in the Sub-Saharan West Africa region (Appendix 3).
- The residual fuel produced by the refinery is of good quality, and there are seldom disputes as to the quantity supplied.
- The country ranks as number seven for the merchant fleet in the Sub-Saharan West Africa region (Appendix 2).

The Group Sonangol Market mix showed that the IFO 180 CST could be used for market development post-2020. It could be achieved by selling more of the existing IFO 180 CST product to new markets segment. As per the study, the Group Sonangol could expand its market sales and thus increasing its regional shares. However, the following strategies need to be taken into consideration:

- The customers' segment to include vessels without scrubbers off 100 nautical miles from the coast, such as Tankers, Dry Cargo, and Containers vessels.
- The product, to be marketed is the IFO 180 CST since the product meets customers’ needs and expectations for the 2020 Sulphur Cap.
- Product strategy pricing to include premium price and the geographical price.
- Direct response and direct marketing to be chosen as the preferred methods for the promotion of the IFO 180 CST.

- The direct distribution method for IFO sales should be adopted, as it will make the price cheaper for the end-users. Also, payment in other currencies to be accepted as a viable alternative.
- The product distribution network along the country's coast needs to be reconfigured. The suggestion is to use three permanent storage at Luanda, Cabinda, and Namibe to ensure efficiency and better utilisation of the bunkering fleet. Thus, minimising the resupply time for the bunkering supplying vessels.

In brief, the Angola offshore IFO 180 CST fuel market has positive leverage on the back of the two crucial elements, such as:

- The country's positive offshore attributes for bunkering selection
- The upcoming 2020 Sulphur Cap.

The country's positive offshore attributes for bunkering selection singles out the Angola OPL bunker market among the other OPL markets in the West Africa region. The 2020 Sulphur Cap serves as an opportunity. It mainly opens the door for the offshore bunker industry to increase its market share and to expand its footprints in the West Africa region. Thus, the market can increase its regional share. Also, develop its bunker industry towards a hub in the Sub-Saharan West African region.

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Chapter 7 - Appendices

Appendix 2: Sub-Saharan Africa Refineries, 2008

Country	World Region	Owner/Operator	Location	Type	Total Capacity (barrels a day)
Senegal	West Ste.	Africaine de Raffinage	M'Bao (Dakar)	Simple	25,030
Ghana	Africa West	Tema Oil Refinery Co. Ltd.	Tema	Complex	45,000
Ivory Coast	Africa West	Societe Ivoirienne de Raffinage/ Societe Multinationale des Bitumes	Abidjan	Complex/ Bitumen	73,990 (63,990/10,000)
Cameroon Africa West	Africa West	Societe Nationale de Raffinage	Cape Limboh Limbe	Simple	47,110
Nigeria	Africa West	Kaduna Refinery & Petrochemical Co. (NNPC)/ Port Harcourt Refining Co. (NNPC) Rivers State/Warri Refinery & Petrochemical Co. (NNPC)	Kaduna / Rivers State/ Warri	Complex	445,000 (110,000/210,000/125,000)
Congo, Republic of	Africa West	Coraf	Pointe-Noire	Simple	21,000
Gabon	Africa West	Ste. Gabonaise de Raffinage	Port Gentil	Simple	24,000
Angola	Africa South	Fina Petroleos de Angola	Luanda	Simple	53,000
South Africa	Africa South	National Petroleum Refiners of S. Africa Pty Ltd/ Caltex Oil SA/ Engen Petroleum Ltd. / Shell and BP PLC Petroleum Refineries Pty. Ltd.	Sasolburg / Cape Town / Durban / Durban	Complex	485,297 (87,547 / 110,000 / 118,750 / 169,000)

Source: (ICF, 2009)

Appendix 3: West Africa Merchant Fleet and National Flag per country

	Country	The merchant fleet, national flag (thousands of DWT)
1	Liberia	217105
2	Nigeria	3660
3	Sierra Leone	1753
4	Togo	1668
5	Cameroon	434
6	South Africa	428
7	Angola	315
8	Congo	74
9	D. Congo	71
10	Ghana	34
11	Equatorial Guinea	33
12	Namibia	27
13	Mauritania	14
14	Ivory Coast	10
15	Senegal	9
16	Gambia	4
17	Guinea Bissau	1
18	Guinea	0
19	Benin	0
20	Gabon	0

Source: (UNTACD, Countries profile 2017)

