ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE, LCSM DEPARTMENT

CHALLENGE OF INTEGRATION OF FUEL SUPPLY CHAIN IN ETHIOPIA

BY

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A SUTUDY SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN LOGISTICS & SUPPLY CHAIN MANAGEMENT

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June, 2017

Addis Ababa

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SIGNED DECLARATION

This thesis is my original work and all sources of materials used for the thesis have been duly acknowledged.

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ACKNOWLEDGEMENTS

I would like to sincerely thank to my advisor Teklegiorgis A. (Asst. Prof), who is a lecturer at Addis Ababa University School of Commerce, for his enduring patience, and timely remarks and inputs to this study.

I would also like to thank Abayneh Awel, EPSE's Supply and Sales Department Head, for providing detail information on the role on EPSE in the fuel supply chain of Ethiopia and other secondary data that was very helpful for the study.

Special thanks to Birhanu D. (PhD), who is a lecturer at Addis Ababa University School of Commerce, for his valuable guidance and encouragement during project proposal defense.

Last, but not least, I thank the seven Oil Companies (NOC, Total, Oilibya, YBP, TAF, Nile & Dallol) for their support and kind permission to collect data from their fuel stations and for filling in the questionnaire timely.

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List of Abbreviations/Acronyms

BRV	Bulk Road Vehicle
CFR	Cost and Freight
CODO	Company owned & dealer operated
DODO	Dealer owned & dealer operated
EAL	Ethiopian Air Lines
EIA	United States Energy Information Administration
ENOC	Emirates National Oil Company
EPSE	Ethiopian Petroleum Supply Enterprise
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
HTL	Horizon Terminal Limited
IEA	International Energy Association
KMC	Kilo Meter Cube
KPC	Kuwait Petroleum Corporation
LPG	Liquefied Petroleum Gas
MC	Meter Cube
MoMPNG	Ministry of Mines, Petroleum and Natural Gas
MoT	Ministry of Trade
NOC	National Oil Ethiopia
NPRDA	National Petroleum Reserve Depot Administration
SCI	Supply Chain Integration
SCM	Supply Chain Management
SLA	Service Level Agreement
WAS	Wadi Alsundus
YBP	Yetebaberut Beherawi Petroleum
YTD	Year to Date

Abstract

The oil industry is involved in a global supply-chain that includes ordering, transportation, import/export facilitation, inventory visibility and control, depot administration, distribution management, customer service and information technology. Realizing the synergies that exists in these functions, many companies have extended the concept further upstream and downstream; the supplier of suppliers and customer of customers.

The country is facing sporadic shortage of fuel at different times and the supply chain members give different reasons, sometimes contradicting to each other. The purpose of this paper is to assess the existing fuel supply chain integration practices, identify the gap and potential constraints for a seamless integration that would ensure reliable supply of fuel in the country. To meet the purpose, qualitative assessment of the existing information integration, coordination and collaboration, and process integration within the supply chain partners are made. From different literatures, the study identified factors that are considered as a good measure of the three aspects of the supply chain integration. Then, information from primary & secondary sources is used to conduct out the assessment.

The relative importance index run on the mean factors indicated that, most of the factors that are essential for internal (within Ethiopia Petroleum Supply Enterprise), customer and supplier integrations are not implemented effectively. The study further revealed that capacity constraints of Horizon Terminal, low profit margin of Oil Companies, vehicle shortage, dealers (retailers) & transporters have adversely affected the synergy of the partners involved in the supply chain. Implementing a complete integration both on upstream, and downstream of the supply chain is a better solution. Some of the major challenges identified are lack of information sharing, lack of collaboration on development program and decision making, no robust inventory management system, and lengthy approval process to uplift from NPRAD depots.

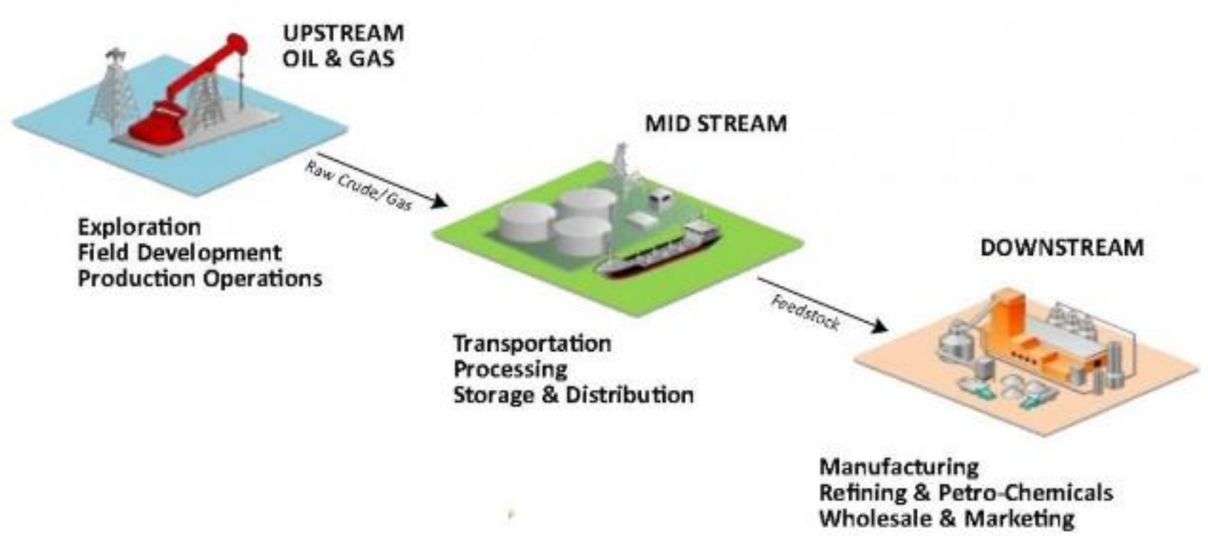
Therefore, the supply chain partners and the stakeholders should have a regular open and transparent meeting, maintain collaborative relationship and work collaboratively on development program and decision making to address the barriers captioned above and thereby ensure a seamless integration across their supply chain.

CHAPTER 1: INTRDUCTION

1.1 Background of the study

The generic supply chain of fuel includes upstream sectors (companies involved in exploration and extraction of crude oil), midstream sectors (companies involved in transportation, processing, storage & distribution), downstream sectors (companies involved in refining, marketing, distributing and transporting of petroleum product), and the consumers.

Figure 1 – The Oil and Gas Industry



Source: http://avata.com/oil-gas website

In recent years, there have been concerns and many have argued that the oil and gas industry may have entered an era of very scarce resources. However, in reality, the resources are not the cause of supply constraints, rather putting these reserves into production and delivering the final products to consumers. Thus, a solid supply-chain management program will enhance this goal (Christopher 2007). Supply chain has always been about companies working together to achieve a common goal; serving the end customer effectively and efficiently.

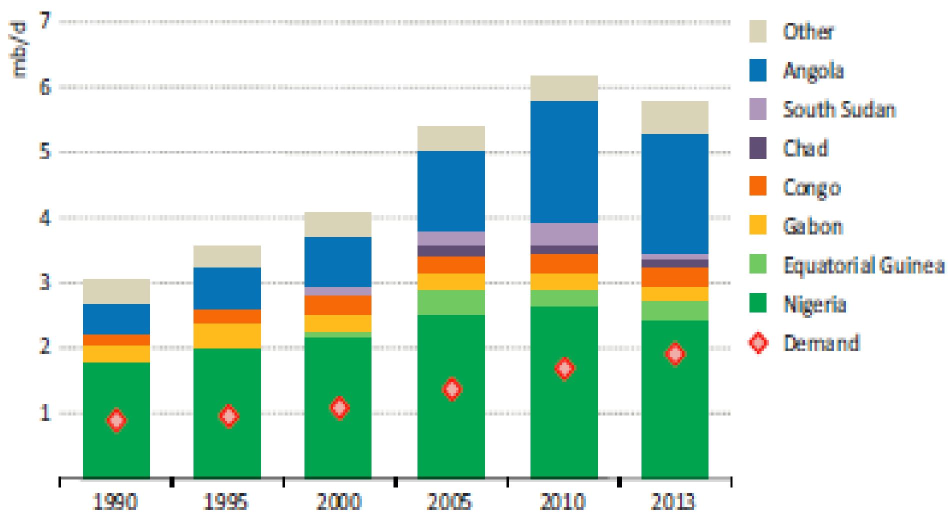
More than 80% of the world's proven oil reserves are concentrated in just 10 countries. Venezuela holds the world's biggest oil reserve followed by Saudi Arabia, while Canada and Iran hold the third and the fourth largest oil reserves. Nigeria holds the tenth largest proven oil reserves in the world (Hydrocarbons-Technology December 2013).

The five biggest oil consuming countries are United States of America, China, Japan, India and Russia (Hydrocarbons-Technology October 2013). According to IEA (2014) report, oil demand in sub-Saharan Africa stood at 1.8 million barrels per day (mb/d) in 2012 and made up 15% of total energy demand. South Africa accounts for around 30% of oil demand and Nigeria for more than 20%, with the remaining 40-plus countries collectively consuming less oil than the Netherlands (International Energy Association 2014).

According to the United States Energy Information Administration (EIA 2016) Oil Market Report forecast, worldwide average demand for 2016 was nearly 96 million barrels of oil and liquid fuels per day. It also forecasted that in the next five years, Asia will remain the major source of oil demand growth and China will be central to demand growth, partly because of the underlying rise of oil demand but also due to its build-up of strategic reserves which will reach at least 500 million barrels by 2020. Gruenspecht (2011 cited in Richard & Francis 2014) mentioned that EIA projects that the world's energy consumption will increases from 2011 by 53% by the 2035.

International Energy Association (2014) study indicates Oil production in sub-Saharan Africa has doubled since 1990. According to the report, Nigeria is first followed by Angola and Equilateral Guinea.

Figure 2 - Sub-Saharan Africa oil production by country and total demand



Source: IEA (African Energy Outlook)

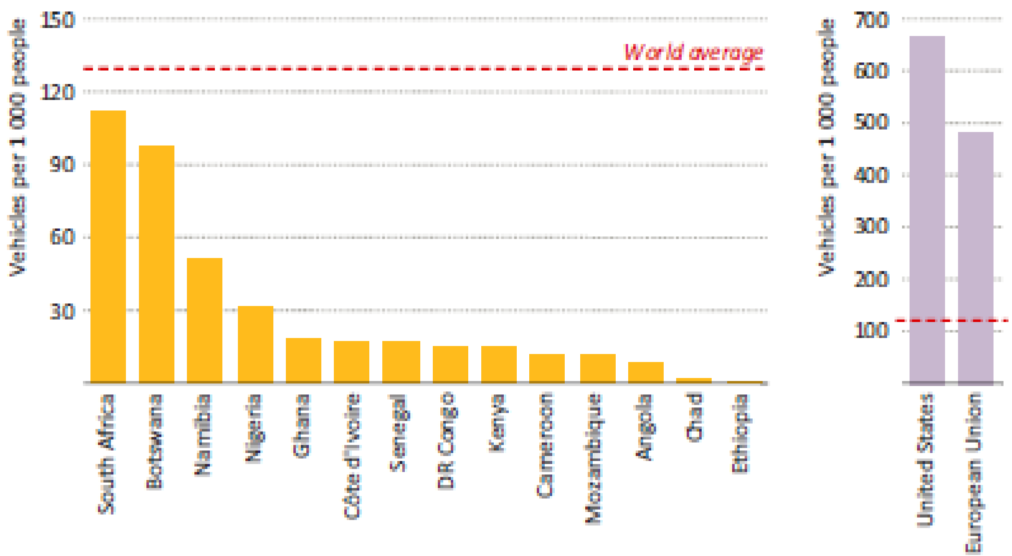
Ghana has joined the producers in commercial quantity in 2014. Kenya & Uganda are expected to join these countries soon.

Energy consumption in transport in sub-Saharan Africa has increased by 4% per year since 2000 and was around 50 Mtoe (million Tones) in 2012. The consumption is heavily concentrated on vehicles IEA (2014). The report also mentions that road transport in sub-Saharan Africa is typically characterized by a high degree of diesel use (almost 0.4 mb/d) which accounts for 39% of oil consumption in road transport. In most of African countries diesel has a share of around 45% in road transport, except in countries where gasoline prices are relatively low (such as Nigeria, with only 12% diesel).

The report continued, and mentions that transport fuel is subsidized in several countries in Africa, but is still expensive relative to average incomes of the population. Poor condition of the roads and the low affordability of fuels also lead to relatively low use of cars and trucks, compared with the global average. As a result, the cost of transporting goods in Africa is among the highest in the world.

Although the number of truck ownership in Ethiopia is the lowest, the average demand growth for Ethiopia (10% per year) is higher than for the sub-region (4% per year). This is mainly due to the fact that many construction projects are undergoing in the country that use heavy construction machineries and also increase of import & export activities that need transportation service from and to Djibouti which covers on the average 1,854 km for a round trip.

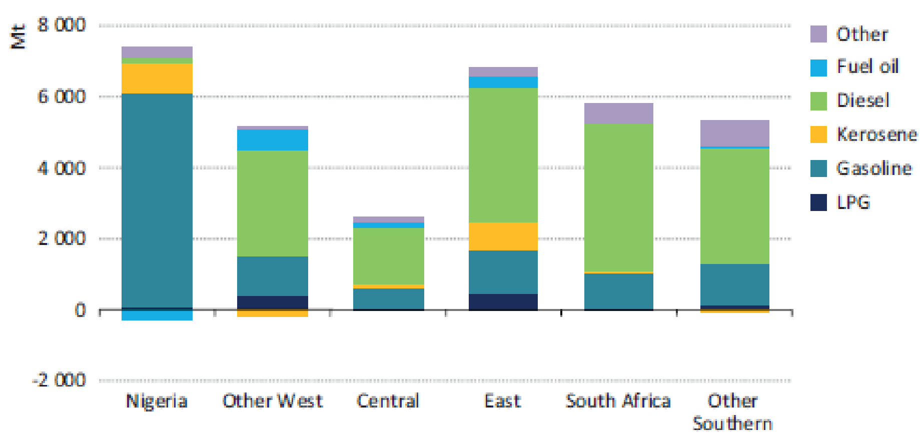
Figure 3 - Car ownership in selected countries in Africa, 2012



Source: IEA (African Energy Outlook)

The IEA report also shows that, except in Nigeria where the demand for gasoline has grown significantly, in all other sub regions the diesel demand has increased significantly.

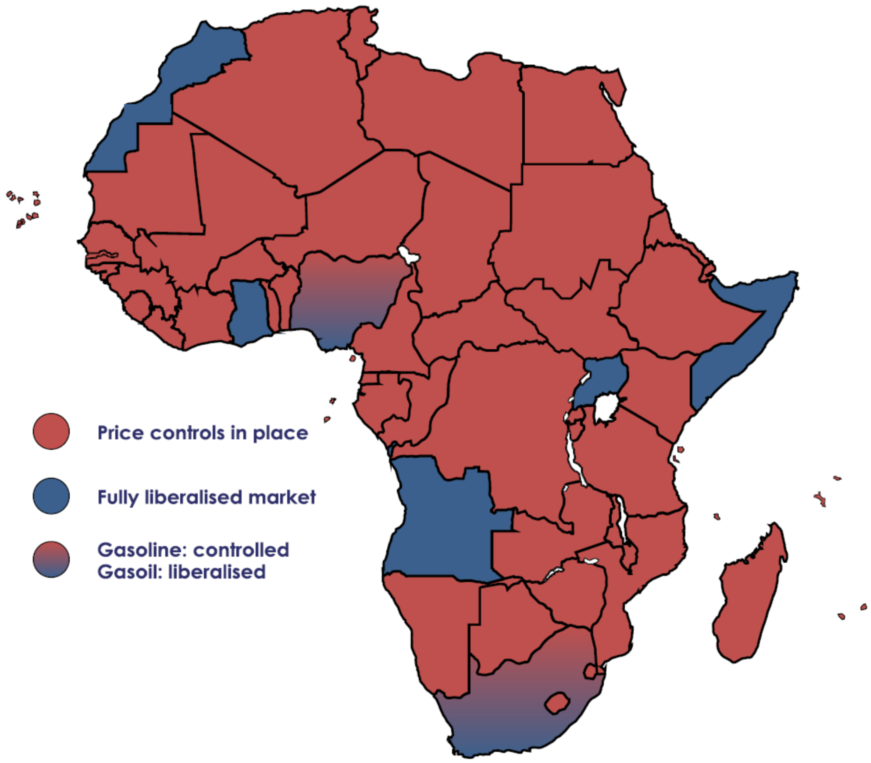
Figure 4 - Oil demand growth by sub-region 2000-2012



Notes: Mt = million tonnes; kerosene includes jet fuel. Sources: CITAC; IEA analysis.

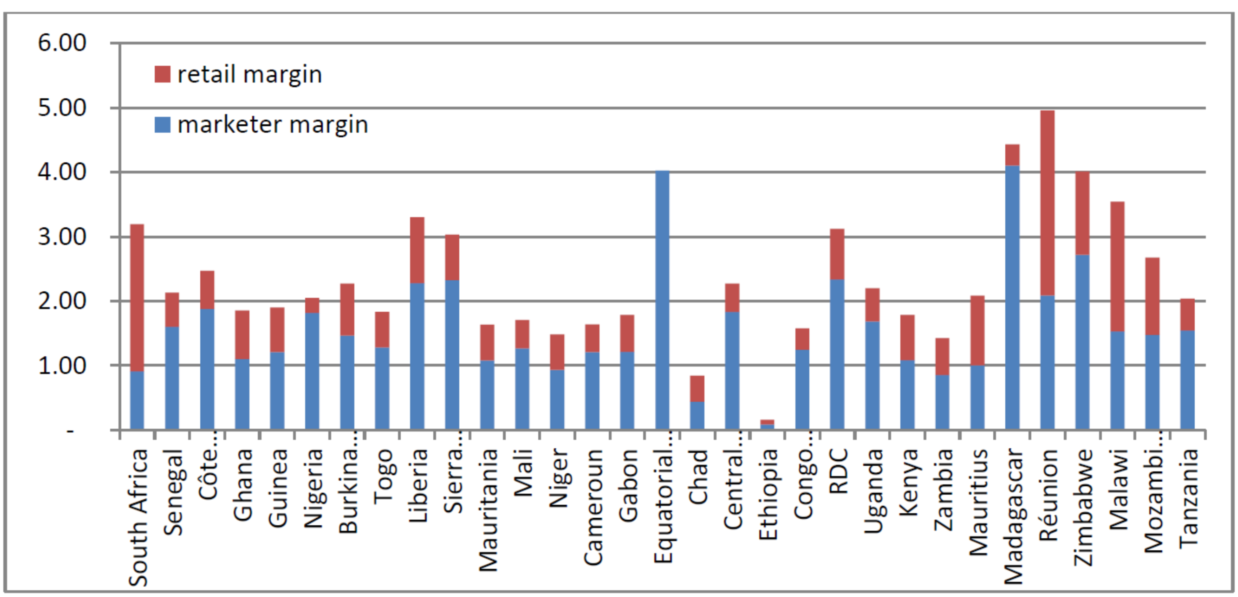
Since fuel has a considerable impact on the economy of a country, through cost of transportation which in turn affects cost of goods, in most African Countries, the price of fuel is regulated by the government and so is the profit margin of Oil Companies & Retailers.

Figure 5 – Pricing mechanism of fuel in Africa



Source: Kundi Consultants Pls (2016) obtained from CITAC

Figure 6 - Company and retail margin components



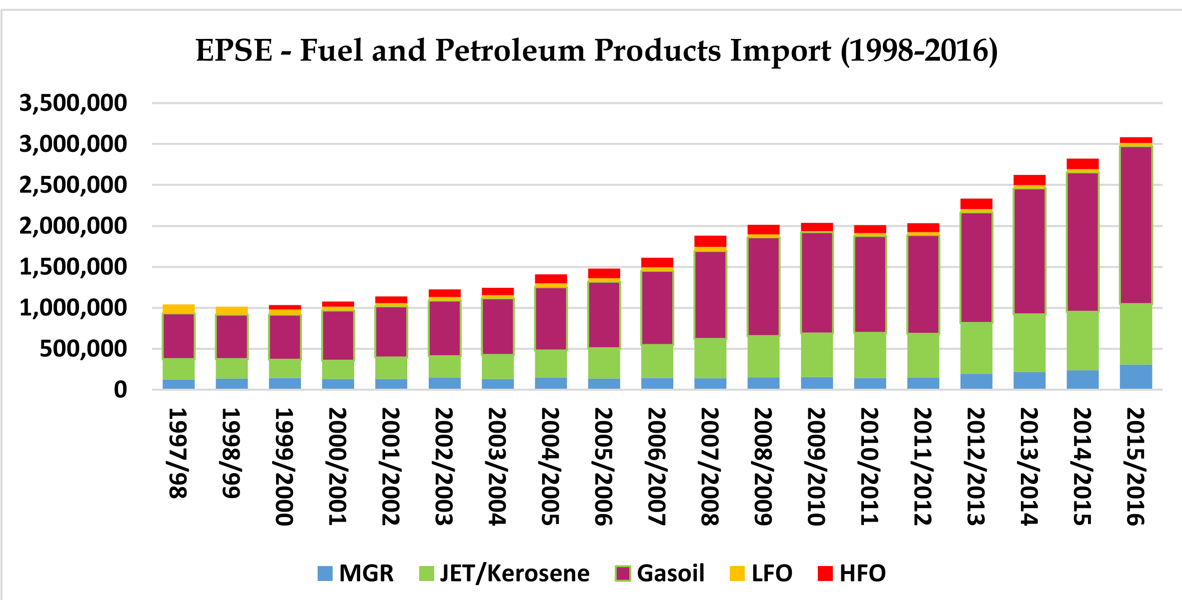
Source: Kundi Consultants Pls (2016) obtained from CITAC

In Ethiopia, so far, there has been no discovery of oil in commercial quantities. However, exploration for oil and natural gas is currently taking place in different areas of the country, including the parts of the Ogaden Basin, in Southern Rift Basin, the Gambela Basin, the Mekele Basin, Metema Basin, the Abay Basin in North Western and main Ethiopia Rift Basin regions. The sector is currently at a very early stage of development. However, it shows a good potential for development in the future (The World Bank 2016).

Over the past 50 years, the fuel supply chain management of Ethiopia had been regulated by government, including the price of fuel and the transport rate to be paid for Bulk Road Vehicle owners.

At present, Ethiopia spends 2.5 billion USD annually on imported petroleum products (The Reporter 2016), 20% of the country's imports of goods is purely spent on fuel (Euromoney 2014). The fuel demand would call for significant resources and put pressure on foreign current reserves which is currently absorbing more than 4% of the GDP, roughly equals the foreign currency and gold reserves and would increase to around 7% of GDP in 2030 (Federal Democratic Republic of Ethiopia, 2011 CRGE report). The country consumes daily one million liters of benzene, 6.5 million liters of diesel and two million liters of jet fuel. The annual kerosene consumption is 260,000 metric tons. The country's annual fuel consumption has been growing at a rate of ten percent per year. In 2017 the fuel consumption is expected to surge to 3.4 million metric tons.

Figure 7 – Petroleum product imported into the countries from 1998-2016

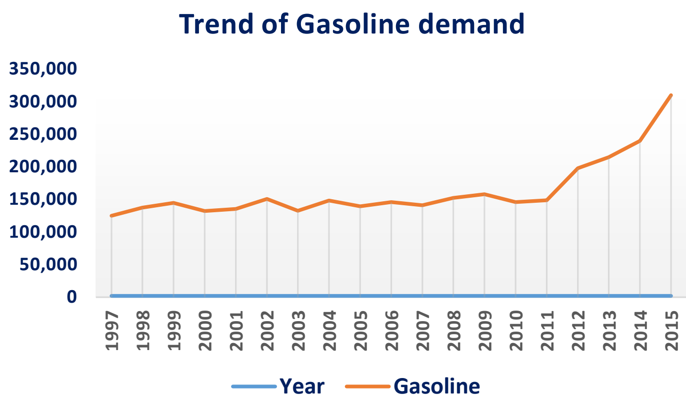


Data source EPSE - in metric tons

In Ethiopia, during the last five years the oil demand has increased on the average by 10% per year. Diesel accounts for 85%-87% of oil consumption. In the country, the fuel demand is more of driven by demand of the transport sector. Lewin (2003) states the importance of the sector in fulfilling most transportation needs, providing power and serving as a foundation for petrochemical business underpins the survival of other essential industries.

The figure below shows the trend of importation of main fuel into the country by product type.

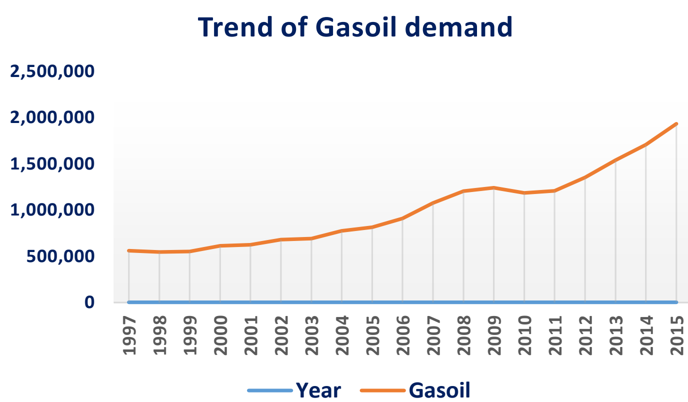
Figure 8 – Importation trend of Gasoline



The demand is growing due to increasing number of automobile in the country and introduction of Bajaj into the country

Source: EPSE - in metric tons

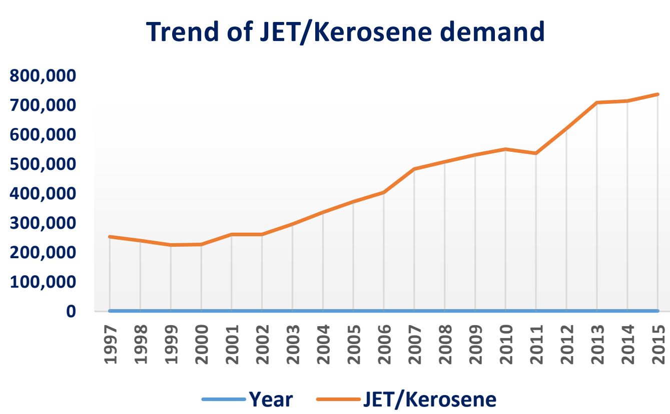
Figure 9 – Importation trend of Gasoil



The demand is growing due to boosting of infrastructure projects in the country, such as road, rail & dam.

Source: EPSE - in metric tons

Figure 10 – Importation trend of JET/Kerosene



The demand is growing due to increasing number of EAL destination.

Source: EPSE - in metric tons

The key players in fuel supply chain of Ethiopia, from importing the product up to distributing the product to the end customers are discussed on the next section.