Appendix 4: West Africa liner Shipping index per country

	Country	Liner shipping connectivity index (maximum 2006 = 100 for China)
1	South Africa	37.85
2	Togo	29.15
3	Congo	24.23
4	Angola	23.45
5	Nigeria	22.59
6	Ghana	20.54
7	Ivory Coast	18.83
8	Senegal	17.18
9	Cameroon	17.09
10	Benin	17.05
11	Namibia	16.02
12	Guinea	11.51
13	Equatorial Guinea	11.25
14	Sierra Leone	8.17
15	Liberia	7.43
16	Mauritania	7.1
17	Gambia	6.15
18	D. Congo	6.14
19	Guinea Bissau	6.01
20	Gabon	0

Source: (UNTACD, Countries profile 2017)

Appendix 5: Sonangol Group Bunker fleet

Ship Name	DWT (MT)	Years Built	Owned/TC Contract
African Ruby	11027	2009	TC
Ngol Zaire	4800	2006	Owned
Mandume	7252	2010	TC
Ana Nzinga	17,497	2009	TC
Sonangol Girassol	130,000	2000	Owned

Source: Sonangol Distribution

Appendix 6: Microsoft 365 Survey Form

Factors Affecting Selection of Offshore or Anchorage Bunkering Location in West Africa

Please rate the importance of the following factors on scale 1(not important) to 5(very important) for bunkering selection at offshore or anchorage location in the West Africa region.

1. Bunker Price.

Not Important at All 1 2 3 4 5 Very Important

2. Bunker Quality.

Not Important at All 1 2 3 4 5 Very Important

3. Geographical Advantage.

Not Important at All 1 2 3 4 5 Very Important

4. Offshore or Anchorage Location Security and Safety.

Not Important at All 1 2 3 4 5 Very Important

5. Bunker Infrastructure

Not Important at All 1 2 3 4 5 Very Important

6. Quality of Bunkering Services.

Not Important at All 1 2 3 4 5 Very Important

7. Availability of Low-Sulphur Bunkers or other IMO 2020 Compliant Fuels.

Not Important at All 1 2 3 4 5 Very Important

8. Reliability and Punctuality of Bunker Suppliers.

Not Important at All 1 2 3 4 5 Very Important

9. How do Identify your Company, Please Choose one of the Options?

Select your answer

Appendix 7: Targeted Vessels Group Count

Vessel Type Counts (On Screen)		
Rank	Vessel Type	No
	Offshore Units	
	Mobile Offshore Drilling	17
	PSV	104
	AHTS	92
	Tug	91
	Mobile Offshore Production	27
	Rescue & Salvage	3
	Construction Vessel	25
	Survey	11
	Dredgers	10
	Logistics	6
	Utility Support	64
	Total	450
	Tankers	
	Crude Tanker	90
	Products Tanker	76
	Chemical Tanker	50
	LPG	19
	LNG	14
	Specialized Tanker	2
	Total	251
	Cargo Vessels	
	General Cargo	39
	Multipurpose	62
	Bulk carrier	200
	Reefer	15
	Combined Carrier	3
	Total	319

Source: Clarkson's Seanet.

Appendix 8: Kalahari Speed and Consumption

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SPEED & CONSUMPTION (NOTE ALL FIGURES ARE ABT)
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  LADEN (MT/D)      BALLAST (MT/D)
  KTS     TONS      KTS     TDNS
  13.0     43,5     13.0    41,5
  13.5     50,5     13.5    48,5
  14.0     54,5     14.0    53,5
  14.5     61,5     14.5    59,5
  15.0     66,5     15.0    64,5

  CONSUMPTION P/D
  GENERATOR
  AT SEA          3,8
  IDLE IN PORT    3,8
  TANK CLNG       8,0 (ALL TANKS)
  DISCHARGE       8,0 (ALL PUMPS)

  BOILER
  IDLE IN PORT    6,8
  TANK CLNG      25,0 (ALL TANKS)
  DISCHARGE     55,0 (ALL PUMPS)

  WITH RESPECT TO TANK CLEANING AND INERTING BASIS ALL TANKS.
  INERTING       25 MTS MTS HFO (ALL TANKS)
  TANK CLEANING 50 MT  MTS HFO BASIS ALL TANKS

  FOR ALL ABOVE CONDITIONS AND OPERATIONS THE VESSELS HAVE USED HFO
ONLY.
  DAILY CONSUMPTION OF MDO = 0.3 MT ( INCINERATOR + IGNITION OF
BOILER).


  BUNKER TYPE:
  ISO 8217(2005) RMG 380 AND MDO ISO 8217(2005) DMA
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Source: (Sonangol Distribution)