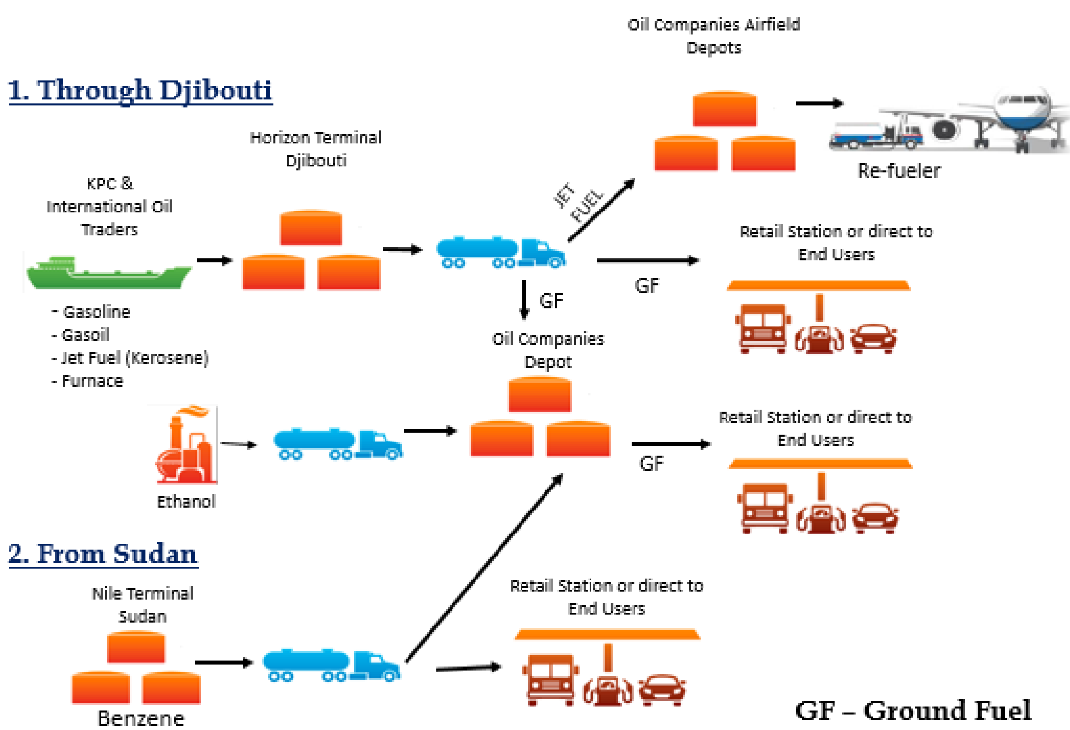
1.2 Downstream Petroleum Sector in Ethiopia

Since Ethiopia does not produce oil, to meet the country's oil requirement, the country imports fuels from oversea. Accordingly, the study focuses on downstream petroleum sector of the supply chain, particularly in purchase and distribution of petroleum product to customers.

Ethiopia buys 100 percent of the country's jet fuel consumption, 800,000 metric tons and 60 percent of diesel, 1.2 million metric tons from state-owned Kuwait Petroleum Corporation (KPC) that supplies the products directly from Kuwait using its own fuel tanker vessels. 30%-80% percent of Ethiopia's benzene consumption is bought from Sudan. The remaining are bought from international oil trading firms through an international open tender process.

A supply chain consists of all stages involved, either directly or indirectly, in fulfilling a customer request. The relationships among these companies have always involved some degree of collaboration and coordination to solve bottlenecks in the supply chain network and overcome bumps in demand and supply (Gonewa & Henry 2003). Through supply chain integration, the total supply chain network in the industry will work more efficiently by sharing valuable information, resources, knowledge and expertise with each other (Tamzidul 2012). Larry (2016) stressed that all partners of the network should be working together to satisfy end customers; organizations should work in a coordinated manner toward a common goal.

Figure 11 – Fuel Supply Chain of Ethiopia

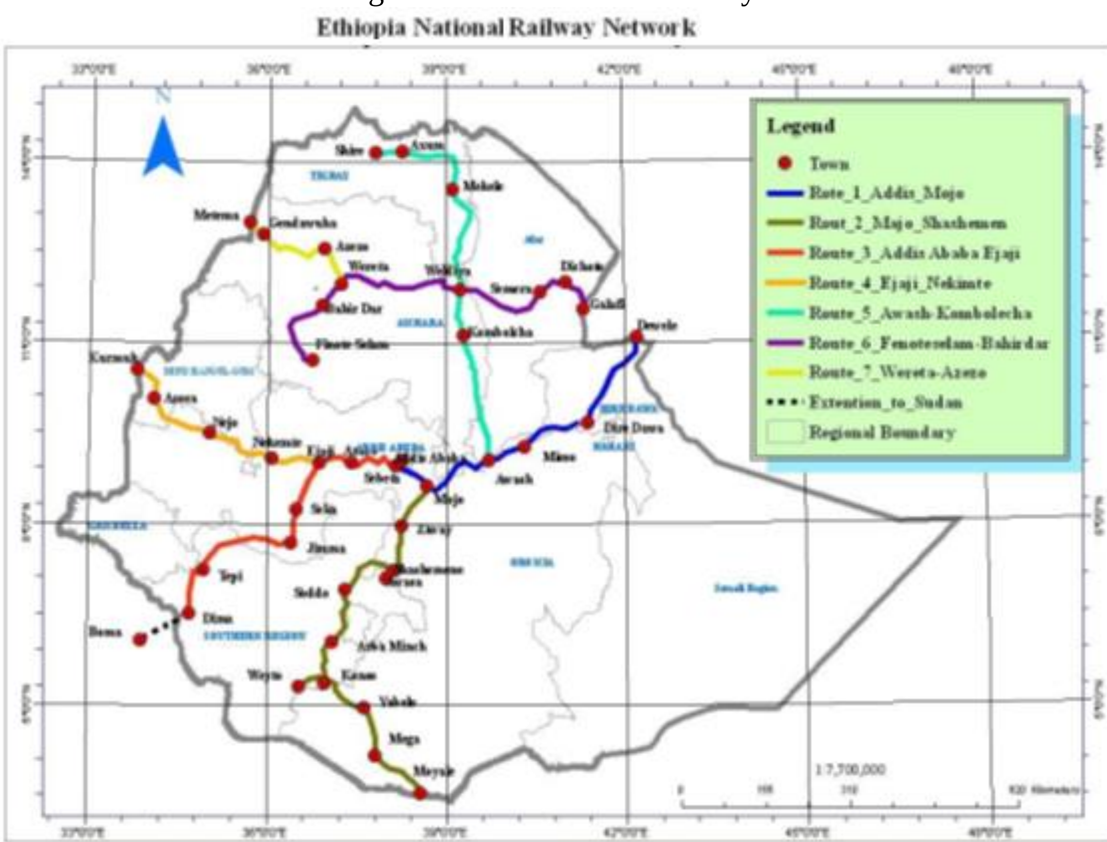


Source: Developed by the author

In Ethiopia, the demand for oil is growing exponentially. Fekadu (2013) mentioned that at present, liquid bulk cargo tanker trucks are transporting fuel from Duraleh petroleum terminal of Djibouti port and from Sudanese refinery at El Geli located 42kms north of Khartoum to the hinterland. The government has an intention of increasing the number of depots, but also to elevate the capacity of the existing depots. Accordingly, in Awash NPRDA depot a project for installation of additional 30,000 cubic meter tank is undergoing.

There is also a plan to use rail wagons using the electricity-powered railway system that has just been completed from Djibouti to Sebeta. The aim for the National Railway Network of Ethiopia is to build eight new railway lines for freight and passengers covering a total distance of 5,000 kilometers working across the country by 2020 (www.ethiopianembassy.be/en/2017). But the railway that connect to Duraleh petroleum terminal of Djibouti port and then from Awash main line to the Awash NPRDA depots have not been started yet. The areas to be supplied from this depot depends mainly on the number of trains to be dedicated for the purpose and the storage & loading capacity of the terminal. Using the railway will reduce the demand for fuel since part of the dry cargo and bulk fuels will be transported using the train which uses electricity as a source of power. There is also a plan to build a depot at a location some 30km south of Addis Ababa at Dukem connected with the newly built railway (The Reporter 2016) and BRVs to uplift from this depot. This will further reduce the total distance to be covered by the BRVs to deliver fuel to customers as well as the time required to deliver.

Figure 12 - The national railway network



Source - ERC, 2010 cited in Fekadu 2013

Fekadu (2013) stated that two Chinese state-owned companies have been involved in building of the rail way and transportation cost can be reduced further and environmental impact of fuel transport can be minimized by using train tankers and/or pipelines.

Besides, their rail transportation, there is a plan to stretch a pipeline up to Awash, the main stock reserve depot. The Reporter (2016) mentioned it is found viable a 550km-long pipeline that will stretch form Djibouti port to Awash national reserve depot, which is 250km to the east of Addis Ababa with a capacity of 100,000 cubic meters, so that the whole country can be supplied directly from Awash.

Key players in the overall supply and distribution of fuel in Ethiopia and their key roles are listed below.

Ministry of Mines, Petroleum and Natural Gas (MoMPNG): Until recently, the oversight of the oil and natural gas sector was split between ministries. The Ministry of Mines was responsible for upstream issues, including the allocation of exploration and production areas. The Ministry of Water Resources, Irrigation and Energy was responsible for downstream activities related to the use of domestic and imported fuels.

The consolidation of upstream and downstream activities under the MoMPNG provides the opportunity to adopt and implement a comprehensive strategy for the sector under a sector master plan (The World Bank, January 2016).

Ethiopian Petroleum Supply Enterprise (EPSE): EPSE is a government agency which is licensed by MoMPNG as a bulk supplier. EPSE imports oil, stores and sells petroleum products to Oil Companies. It was established in 2012 by the Council of Ministers Regulation No. 265/2012. It is an amalgamation of the Ethiopian Petroleum Enterprise (EPE) and the National Petroleum Reserve Depot Administration (NPRDA).

The EPE, established in 1995, was the sole entity established to meet the country's demand for petroleum, with the exception of liquefied petroleum gas (LPG), bitumen products, and lubricants. The NPRDA established in 1997, was an autonomous institution responsible for overseeing Ethiopia's petroleum reserves to maintain the regular petroleum supply in case of interruption or shortage (Fortune 2015).

Besides being the sole importer of fuel into the country, EPSE has a plan to build 160 retail stations across the country and involve in retailing fuel to public, to resolve the occasional shortage of petroleum (Oil Review Africa 2015).

International Oil Traders: They supply oil through an international open tender process.

Horizon Terminal Limited and Nile Petroleum Terminal: Since Ethiopia is a land locked county and does not produce oil, it is necessary to use as intermediate storage terminal of the countries through which the oil is imported. About 85% of the countries Gasoline consumption is purchased from Sudan Petroleum Corporation and loaded from Nile Petroleum Terminal whilst the rest of the product is imported via Djibouti port and stored at Horizon Terminal before it enters the country.

Horizon Terminal is operated by to Horizon Terminal Limited (HTL) and owned by ENOC. The terminal is located at Doraleh village, which is 10 kilometers from Djibouti Port, strategically located on the Red Sea. It provides service to both Djibouti and Ethiopia.

Bulk Distribution Companies (Oil Companies): These companies have been licensed by the MoT as bulk distributors. They purchase oil from EPSE and distribute the product either through their Retail Network or directly to commercial customers. At present, there are thirteen Oil Companies in the country; namely Oil Libya, Total, National Oil Ethiopia (NOC), Yetebaberut Beherawi Petroleum (YBP), Kobil, TAF, Nile Petroleum, Wadi Alsundus (WAS), Dallol, Olway, Gomeju, Yeshi, and Getnet. All are local companies, except Libya, Total, Nile and WAS.

As per the monthly fuel uplift report compiled by EPSE Oil Libya, Total, National Oil Ethiopia (NOC), Yetebaberut Beherawi Petroleum (YBP) and TAF uplift more than 85% of the countries consumption.

Ministry of Trade (MoT): The MoT was re-established in August 1995 under the proclamation No. 4/1995. The Ministry was again reorganized with a proclamation No. 619/2003. The main objectives of the ministry is to ensure a modern fair trading practices. The ministry has three main responsibilities:

a) Provides a trade license for Oil Companies and dealers (fuel station operators).

b) Regulates and establishes the price of fuel in the country by preparing a price build up that shows the price structure from purchasing price at Djibouti and Sudan up to the pumping price at the station. The price build-up is used by all stakeholders involved in the marketing and distribution process (including transport rate to be paid to Bulk Road Vehicles).

c) Calibrates Bulk Road Vehicles and dispensing pumps/meters installed at depots and stations.

The Ministry retains regulation of the entry of petroleum marketing firms in the downstream sector. It requires the Oil Company to construct a depot that can store a minimum of 500,000 liters and have a minimum of 6 filling stations before issuing a license to operate as oil distributor in Ethiopia. Although, the requirement is not implemented strictly.

Retailers (Dealers): They procure oil from Oil Companies and sell to bulk consumers and the general public through fuel stations. There are more than 300 retailers in the country and are either company owned & dealer operated (CODO) or dealer owned & dealer operated (DODO).

1.3 Statement of the Problem

Ethiopia is implementing the second 5-year growth and economic transformation plan that aims to sustain or exceed the decade long double digit growth trajectory. This vibrant economic growth needs to be supported by a robust, safe and operationally sustainable downstream oil sector.

In recent years, it has been witnessed a sporadic shortage of supply of fuel in the country. Even though the level of intensity has reduced to a certain extent, the problem persists. For example, there was shortage of Gasoil from November 24-29, 2016 and from December 14-17, 2016. Even recently, from May 1-12, 2017. (Fortune 2017). In some of the events, it is observed Ethiopian Petroleum Supply Enterprise (EPSE), Oil Companies, and Retailers giving different reasons sometimes contradicting each other.

EPSE mentions there is adequate product, but Oil Companies and fuel stations are hoarding the product or not uplifting adequately from the supply points speculating price decrease respectively. Or there was shortage of product just for few days and now we have adequate supply, but it is vague why still there is shortage of product in the cities. On the other hand, Oil Companies states there was shortage of supply at the main supply points and still the problem persist or stabilizing the supply needs more time. Whereas, fuel stations mention that they have placed orders but are not supplied by Oil Companies and there is no product that we hoard from our customer.

This shows there is some sort of integration problem in the supply chain network. Christopher (2007) emphasizes one of the weaknesses of a supply-chain is that each company is likely to act in its best interests. The goal of satisfying the ultimate customer is easily lost and opportunities that could arise from some coordination of decisions across stages of the supply-chain could also be lost. Most SCI related problems emanate, either from uncertainties or an inability to co-ordinate several activities and partners (Sweeney 2011).

When the shortage occurs, customers suffer since at present there is no other substitutes that serve the same purpose. It touches on people's everyday lives with services ranging from transportation, electricity, heating, etc. (Richard & Francis 2014) and construction works which involve heavy machineries such as construction of dams and road. As soon as motorists notice there is no fuel in one of the stations or there is queue of cars in stations, they will get panic, join the line and purchase more fuel than they usually purchase, thinking the shortage will continue for some time. This will further aggravate the issues by depleting the stock earlier than expected.

To achieve a smooth and reliable supply of fuel in the country, all partners involved in the fuel supply chain need to follow integrated approaches and always share a big picture.

Regardless of the impact of the problem on the country's economy and every one's life, no study has been made on the root cause of the shortage and thereby to look for a sustainable solution. This study is a modest contribution to this end.

1.4 Research Question

To achieve the objectives of the study presented on section 1.5, the questions below will be investigated.

Q1: What are the challenges for integrating the fuel supply chain between EPSE and International Oil Traders (suppliers to EPSE)?

Q2: What are the challenges for integrating the fuel supply chain between the Oil Companies and EPSE?

Q3: What are the challenges for integrating the fuel supply chain between the Oil Companies and the Fuel stations?

Q4: What are the challenges for integrating the fuel supply chain between the Oil Companies and Commercial customers?

1.5 Objective of the Study

1.5.1 The main objective

The main objective of the study is to establish challenges which inhibits effective implementation and use of supply chain integration in the industry and how these affect the supply of oil in the country.

1.5.2 The specific objectives

Based on the above main objective of the study and the problem statement, the study will have the following specific objectives:

a) To examine the country's end to end fuel supply chain activities and processes - identify if there is misalignment of processes and activities and device a mechanism how it can be streamlined;

b) To examine the information flow within the supply chain partners - identify if there is information gap and advise what information can be shared consistently across the supply chain members on timely manner.

c) To examine how the supply chain partners coordinate and collaborate their effort – identify if there is lack of coordination or collaboration and see how to achieve seamless coordination and collaboration towards serving the end customer.

CHAPTER 2: PRELIMINARY LITERATURE REVIEW

2.1 Supply Chain of fuel

Commodities such as oil, gas, and petrochemicals are transported using different mode of transportation such as pipe-lines, vessels or tankers, roads, and railroads. These commodities are produced in limited places of the world, yet they are demanded all over the globe since they are an essential source of energy and raw material for many other industries (Raed, Tiravat, Basheer, 2006).

The boom in global demand of oil along with the ease of international trade and the inflexibility involved in the petroleum industry's supply chain has made its management more complex and more challenging (Coia 1999 cited in Barua 2010).

A supply chain consists of all stages involved, either directly or indirectly, in fulfilling a customer's request (Chopra & Meindl 2001). John, C. John, Rober & Brain (2013) describe supply chain as an extended enterprise that crosses the boundaries of individual firms to span the related activities of all the companies involved in the total supply chain. There is a tremendous need to get everyone to pull together in the same direction (Handfield 2016); should attempt to execute or implement a coordinated, two-way flow that bring products or services to market (Lambert, Stock, and Ellram 1998). It includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers (CSCMP 1984). Organizations have realized that effective and efficient management of supply chains is essential for present and future survival (Olhager, Perssom, Parborg, & Rosén 2002 cited in Gupta, Abidi & Bandyopadhayay 2013).

Shah, Li, and Ierapetritou (2011 cited in Shatina, Zulkifli & Norlena 2014) state that, a typical petroleum industry supply chain is composed of an exploration phase at the wellhead, crude procurement and storage logistics, transportation to the oil refineries, refinery operations, and distribution and transportation of the final products.

Christopher (2007) states in a supply-chain, a company will link to its suppliers upstream and to its distributors downstream in order to serve its customers. The links shown below represent the major supply-chain links in the oil and gas industry. The links represent the interface between companies and materials that flow through the supply-chain. Currently, more opportunities exist for coordinating supply chain activities across oil and gas operations due to improved information and communication systems and technologies (Christopher 2007 cited in Richard & Francis 2014).

Exploration → Production → Refining → Marketing → Consumer

A hiccup in one of links early in the supply chain can have a ripple effect on a link further down the chain (Norman 1996). Thus, a breakdown anywhere in the supply chain has the potential of bringing production to a halt (e.g., strikes at two GM parts plants in 1998 resulted in the shutdown of virtually all assembly operations within days). Supply chain participants must individually and collectively assess the probability of production-stopping events and their tolerance for risk, which must be balanced against the savings from increased sole-sourcing, tighter integration with the remaining suppliers, and reduced inventories and production capacities (National Research Council 2000).

Shatina, Zulkifli & Norlena (2014) mention the petroleum industry can be characterized as a typical supply chain where all levels of decisions (strategic, tactical, and operational) may arise in it. Oil companies have formed a key part of the global economy for the last decade since petroleum or crude oil has become the main fuel source.

Shah, Li, and Ierapetritou (2011 cited in Shatina, Zulkifli & Norlena 2014) mentioned that in the exploration and production sectors of the oil industry, the product from the source is the same for all competing firms. Consequently, many of these firms cannot differentiate themselves from one another by differentiating their product. Thus, companies can only differentiate themselves based on the ability to economically find and produce oil and gas more efficiently than their competitors. The differentiating factor can lie in the ability to adapt a sound supply-chain management program.

They recommended the following eight strategies for improving oil and gas industry supply-chains.

a) **Segment customers based upon service needs -** matching of what is produced, when it is produced and the quantities to be produced to the specific customer requirement.
b) **Customize the Logistics Network -** deliver the product-service bundle in the quantities and particularly, timing requirements set by the customer.
c) **Watch for market signals and plan accordingly –** to minimize bullwhip effect.
d) **Form partnerships to enhance supply-chains** – the relationship should not be adversarial.
e) **Apply strategic sourcing -** suppliers who have consistently demonstrated superior performance to be provided a favorable status, including customer loyalty and preferential treatment.
f) **Adapt a supply-chain wide technology strategy –** more integrated approach to exploration, production, refining and marketing operations.
g) **Develop channel spanning performance measures –** developing supply-chain-wide performance measurement.
h) **Adapt or create operational innovation – "**news ways of doing work" (Close 2006)".

The same applies to downstream sector players (EPSE, Oil companies and Retailers) that are involved in the distribution of oil, besides they must ensure:

- Maintaining reliable supply to the customer.
- Reaching the customer by opening site near the customs – increasing access and choice for consumers in terms of driving distance and time to reach a Retail Station.
- Providing clean product (none-contaminated).
- Having good Customer Service Management.

2.2 Supply Chain Integration (SCI)

Supply chain management will be able to run optimally when there is a synergy between all the components involved in every activity from upstream to downstream (Ketchen & Hult 2007). SCM seeks to enhance competitive performance by closely integrating the internal cross-functions within a company and effectively linking them with the external process of suppliers, customers, and other channel members to be successful (Narasimhan & Jayaram 1998 cited in Alexander, Jonathan & Emmanuel 2013).

Supply chain integration, is the degree to which an organization strategically collaborates with its supply chain partners and collaboratively manages intra and inter-organizational processes, in order to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer (RMS Consulting 2014). These partners either succeed as a whole in delivering superior value to the end customer or they do not (Christopher 2007).

Clancy (1997) cited in Putzger (1998) describes SCI as an attempt to elevate the linkages within each component of the chain, to facilitate better decision making and to get all the pieces of the chain to interact in a more efficient way. Supply chain integration is the extent a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes (Flynn, Huo & Zhao 2010 cited in Krishnapriya & Baral 2014).

Sezen (2008) argued that proper implementation of supply chain integration in the organizations will meet individual customers' demand, reduce delivery time, decrease logistics and purchasing cost, reduce the level of inventories and increase work force efficiency and market share by sharing the supply and demand information. Integration is a process of redefining and connecting parts of a whole in order to form a new one (Craft 2006). Supply chain integration is, to a great extent, concerned with the development of more integrated approaches that hold out the prospect of eliminating many of the inefficiencies directly attributable to supply chain fragmentation (Sweeney 2011).

Singh and Power (2009), Ou, C. S., Liu, F. C., Hung, Y. C., Yen & D. C. (2010), Wiengarten, Humphreys, Guangming, Fynes & McKittrick (2010) cited in Alexander (2013) indicated that in recent years, there has been a great deal of empirical evidence to show that successful SCI can improve a firm's performance and competitive advantage. Gimenez, Vaart, and Donk (2012 cited in Krishnapriya & Baral 2014) in their research show that supply chain integration increases performance moderated by a context variable like supply chain complexity.

SCI problems and inefficiencies can consume a considerable amount of resources, money and time, and ultimately lead to customer dissatisfaction. Most supply chain management related-problems stem either from uncertainties or an inability to co-ordinate several activities and partners (Turban, McLean, & Wetherbe 2004).

Researchers tried to define SCI from different dimensions and perspective, but all have mentioned about the need for collaborative relationship, information sharing and to work as a single entity with a common objective to serve the end customer. Although, the importance of supply chain relations is widely acknowledged, seamless coordination is rarely achieved in practice coupled with several challenges (Alexander et al, 2013).

According to (Amue1 & Ozuru 2013), SCI is the integration on information, knowledge, processes and through which different functions within and outside of the sector can work together to enhance the level of efficiency as well as reduce the cost of operation to increase organizational effectiveness. Integration in this context refers to the extent to which various supply chain activities and processes work together in as seamless manner as possible (Sweeney 2011). He continues, and mentions that there is significant evidence confirming effective implementation of integrated SCM has the potential to generate significant improvements in the performance of firms.

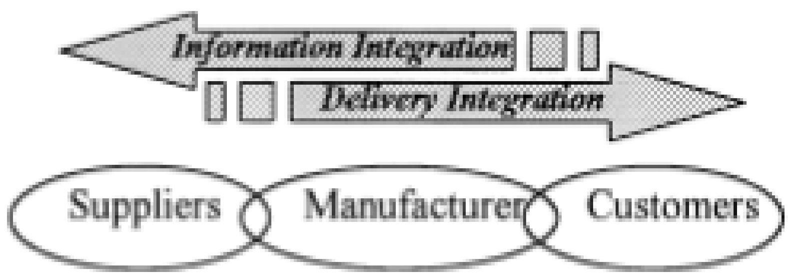
Handfield and Nichols (cited in Power 2005) outlined the main drivers of integration are:

- The information revolution;
- Increased levels of global competition creating a more demanding customer and demand driven markets; and
- The emergence of new types of inter-organizational relationships.

According to them, the three principal elements of an integrated supply chain are information system, inventory management, and supply chain relationships.

Langley and Holcomb (1992) and Shapiro, Singhal & Wagner (1993) mention that literatures suggest that there are two interrelated forms of integration that manufacturers regularly employ (Fig. 9). The first type of integration involves coordinating and integrating the forward physical flow of deliveries between suppliers, manufacturers, and customers. The other predominant type of integration involves the backward coordination of information technologies and the flow of data from customers to suppliers. Information technologies allow "multiple organizations to coordinate their activities in an effort to truly manage a supply chain".

Figure 13 – Integration in Supply Chain



Source: (T. Frohlic; Westbrook, 2001)

Besides, they depicted the strategic position of each respondent with respect to the extent of supply chain integration development using "arc of integration" and empirically proofed that Companies with the greatest arcs of supplier and customer integration will have the largest rates of performance improvement. Researchers cited in Alexander *et al.* (2013**)** argue the best integration strategy must involve "complete integration".

Lambert and Cooper (2000 cited in Power 2005) mentioned that integrating and managing all process links throughout the entire supply chain is likely not appropriate. Since the drivers for integration are different from process link to process link, the levels of integration should vary from link to link, and over time.

Bask and Juga (2001) state the relationships between organizations are delicate and complex and no one recipe exists on how the supply chains achieve best performance. For some companies, tight integration is the answer under regimes like efficient consumer response, quick response, etc. For others, intensive integration may be the goal in selected areas of SCM, while in other areas it can be beneficial to strive for limited integration.

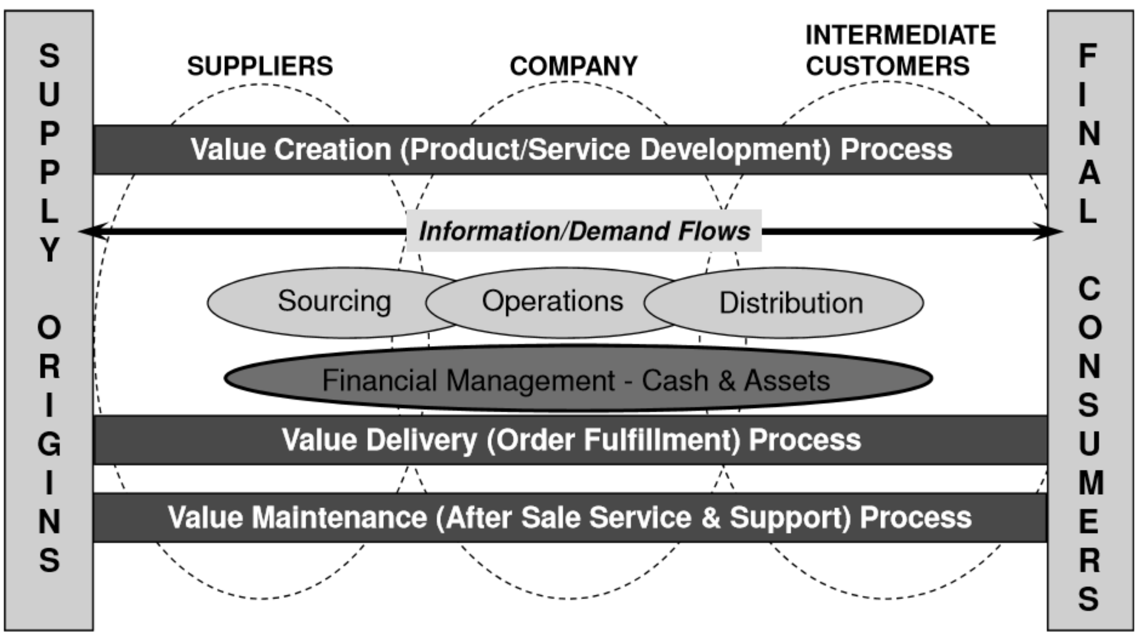
There are researchers who consider SCI as two dimension: internal integration and external integration (Tutuncu and Kucukusta 2008).

According to Katunzi (2010), the pillars of supply chain integration are cooperation, collaboration, information sharing, trust, partnership, shared technology, and a fundamental shift away from managing individual function processes, to managing integrated chains of process.

Alexander *et al.* (2013) argue that SCM has three independent variables: internal, suppliers and customer integrations. Flynn *et al.* (2010 cited in Alexander *et al.*) established the link between SC integration (customer, supplier and internal integration) and their interactions on performance. Frohlic and Westbrook (2001) argue that over the past decade there has been a growing consensus among researches concerning the strategic importance of integrating suppliers, manufacturers, and customers.

Similarly, Whipple (2016) mentioned in a more comprehensive way that to have a complete SCI to essential to have internal integration, supplier integration and customer integration which focus on the alignment of value creation, value delivery and value maintenance processes with effective follow of information across the boundaries.

Figure 14 –Integrated Supply Chain



Source: (Judy Whipple Professor, 2016)

Awad & Nassar (2010) try to classify supply chain challenges into three part,

a. The Business Micro-environmental challenges - challenges related to the challenges that effect the supply chain integration from inside the organization's environment.

b. The Business Macro-environmental challenges (relationships) - challenges related to the challenges that effect the supply chain integration from outside the organization's environment and

c. The Technical challenges of SCI - challenges related to the technical challenges that effect the supply chain integration from inside-outside the organization's environment which is more or less related to information technology.

Stevens (1989) classifies SCI into three levels, from functional integration to internal integration and to external integration. He mentioned that the result of his study confirms with the existing literature and aligned with organizational theory as proposed by other researchers, which suggests that, there are three levels of integration that leads to improved performance and competitive advantage.

Functional Integration is the process of integrating key business processes. As a firm begins to divide labor and seek specialization among organizational members, it is necessary to make certain that everyone continues to work toward the common goals of the organization. Thus, coordination and control of actions among firm members become imperative (Mintzberg 1996 cited in Matiwos 2013). While functional excellence is important, it must be supportive of overall logistical competency.

Internal Integration is a process of inter-functional interaction, collaboration, coordination, communication and cooperation that bring functional areas together into a cohesive organization which can be accomplished through automation and standardization of each internal logistics process, introduction of new technology, and continuous performance control under formalized and centralized organizational structure (Bowersox 1989).

External Integration is a process where firms collaborate with their customers and suppliers to obtain information and complementary resources, which they can deploy to build competitive advantage. It involves: customer integration - refers to the process of interaction and collaboration between an organization and its" customers to ensure an effective flow of products and/or services to customers (Zhao, Xie, & Zhang 2002) and supplier integration refers to the process of interaction and collaboration between an organization and its suppliers to ensure an effective flow of supplies (Zhao, Baofeng, Willem, Jeff Hoi 2011).

Bowersox, Closs and Stank (2001 cited in Katunz 2011) have classified integration in a supply chain context in six different types. These are customer integration, internal integration, material and service supplier integration, technology and planning integration, measurement integration, and relationship integration.

Lee (2000 cited in Skjott-Larsen & Bagchi 2002) outlines three dimensions of supply chain integration: information, coordination and organizational linkage. Information integration refers to the sharing of information and knowledge among the members in the supply chain, including sales forecasts, production plans, inventory status and promotion plans. Coordination refers to the realignment of decisions and responsibility in the supply chain.

Organizational linkages include communication channels between the members in the supply chain, performance measurement, and sharing of common visions and objectives.

Gimenez & Ventura (2005), Stock, Greis & Kasarda (1998) and Amue & Ozur (2013) measure the strength of supply chain integration from three dimensions: Information integration, Collaboration and Coordination and Process integration.

Information integration: Sharing online information throughout the supply chain network enables the connected firms/units to integrate value chain and entire value systems. Through sharing accurate information timely and maintaining close communication within the supply chain network, better customer service can be ensured, more accurate demand can be forecasted, companies can get market information in real time and more accurately (Amue1 & Ozuru 2013). Rabobank (2013 cited in Krishnapriya & Rupashre 2014) stated that when each member of the chain enters into longer-term partnerships, information relating to each link could be shared across parties, enabling greater flexibility (Leach 2013). According to Coyel, Bardi & Langely (1988), quality of information is characterized by three issues:

a) Having the right information available to make the best possible decisions.
b) Making sure that the information is as accurate as possible.
c) Effectiveness of the various means that are available to communicate information.

The way information is communicated plays an extremely important role in external process integration (Lambert 2008 cited in Katunzi 2011). According to Lambert and Cooper (2000 cited in Dannis & Kampton 2010), operating an integrated supply chain requires continuous information flows which in turn assist to achieve the best product flows.

Collaboration and Coordination: A common feature of these approaches was recognition that 'the whole is greater than the sum of the parts'. Delaney (2000) states that collaboration allows companies to "leverage each other on an operational basis so that together they perform better than they did separately". Collaborative relationships internally and externally are necessary ingredient for success (John, C. John, Rober, Brain 2013). Teece, Pisano & Shuen (1997 cited in Shatina, Zulkifli & Norlena 2014) identified a dynamic collaboration capability should help a company access, shift and leverage supply chain resources to rapidly respond to a changing competitive environment.

For cooperation to exist, channel members must agree that they have concerns of mutual interest, must work together toward the achievement of those goals, and must collectively have the ability to create logistical and transactional channels that will enable the channel as a whole to be competitive in the market places (Coyel, Bardi & Langely 1988).

Process integration: it involves collaborative work between buyers and suppliers, joint product development, common systems and shared information. Lambert and Cooper (2000 cited in Dannis & Kampton 2010) support the idea that optimizing the product flows cannot be accomplished without implementing a process approach to the business. Viewing the supply chain as a set of integrated process capabilities can be used to improve performance; complex activities can be coordinated to great advantage between functions and redundant or non-value-added activities, can be eliminated (National Research Council 2000).

The oil industry is one of the largest and most complex industries in the world that encompasses many stakeholders, involves huge investment and touches on peoples' everyday lives with services ranging from transportation, electricity, heating, etc. (Richard & Francis 2014), using integrated process across the network will enhance the overall process.

Shared information between supply chain partners can only be fully leveraged through process integration. By connecting the business process both within the enterprise and between enterprises, the network moves the information and intelligence by extending the reach and richness of the information (Westbrook 2002). He continued and emphasizes that information can be available across the supply chain through a collaborative process and the logistics of making, distributing and delivering good become more efficient.

Regardless of the petroleum sector existed for decades and the essential role it plays in fulfilling most transportation needs, literature related to supply chain of oil, in particular on challenges of integration of oil supply chain are very few.

2.3 Challenges and obstacles of logistics of fuel supply

For the purpose of this research, among many definitions of logistics, the definition used by Council of Supply Chain Management Professionals will be used "logistics is part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, service, and related information from point of origin to point of consumption in order to meet customer requirements". Or it is 'the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimizing the goods- or service-producing network to fulfil customer requests; and utilizing the network to fulfil customer requests in a timely way' (Tilanus 1997 cited in Tseng & Yue 2005).

Oil is produced in a few places, but the demand is everywhere. For more than a century, oil has been the lifeblood of our transportation system. In the oil industry, product reaches to end customer through channel of distribution. Where channel of distribution is any series of firms or individuals who participate in the flow of goods and services from the producer to final user or consumer (Ammer & Material, 1980). Usually, the lead time from the shipping point to the final customers' location takes weeks in this industry (Raed, Tiravat & Basheer 2006). They continued and mentioned that opening new production sites or distribution centers closer to dispersed customers is one way to reduce the lead time and transportation costs. However, the acquisition of such facilities in the oil and petrochemical industries, if feasible, is typically very costly and often results in higher inventory and operating costs (Hebert 2004). Red Cavaney, president of the American Petroleum Institute, said that "Most companies are unlikely to undertake the significant investment needed to even begin the process" (cited in Hebert 2004). Companies therefore have recognized that improved supply chain efficiencies represent a huge area for cost savings, specifically in the logistics area; they are estimated to be an average between 10 and 20 percent of revenues (Hamilton 2003).

According to Chopra and Mendhl (2001), a number of factors can impede external process integration along the supply chain, causing information distortion, longer cycle times, stock-outs, and bullwhip effect, resulting in higher overall cost and reduced customer service capabilities.

These obstacles are summarized below (Katunzi 2011):

- **Silo Mentality** - Failing to see the big picture and acting only in regard to a single department within the firm or a single firm within the supply chain.
- **Lack of supply chain visibility** - The inability to easily share or retrieve trading partner information in real time, as desired by supply chain participants.
- **Lack of trust** - Unwillingness to work together or share information because of fear that the other party will take advantage of them or use the information unethically.
- **Lack of knowledge** - Lack of process and information system skills and lack of knowledge regarding the benefits of SCM among management and other employees, within the firm and among partners.

On the other hand, Awasthi & Grzybowska (2014) identified 17 factors affecting the integration of the supply chain through a survey addressed to experts from Poland and Canada. The result of their study shows the top five barriers in supply chain integration are:

- Lack of Resource sharing (integration),
- Lack of Organizational compatibility,
- Lack of Information sharing,
- Lack of Responsibility sharing, and
- Lack of Planning of supply chain activities

The study will focus on logistics process which is the main challenge of the downstream sector of petroleum industry. Special problems and features that relate to logistics of fuel supply are listed below:

a) The oil and petrochemical industries are global in nature. Thus, these commodities and products are transferred between locations that are—in many cases—continents apart. Usually, the lead time from the shipping point to the final customers' location takes weeks in this industry. The long distance between supply chain partners and slow modes of transportation induce not only high transportation costs and in-transit inventory, but also high inventory carrying costs in terms of safety stocks at the final customer location (Raed, Tiravat, Basheer 2006). In the case of Ethiopia, according to The Reporter (2016) a truck takes four and a half days while the rail cargo takes eight hours from Djibouti to Addis Ababa and with up to 3,000 Tons of cargo transported in one go (www.railway-technology.com 2016).

b) Opening new production sites or distribution centers closer to dispersed customers is one way to reduce the lead time and transportation costs. However, now a day the acquisition of such facilities in the oil and petrochemical industries, if feasible, is typically very costly and often results in higher inventory and operating costs (Hebert 2004 cited in Raed, Tiravat & Basheer 2006). In some developed countries, the number of retail stations has reduced significantly over the last two decades due to competition, for example in UK, between 2001 and 2011 the number of Retail Station has reduced from 12,258 in 2001 to 8,677 in 2011 (a 29% decrease). On the average a customer is expected to drive 10 minutes to access petroleum (Deliotte 2012). In Ethiopia, the number of station is increasing, but not at rate required and customers are expected to drive more distance to get access or purchase from their choice, especially in rural areas. This is mainly since the cost of building a distribution center is very high and the payback period is not encouraging.

c) Because fuel is so easily ignited, it must be handled with great care. It is one of the most hazardous substances that we use. It requires a special precaution at the time of storage, loading, discharging, transporting, and usage. Shatina, Zulkifli & Norlena (2014) mentioned that from a health, safety and environmental perspective, there is a continuous concern for safety in Oil & Gas operations.

d) Given the adoption by most contemporary producers, manufacturers, suppliers and even entire industries of just-in-time processes, contemporary supply chains do not have buffer inventories held at specific points within the supply chain to accommodate disruptions (So & Sun 2011 cited in Al Fayad 2006); they are dependent on frequent replenishment. In the Oil industry, inventory is expected to be held by all members in the supply chain, but each member has a constraint in terms of storage capacity and working capital (inventory carrying cost). When it comes to retail station storage capacity, in some countries like UK provide a cover for six to eight days in case of fuel disruption if the retail stations capacity is fully utilized (Deliotte 2012). In Ethiopia, where the number stations in the country is low and their storage capacity is low, the cover might extend for one half day to three days. Hence, they must replenish more frequently. When disruption of supply sustained over a period of time, most of the Oil Companies and Stations are observed to be out of product since they are reliant on frequent refueling. Similarly, consumer may not fill their fuel tank fully each time they go to Retail Station which may in turn reduces the number of days cover. As a result, whenever there is a shortage of supply at the station, the customer will be impacted within short period of time.

e) Fuel expands when the temperature raises and contracts when the temperature falls. Gasoline has 1% volumetric change for every 15^0 F change, and diesel has 0.6% volumetric change for every 15^0 F change (Siebert 2007). Subsequently, the volume of fuel various with the temperature of the tanker which in turn depends on the atmosphere temperature. To avoid volume difference due to temperature variation, standard volume measurement is used at the supplying terminal and receiving site (usually the volume at 15^0 and in the case of Ethiopia it is 20^0).

   Thus, at the time of loading, on the Delivery Note provided by the supplying terminal, both the observed volume and the volume at standard temperature, which will be obtained using API Petroleum Table shall be written.

f) Most depots have set a tolerance limit as a Transit Loss, .080% & .15% for Diesel & Kerosene and Benzene respectively that will be used at the time of receiving product. The average loss rates of gasoline tended to exceed the average loss rates of diesel (Yan 2008). This tolerance is provided taking into account the following two assumptions:

   i. Lose due to evaporation; while the product moved from loading terminal to discharging depot
   ii. Accuracy of the loading meter; it is difficult to ensure the accuracy of the meter 100%

In Ethiopia, depots receive product after measuring the observed volume and temperature of the product and converting the volume into standard volume (volume at 20^0). Whereas stations do not measure the temperature, they simply consider the observed volume is the standard volume (at 20^0) regardless of temperature inside the tanker. Thus, when the product temperature inside the tanker is higher than 20^0, the actual volume they receive is less than the standard volume. The reverse is true when the product temperature inside the tanker is less than 20^0.

g) Petroleum products distribution is faced with short deliveries (Abdulmalik and Omokoghio 2009), most of the delivers encounter short delivery. The petroleum products are entrusted to the transporter and driver until the point of discharge at the dealers' premises. It is usually within this stage of the supply chain that short deliveries are experienced, where the quantity loaded is less than what is recorded at the discharge point. It has become a perennial problem in the industry to see short deliveries daily.

h) Product adulteration is one of challenge in the distribution of fuels to end customer in the countries where there is significant price variation between kerosene and other products (Gasoline and Gasoil) – where the price of Kerosene much lower than the two products.

When it comes to Ethiopia where the transport rate is fixed by government and not revised regularly to reflect the prevailing cost of a Bulk Road Vehicle and the associated maintenance cost, fuel transportation is not considered as an attractive business. Thus, for the last couple of years, the available fleet in the market did not grow in line with the demand of the industry and subsequently shortage of Bulk Road Vehicles becomes an acute problem, which led Oil Companies to snatch transporters from each other by providing different loans in the form of advance payment.

i) Discharging and loading cannot be done simultaneously into and from a tank since coagulation of sediments that usually settle at the base of the tank can be shaken and pass through the dispensers and it is recommended to wait until the product settle. Thus, whenever a product is being discharged into the storage tank (even at stations), loading (selling) operation from the tank must stop. Once the product arrives at station, it will take a minimum of an hour and half for a product to be ready for sale (15 minutes for a product inside the fuel tanker to settle, 45 minutes to discharge a lorry and 30 minutes to settle inside the tank of the station).

j) When customers purchase from Retail Stations, the volume is measured using a meter installed on dispenser pump. These meters are open for manipulation and need to be calibrated on a regular basis. It is the responsibility of regulatory body to randomly check on the correctness of the meter. In the case of Ethiopia, it is done by MOT. It is a huge task to the Ministry since the stations which are dispersed across the country.

k) Since fuel is considered as a strategic commodity, most countries have a National Reserve depots which are located at different geographical locations across the country to hold adequate stock which would be used when there is source of supply from the main supply point or transportation of the product is blocked somewhere between the supply point and intended destination.

In Ethiopia, there are 13 strategic depots which are located at different geographical location of the country. These depots are used when there is shortage of product at the main supply point or when the road is blocked due to flood within Djibouti territory.

l) Operation loss at the depot is a common phenomenon which is attributed mainly to the following three causes:

i. Emission lose – due to volatile nature of the product, this is expected at the time of discharging the product.

ii. Left over - since it is difficult to discharge all product to the last liter from the Bulk Road Vehicle, there is always some left overs.

iii. Tolerable Transit Loss - since loading and discharging happens at different temperature and the product travels long distance, there is a tolerable transit loss that will be considered at the time of receiving product at the terminal.

2.4 Management decisions in Supply Chain of fuel (in Downstream Business)

As defined earlier, supply-chain management involves configuration, coordination, and improvement. There are decisions to be considered in the downstream business of fuels supply chain adopted from (Christopher 2007) are:

Supply chain configuration:

- What product-service bundle to sell in each location. For example, in the areas where Kerosene is not required (not residential area), not to avail kerosene in retail station,
- Facility capacity (storage capacity of the tank in depots, stations and customer sites),
- Location of facilities (depots and stations –convenience to customers),
- Type of technology to adapt (depot and station automation),
- Fleet size based on expected sales volume & distance to be covered,
- Handling communications between suppliers and customers (for example order placing through EDI, email, phone, etc.),
- Standards expected of customers and suppliers,
- Mode of transportation,
- From which depot to supply a customer & using which route

Supply chain members' coordination:

- Ensuring supplier effectiveness in cost,
- Timeliness of delivery and product quality (adulteration free),
- Setting appropriate targets for inventory, capacity, and lead time,
- Online sharing of demand information based on actual sales to avoid bullwhip effect,
- Monitoring demand and supply conditions,
- Informing any change to happen to customers and suppliers promptly,
- Watching for Market Signals and Plan Accordingly,
- Forming Partnerships to enhance Supply-Chains,
- Communicating market and performance results to customers and suppliers.

Improvement of the supply chain requires continuous evaluation and involves changing as required, the configuration and/or the approach to coordination in order to enhance the performance of the overall chain. It has been suggested that demand variability amplification in a supply-chain is problematic, but can be dampened by operating the supply-chain more coherently by using information sharing and lead-time reduction. The effect of such a move is simply to reduce costs along the chain (Christopher 2007).

2.5 Benefits of supply chain integration

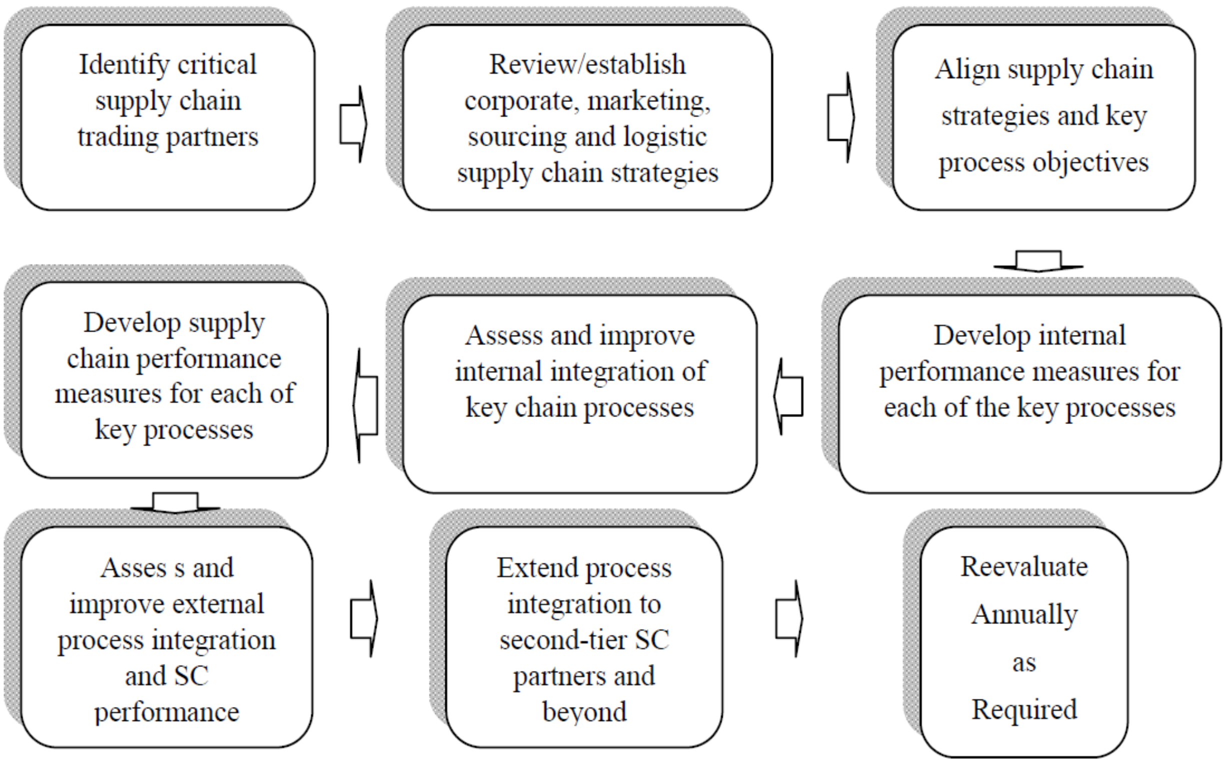
According to National Research Council (2000) & Katunzi (2010), potential benefits of supply chain integration are:

- Cost savings that result from reductions in inventory
- Reduction in transaction costs through information sharing
- Reductions in supplier redundancy can reduce product costs
- Reduced friction, fewer barriers, and less waste of resources on procedures that do not add value
- Increased functional and procedural synergy between participants
- Faster response to changing market demands
- Lower cost manufacturing operations
- Lower capital investment in excess manufacturing capacity
- Shorter product realization cycles and lower product development costs
- Increased competitiveness and profitability
- Improved delivery performance
- Increased forecast accuracy

2.6 Supply chain process integration model

The figure below shows the generic end to end supply chain integration process, which covers from identifying the critical supply chain network up to revaluating the strength of integration.

Figure 15 - The supply chain process integration model



Source: Wisner et al, 2006

Closs and Savitskie (2003 cited in Tovi 2009) have identified that several recent studies have identified internal and external supply chain dimensions as critical to achieving performance-related competitive advantage. "Integration is important as it is desired for its capability of bringing about better performance at lower cost".

Identify critical supply chain trading partners – Identifying only primary trading partners allows the firm to concentrate its time and efforts on managing important process links with these companies, enabling the larger supply chain to perform better.

Review/establish corporate, marketing, sourcing and logistic supply chain strategies – on an annual basis, management should identify the basic supply chain strategies associated with each of its trading partner's goods and services.

Align supply chain strategies and key process objectives – align the all strategies and key process objectives toward the big picture; adding value to the end customer. Eight (8) Key Supply Chain Processes:

(a) Customer Relationship Management - tailor products and services to meet key customer needs

(b) Customer Service Management - provide information to customers and administer product and service agreements

(c) Demand Management - balance customer demand with output capacity

(d) Order Fulfillment - develop production plans to meet customer requirements

(e) Manufacturing Flow Management - determine the right mix of manufacturing flexibility and speed to satisfy customer demand

(f) Supplier Relationship Management - develop close working relationship with key suppliers

(g) Product Development and Commercialization - develop new product.

(h) Returns Management - managing post-sale product dispositions

Develop internal performance measures for each of the key processes – it's the only way we can know how well we are achieving our set goals as well as how much we are deviating. Performance should be continuously measured. ERP systems support measures. Firm is able to track progress in each key processes

Assess and improve internal integration of key supply chain process – includes team cooperation across all functions, management support, and developing an understanding of the internal supply chain. ERP system is the primary enabler of integration.

Develop supply chain performance - A well-defined lean supply chain measurement system increases the chance for success because it enables managers to see areas where supply chain performance can be improved, so they can focus their attention, and obtain higher levels of performance. Monitor links w/trading partners in key SCM processes. Trading partners should monitor performance measures across member firms for each of the supply chain processes.

Asses and improve external process integration and SC performance - includes to build, maintain and strengthen key external relationships, share knowledge such as forecast information, new product launch plans, expansion plans, etc.

Extend Process Integration to 2nd Tier Supply Chain Partners - using today's advanced supply chain software applications, companies can in real time work with 1st and 2nd tier suppliers and customers to compare design ideas, forecasts ad order commitments, determine supply/demand mismatches, and analyze supplier performance.

Reevaluate the Integration Model Annually - Trading partners should revisit the integration model annually for changes within the supply chain and to assess the impact of these changes on integration efforts.

CHAPTER 3: METHODS OF THE STUDY

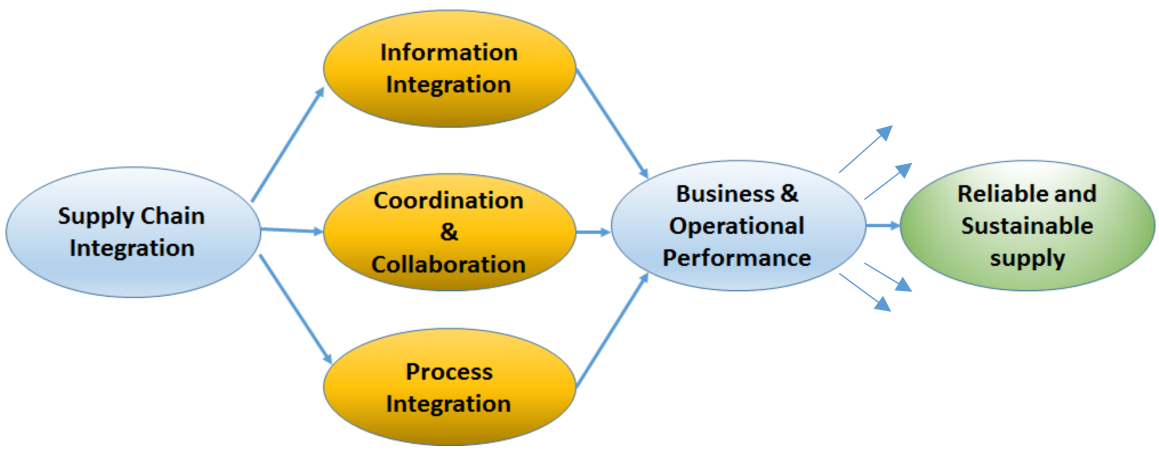
3.1 Research Design

This research tried to investigate the challenges in integrating the fuel supply chain of Ethiopia. It is more of explanatory type of research.

3.2 Conceptual framework

In recent years, there has been a great deal of research supported by empirical evidence showing that a successful supply-chain integration can enhance firms' performance and competitive advantage Singh and Power (2009), Ou *et al.* (2010) & Wiengarten *et al.* (2010). Integration in this context refers to the extent to which various supply chain partners, activities and processes work together in seamless manner to deliver a sustainable and reliable service or goods to the end customers. A common feature of these approaches was recognition that 'the whole is greater than the sum of the parts'. Lack of efficiency and/or effectiveness is often a result of the poorly designed interfaces between subsystems rather than any inherent subsystem weaknesses (Sweeney 2011).

Figure 16 - Dimensions of supply chain integration



Source: (Author's construct, adopted & modified from Lee, *et al.* 2007)

Lee (2000 cited in Katunzi 2011) outlines three dimensions of supply chain integration: information integration, coordination and resource sharing (collaboration), and organizational relationship linkage (process integration). Information integration refers to the sharing of information and knowledge among the members in the supply chain, including sales forecasts, production plans, inventory status and promotion plans. Coordination and resource sharing refers to the realignment of decisions and responsibility in the supply chain. Organizational relationship linkages include communication channels between the members in Challenges of Integration in a Supply Chain Network the supply chain, performance measurement and sharing of common visions and objectives. Accordingly, this study examined the information sharing, coordination and resource sharing and organizational linkages of the members of the fuel supply chain network (process integration) in Ethiopia towards common goals of creating reliable and efficient supply chain in the country.

Maigaet *et al.* (2010). Zhang *et al.* (2006), Sezen (2008), & Wong *et al.* (2011) argued that proper implementation of supply chain integration in the organizations will meet individual customers' demand, reduced delivery time, decrease logistics and purchasing cost, reduced the level of inventories increase work force efficiency and market share. Here, the dependent variable is Supply Chain Integration while the independent variables are information sharing, collaboration and collaboration and process integration. The study tried to assess the three independent variables with respect to the existing supply chain practice of the industry, identified the gaps and recommend actions required to close the gaps

3.3 Measures or variables

The logistic processes in the supply chain are interwoven. For the activities of a process to succeed, it depends on the next process. Therefore, these processes need to be integrated to enhance operational performance.

This study measured the supply chain integration of fuel supply from the three perspectives which is scientifically proven: information integration, collaboration & coordination and process integration. A set of statements using a 5-point Likert-type scale that ranged from strongly disagree to strongly agree were used to gather the information on the perceptions of the respondents about supply chain integration.

3.4 Research Methodology

The research adopted a mixed method approach in gaining a much deeper understanding of Ethiopia's downstream petroleum supply network. Thus, both qualitative and quantitative methods of data collection and analysis were used.

3.5 Sample size and sampling method

Since EPSE is the only importer and bulk supplier in the country, data was gathered from EPSE about the information, collaboration & coordination, and process integration that EPSE has with International Traders and Oil Companies. To gather data that is representative of Oil Companies, out of the thirteen Oil Companies, seven of Oil Companies' that contribute more than 90% of the total market share in the country were participated in the survey.

Although the stations are dispersed across the country, more than 78% of Gasoline is sold in Addis Ababa. Accordingly, for retailers the target population of this research consisted of all active stations in Addis Ababa that belong to the six Oil Companies. To get unbiased representative of these population, proportional stratified sampling was used depending on the number stations each Oil Company has in Addis Ababa.

These Oil Companies cumulatively own 109 stations in Addis Ababa. To increase precision and minimize sampling bias, 90 stations were selected from the six Oil Companies in proportion to the number of stations they have in Addis Ababa.

Table 1: Strata Size of population and the actual size of the sample:

Supply Chain members	Sample	Population
Sole Importer (EPSE)	1	1
Oil Companies	7	13
Retailers	90	109

Oil Company	Population	Sample
Total	42	35
OILIBYA	31	26
NOC	21	17
YBP	10	8
TAF	4	3
Nile	1	1

The sample size of retailers is determined using sample size calculator which is posted on http://www.surveysystem.com/sscalc.htm. The parameters used in determining the sample size were population size which is 102, confidence level of 95% and confidence interval of 5%.

3.6 Method of data collection

Data for the research consists of two parts, primary and secondary data. The secondary data was collected from EPSE (the monthly uplifting performance of each company by product type to compare forecasted demand versus the actual) as well as from Dawit (2014) imported fuel for the last 19 years. Interviews, administered questionnaires and self-administered questionnaires were used to collect the primary data from Horizon Terminal, EPSE, Oil Companies and Retailers. Both open ended and closed ended types of questions were used. The questionnaires and interviews were designed in such a way to give a comprehensive overview of the supply chain, demand and supply dynamics, demand forecasting, fuel inventory and safety stock management, and associated challenges Oil industry in Ethiopia.

The response rate from Oil Companies was 100%, while the response rate from dealers was 94% (85 out of 90).

3.7 Data analysis technique

The data gathered from primary and secondary sources were analyzed using both qualitative and quantitative data analysis tools. The study used descriptive statistics (Mean, Mean Absolute Percent Error (MAPE) & Relative Importance Index) to analyze response data collected through interviews and questionnaires using a 5-point Likert-type scale that ranged from strongly disagree to strongly agree mean & standard deviation). Moreover, used time series forecasting analysis to see the trend of fuel demand growth in the country and see the impact on the existing storage capacity of Djibouti terminal.

3.8 Ethical consideration

Research ethics involve requirements on daily work, the protection of dignity of subjects and the publication of the information in the research (Fouka & Mantzorou 2011). This research is conducted based on data collected from Horizon Terminal, EPSE, Oil companies, and Dealers. The respondents mentioned a concern on the confidentiality of the detail information.

Accordingly, the study approached these issues through informed consent, through communicating of the research guarantees of confidentiality and anonymity in the thesis, acceptance of reluctance or refusals in interviews and by engaging the participants on the purpose of the study, why it was being undertaken, the possible consequences of the research, and how the results are disseminated (summary of the analysis will be presented in the study). The participants are assured that purpose of the study is to enhance the existing supply chain practices.

3.9 Reliability & validity test of instruments

Validity expresses the degree to which a measurement measures what it purports to measure. Reliability refers to the degree to which the results obtained by a measurement and procedure can be replicated (Wiengarten *et al.* 2010).

The construct is established and empirically tested by different researchers. The study simply used the construct as it is and chose additional factors that are specific to oil industry. The aim of the study is to assess the existing practice in terms of the construct using factors (variables) that are selected by the professionals in the field of logistics, identify the gap and recommend actions that would help to close the gap. Both internal and external validity were made to ensure that the measures obtained from the research is quantifying what it is designed to measure specific to the oil industry and how accurately the measures were obtained from the study sample describes the reference population from which the study sample is drawn respectively. Reliability was assessed using test‑retest reliability to avoid lack of reliability.

The test-retest reliability results (appendix f) which is calculated using Pearson Correlation for 14 respondents questioned the same question twice within two-week time indicate that the response is in the range of perfect reliability and acceptable reliability.

CHAPTER 4: ANALYSIS OF THE RESULT

4.1 Fuel supply chain integration between EPSE and its Suppliers

At present, EPSE purchases and imports fuel from four countries: Sudan, Kuwait, Saudi Arabia and United Arab Emirates (UAE). The supply contract with Sudan and Kuwait is government to government type. It is evergreen, but renewed periodically without a tender process. The relationship type is more of partnership. The other two contracts are determined through open tender process where any prequalified International Oil Trader can bid and the lowest bidder wins. The contract period is just for a year (starts in January and ends in December) and the relationship type is more of transactional.

In all contract agreements, the yearly demand is stated as a blanket order. This contract amount is determined by looking the country's historical demand and information on the market condition gathered.

In the global market, the price of oil is changing from time to time. Thus, unlike other commodities the exact price cannot be determined at the time of signing the contract and hence the agreement mentions that the contract price is the sum of the global price of refined oil for the region which is daily posted on the Platt website plus an amount that covers shipment cost up to Djibouti port (which is fixed based on the capacity of the vessel that can accommodate the lot), overhead cost (a certain amount per shipment, applies only for product imported through Djibouti) and profit margin of the supplier (a fixed percentage of the total price of the fuel in that lot). The incoterms used in all except the product coming from Sudan is CFR (cost plus freight).

The global price used in the calculation of the contract price can be 5-day average or monthly average or any average of the global price which is stipulated in the contract agreement.

4.1.1 Placing a Purchase Order to the suppliers

Once the contract is signed, the yearly contract amount is divided into monthly contract amount, in return it is divided into lots or shipments. However, the actual quantity to be ordered for the month mainly depends on the demand forecast obtained from each Oil Company one month in advance, stock position of the two depots, and storage capacity of the two terminals.

For product imported via Djibouti, the quantity to be ordered in a lot usually various due to reasons captioned above, but only up the size of the two berths of the Oil Terminal from where vessels can be moored and the product is discharged (i.e. the size of the berth determines the type of a vessel to be served).

The first berth is for medium size vessel up to 80,000 tons while the second one is for small size vessel up to 30,000 tones. Thus, the maximum oil quantity EPSE can order in a lot (a single shipment) is 80,000 tons (cubic meters). The Supply Department of EPSE is expected to place order of the next month to the Oil Traders within the first ten days of the current month. The order specifies the lots for the month and the delivery schedules. Although, EPSE communicates to the Oil Traders the quantity to be loaded on each lot (shipment), the exact quantity to be loaded depends on the loading capacity of the vessel available for that shipment.

In order to import fuel via Djibouti, the lead time (i.e. from the date of loading up to reaching at Djibouti Oil Terminal) varies depending on the source of supply: a maximum of 3 days if it is from Saud Arabia and 7 days if it is from Quarter or UAE, besides the additional days required to arrange the vessel.

The freight cost of the shipment is fixed based on the loading capacity of the vessel, regardless of the quantity loaded in the vessel. If the loading is less than the capacity of the vessel, the difference will be paid by EPSE as a dead freight. Accordingly, to use the vessel efficiently, at the time of ordering EPSE in consultation with the Oil Traders tries to maximize the quantity to be loaded up to the loading capacity of the vessel. EPSE also considers the ullage of the terminal and the demand of Oil Companies as in the forecast, to avoid the demurrage fee the Oil Trader charges for each day the vessel stranded at the port due to ullage problem.

In the case of Sudan, the monthly contract amount is between 15,000 MC and 12,000 MC Gasoline which is about 10-12 trucks per day. Usually, the exact volume of the contract is fixed at the beginning of the year and it remains the same throughout the month. However, sometimes the amount being supplied becomes lower than the contract amount and affects the entire distribution of Gasoline in the country.

EPSE does not have integrated ERP system that enables to manage end to end process of the fuel supply from placing order to suppliers to selling fuel to Oil Companies. In order to manage its stock and placement of replenishment order, it uses Excel. Daily EPSE receives stock information from the two depots through email and then the stock information (including those in transit) and the daily average sales volume are analyzed using Excel to anticipate the stock level in the coming few days (stock days). Based on this figure, EPSE adjusts the quantity to be ordered in the next shipment and the schedule. Here, the traders needs time to arrange the necessary logistics. In the stock day analysis, it is assumed that Oil Companies will uplift the same quantity everyday throughout the month. However, for different reasons the actual daily uplift might be higher than the average daily sales volume which could lead to inflated stock days, leading the product to deplete faster than it was estimated.

The Oil traders have an obligation to choose a vessel that has the optimal ship's particular for the requested shipment.

4.1.2 Storing and the loading the product to Oil Companies trucks

More than 90% of the country's fuel requirement is imported through Djibouti. Horizon Oil Terminal renders storage and loading service to EPSE. The contract between the two parties is evergreen, although it is renewed every 3 years through negotiation. Horizon charges a fixed fee (throughput fee) for each liter that it loads into BRVs of Oil Companies.

To entertain the growing demand of the country, the terminal works in three shifts throughout the week, from Sunday to Monday. The terminal provides service both for Ethiopia and Djibouti.

Figure 17 – Djibouti Oil Terminal

Source – http://www.horizon-terminals.com/ April 16th, 2017

The cumulative storage capacity of Horizon Terminal that is dedicated for Ethiopia is about 261,000 MC liters. Breakdown of the storage capacity of the terminal by product type is listed below.

Table 2: Horizon Terminal storage capacity

Product Type	Storage Capacity (In MC)
Gasoil	110,000
JET-A1/Kerosene	85,000
Gasoline	15,000
HFO	30,000
LFO	21,000

Source: primary data gathered from Horizon Terminal, 2017

The storage capacity of Horizon Terminal has a limitation on the stock reserve EPSE can maintain and so on the quantity to be ordered in a single lot (in a single shipment). The discharging pump capacity of the terminal from a vessel to the storage tank is 2000T/hour/line.

Table 3: Average daily loading capacity of Horizon Terminal (Taking the highest monthly loading of the last two years)

Product Type	Average Daily Loading capacity (In MC)	Trucks/ Day	Maximum loading Capacity/Year
Gasoil	8,379	192	2,733 KMC*
JET	2,163	48	805 KMC
Gasoline	1,389	24	516 KMC

* KMC –Kilo Meter Cube

Source: Secondary data from EPSE, 2017

The country's fuel demand is growing on the average every year by 10%. The storage capacity of Horizon, however, has not increased at the same rate. Thus, EPSE strives to meet the growing demand of the country by increasing the frequency of shipment which surges the risk of disruption of supply considering the lead time involved. For example, the shipment may delay due to time elapse while the Oil Trader is searching for a vessel that matches reasonably with quantity ordered, technical problem on the vessel identified to load the shipment, the weather condition, etc.

Although, Horizon Terminal works in three shifts and striving to increase the efficiency of the loading, at present, most of the trucks that arrive after 4:30 PM will not be loaded on the same day. This is due to the growing fuel demand of the country and limitation on the loading capacity of Horizon Terminal (refer table -3 showing average daily capacity of Horizon terminal). Thus, for different reasons (such product shortage, road blockage, depot maintenance, etc.), if trucks cannot be loaded for 2 or more days, usually it takes a week to load all trucks stranded at the terminal.

Table 4: Storage capacity in terms of average daily consumption

Product Type	Storage Capacity (In MC)	Average Daily Consumption (in MC)	Days Stock
Gasoil	110,000	7,280	15
JET-A1/Kerosene	85,000	3,201	27
Gasoline	15,000	1,081	14
HFO	30,000	**Adequate storage capacity**	
LFO	21,000		

Source: Primary data from Horizon Terminal & Secondary data from EPSE

The analysis indicated that EPSE must place order for Gasoil and Gasoline at least twice in a month and JET-A1/Kerosene at least once in a month. If the storage capacity remains as it is and the product to be imported increases at the same rate (Gasoil and Gasoline at a rate of 17% and 13% respectively), EPSE must increase the frequency of order by the same percent. If no action taken, after 5 years, EPSE is required to place order almost 3 times in a month which will increase significantly the risk of supply considering the lead time between the source of the supply and Djibouti.

Table 5: Forecast for Fuel to be imported from 2017- 2022

				Stock days		
Year	Gasoline	JET/Kerosene	Gasoil	Gasoline	JET/Kerosene	Gasoil
2016	342,155	767,296	2,157,844	16	40	19
2017	383,299	799,244	2,385,149	14	39	17
2018	424,443	831,193	2,612,453	13	37	15
2019	465,588	863,141	2,839,758	12	36	14
2020	506,732	895,089	3,067,063	11	35	13
2021	547,876	927,037	3,294,368	10	33	12
2022	589,020	958,985	3,521,672	9	32	11

Source: Forecasted using Statistical Package for Social Sciences (SPSS V 20) based on the data shown on Appendix G.

4.1.3 The loading process from Djibouti and Sudan

At Horizon Terminal, each Oil Company has representatives that follow on the end to end loading process of their order; from arrival of trucks up to loading of trucks. Also, they serve as an interface between the Oil Company and drivers/EPSE/Horizon.

Summary of the generic loading process from Djibouti are enumerated below:

a) After discharging the previous load, BRVs head to Djibouti.

b) When the BRVs arrive at Djibouti, the driver reports to the representative of the Oil Company in Djibouti.

a) If the Scheduler is stationed at the H.O., the Oil Company's representative communicates the arrival of the BRVs in batch to the Scheduler through email.

b) The Scheduler assigns order for each BRV. If the Scheduler is stationed at the H.O, sends the scheduling report to their representative in Djibouti. The report includes, BRV number, order number, product and quantity to be loaded, customer name, destination, etc.

c) Oil Company's representative at Djibouti captures the schedule into their own system as well as into the system owned by Horizon Terminal. Then they submit calibration charts of the BRV in batch to EPSE's representative in the terminal.

d) EPSE reviews the loading request, the validity of the calibration chart and approves the request in the system.

e) Horizon calls drivers of the vehicles in batch and lets them enter the depot and load each truck as per the loading request. Then they provide a deliver document (usually known as FDC) to each driver.

f) The Oil Company representative at Djibouti provides the Company's Loading Note to the driver and the driver starts the journey.

The terminal in Sudan belongs to Nile Petroleum and works throughout the week from 7:30 AM-2:30 PM, except Friday where it is closed. They have four loading arms and can load up to 4 trucks at a time. The contract amount for 2017 is 12,000 MC of Gasoline per month. The product is distributed to Oil Companies based on their market share. Thus, depending on their market share, Oil Companies can uplift 1-4 trucks per day.

The loading process from Sudan follows almost the same process captioned above, except that Oil Companies do not have their own representative at the site and drivers do not head to Sudan unless they are advised so by Oil Companies. To use BRVs effectively, Oil Companies advise drivers that are heading to deliver product to Northern part of the country, on their way to enter in to Sudan and uplift Gasoline. This is beneficial to the Oil Company since had it been an empty BRV sent from Addis Ababa, the trip would have been longer at least by three days. Empty trucks are sent from Addis Ababa if and only if the Oil Companies believe fewer trucks are heading to Sudan than it is required.

Sometimes, once BRVs arrived in Sudan or after they travelled a long distance to Sudan, EPSE informs Oil Companies that there is no product or there is shortage of product at the terminal. Thus, BRVs will be forced to stay in Sudan until the product is availed. This makes the trucks ideal/stranded for some time and reduces the number of BRVs arriving at Djibouti. Moreover, since 70%-80% of Gasoline is coming from Sudan, when the supply point is changed to Djibouti, the product at Djibouti will not last more than a week and subsequently there will be shortage of product in the country.

In such circumstance, unless there is an order which was placed upfront, replenishing the stock requires a minimum of 3-7 days just for transporting the product from the source of supply to Djibouti, besides the additional days required to process the order and select the vessel for the shipment.

4.1.4 Internal process within EPSE to supply from strategic depots

EPSE has 13 strategic (NPRDA) depots which are positioned at different locations and are used only when there is a force major that hinders the normal distribution process from the two main supply points. This can happen for different reason, such as product shortage at the main supply point, blockage of the road due to flood or road accident, maintenance of the main supply points, etc.

The below table shows the location of depots and products usually stored.

Table 6: Location of NPRDA depot

		Product Stored		
Number	Location	Gasoil	Gasoline	Kerosene
1	Adigrat	x		
2	Agaro	x		
3	Awash	x		
4	Bahir Dar	x		
5	Gambela	x	x	
6	Gondar	x	x	X
7	Harar	x		
8	Kombolcha	x		X
9	Nekemet	x	x	X
10	Mekele	x		
11	Shashemene	x	x	
12	Suluta	x	x	X
13	Wolaitta	x		

Source: Secondary data from EPSE, 2017

Figure 18 – Location of NPRDA (Strategic) depots

Source: Adopted by the author based on data obtained from EPSE, 2017

Supply of product from these depots needs prior approval from CEO of EPSE or board of EPSE. Once the approval is obtained, the process for loading from theses depots are as follows:

a) EPSE communicates a list of NPRDA depots from which Oil Companies can uplift product via email.

b) Oil Companies pass their order request through email which consists of the order number, customer name, the vehicle id, the depot from which the product is to be uplifted.

c) EPSE's Head of Supply Departments endorses the request and passes the loading request to Depot Administration Department with EPSE.

d) The Depot Administration Department of EPSE communicates the loading request to the loading depot via phone or fax.

e) The depot loads the vehicle and provides a loading note to the drivers.

The above process sometimes delays the loading process, since the loading request of Oil Companies is misplaced somewhere in the process, the email did not reach to EPSE or one of the approver is not in the office.

4.2 Fuel supply chain integration between EPSE and Oil Companies

At present, EPSE is the sole importer of oil into the country. Oil Companies purchase fuel from EPSE and distributes the product either using the network of stations they have or direct to the sites of those customers who purchase in bulk for their own consumption. They earn a fixed profit margin for each liter they distribute to their customers. The margin is set by government via MoT.

Therefore, depending on the distribution network, Oil Companies have two types of customers, Retail and Commercial customers.

- Retail customers – individuals/firms that own or operate a fuel station. They purchase fuel & lubricants from the Company and sell to the end customer inside the fuel station. The Oil Company delivers the product direct to the station using 3rd party contracted BRVs. They sign a dealership agreement with the Oil Company which will be renewed at a certain interval. For each liter they sell to the end customer, they earn a fixed profit margin which fixed by MoT.
- Commercial customers - they purchase fuel & lubricant for their own consumption. They sign a contract agreement with the Oil Company for the supply of fuel in bulk for a limited duration. The company delivers the product to the customer site using 3rd party contracted BRVs or the customer picks the product using its own BRV. Usually the contract lasts one-three years and is awarded through a tender process or negotiation. These are mainly government organizations, factories and construction firms that own a large fleet of trucks and machineries.

4.2.1 Sharing demand forecast and stock position

Demand forecasts form the basis of all supply chain planning. In a supply chain, forecasting is an important determinant of operational performance. The oil industry assumes a pull marketing strategy to sell fuel to its customers.

At the beginning of each year, as part of their planning process, Oil Companies plan their annual sales volume. Usually, they consider the previous year volume and additional information they have about marketing conditions such as new stations to be opened, existing stations to be closed, and new tenders to come during the year which they may or may not win, etc. The yearly plan is then divided into monthly considering seasonality of the demand. The rainy season (July up to mid-September) is the slack season for ground fuel since most of road constructions project slowdown or cease altogether and March up to June is the peak season where most of road construction boosts.

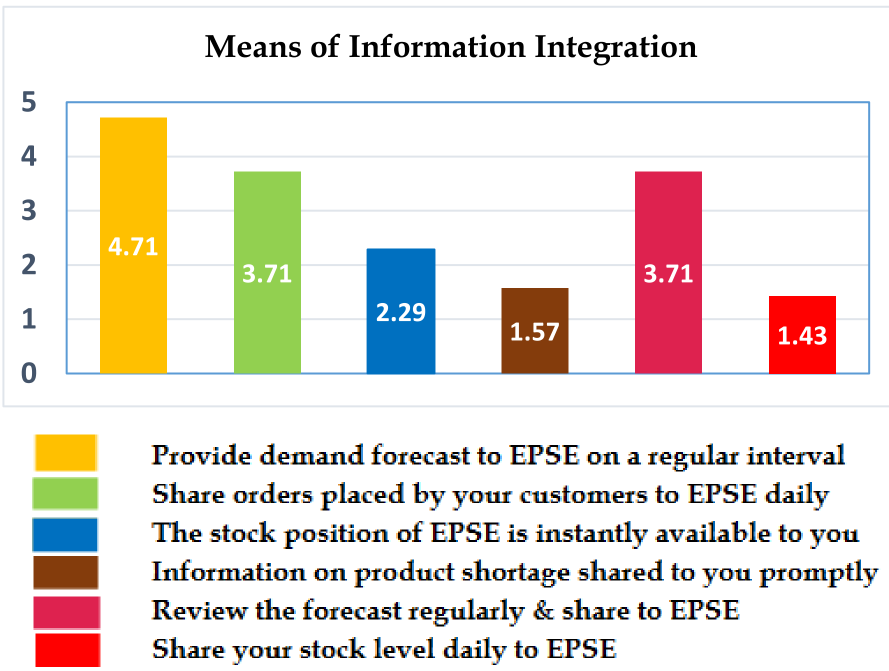
At present, most of the Oil Companies get information on demands coming from new commercial customer, either when a tender is floated or a customer contacted them or hear on the news/read on a newspaper about a new road construction project is awarded to a certain contractor.

Oil Companies do not regularly solicit information on the monthly demand of their existing customers. If they do, only from their major customers. They assume the customer will take the same amount as per the quantity stipulated in the contract which may or may not happen in reality.

Respondents (Oil Companies) asked to rate the factors of supplier integration within their supplier (EPSE) on information integration that contributes to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree‟ to 5 =" Strongly Agree‟. It is discerning enough from figure 19 that there is a gap in some of areas and more needs to be done to close the gap. The highest rated factor was 'Provide demand forecast to EPSE on a regular interval' =4.71 (n=85) while the low rated factors were 'Share your stock level daily to EPSE' = 1.43 (n=85) followed by 'Information on product shortage shared to you promptly' = 1.57 (n=85).

Furthermore, the relative importance index (RII) shows that, providing demand forecast to EPSE on a regular interval = .94 was ranked highest and share your stock level to EPSE = .28 rated low followed by information on product shortage shared to you promptly= 0.40.

Figure 19 - Means of Information Integration (EPSE and Oil Companies)



Source: (Author's own field survey, 2017)

EPSE requests Oil Companies to submit their monthly fuel demand forecast by product type one month in advance. *All respondents mentioned that they provide the demand forecast to EPSE on a regular basis*. However, the monthly forecast provided to EPSE is not supported by a system, rather based on individual knowledge (from Marketing and/or Supply) and historical trend. But also inflate the figure assuming there is always a product shortage and thinking EPSE starts to supply on quota basis as per their monthly forecast. They simply add a certain percentage on the previous month forecast.

Moreover, when there is a tender, they assume that they will win the tender and include the volume in their forecast. However, once they submitted the forecast, the figure is not revised and resubmitted at the middle of the month even if they learned that they did not win the tender. *None of the respondents strongly agreed that they review the request regularly & share to EPSE*. Thus, the forecast submitted to EPSE will not be a good estimate, usually it is overstated. Despite this, there was sporadic shortage of product in the country.

Respondents of three of the major Oil Companies (NOC, Total, and Oilibya) mentioned that they share to EPSE only part of their customers' order for which they managed to arrange truck. EPSE will not have any clue on those orders which are in the hands of the Oil Companies and are waiting for truck. This information could have given EPSE some clue on the actual demand of Oil Companies.

Six out of seven respondents agreed that they do not share their stock position to EPSE daily. This information could have given to EPSE an opportunity to take the necessary action promptly, such as approving the supply of product from NPRDA depot when there is shortage of product at the main supply points and on the actual demand of customers. At present, only when EPSE observes queue of motorist at the stations and request for an update on their stock position that they share their stock position.

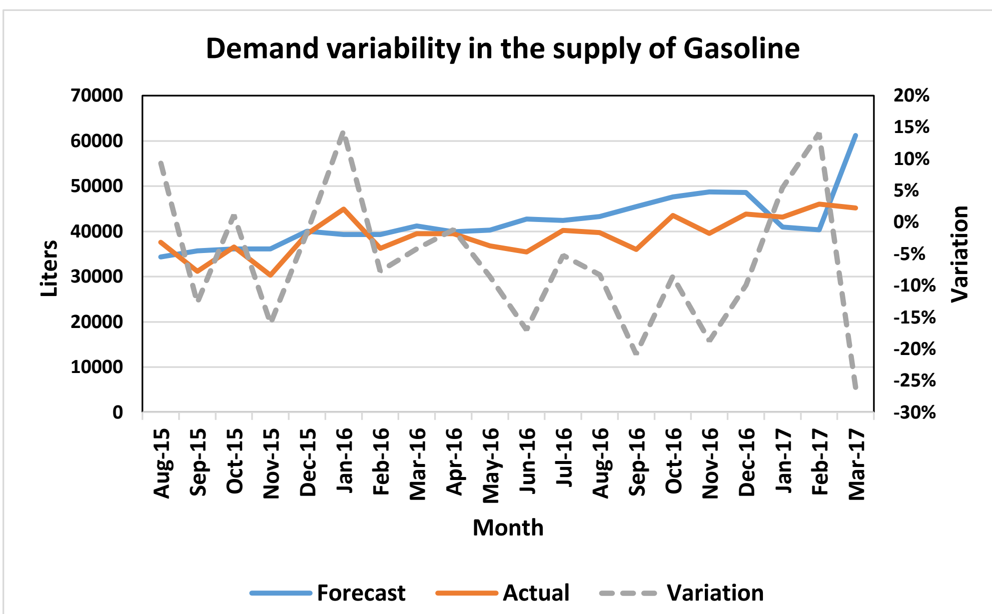
Only two out of seven respondents agreed that they can get the stock position of EPSE instantly. All respondents mentioned that they do not get information on shortage of product promptly. As a normal practice, after discharging products, all BRVs head to Djibouti to uplift the next order. When there is shortage of product and EPSE communicates to uplift from NPRDA depot, most of the trucks have already left to Djibouti. Thus, to uplift from the NPRDA depot, they must driver backward which is out of question since transporters are not paid for backhaul cost.

Actual uplifts versus demand forecasts by product type for 20 months (August 2015 – March 2017) is analyzed in the following section.

a) Gasoline forecast versus actual uplift

Recently, the demand of Gasoline has increased significantly which is mainly due to growing number of cars and introduction of Bajaj in the country which has now becomes a common mode of transportation in small towns, even in some of the major cities.

Figure 20 – Demand variability in the supply of Gasoline



Source – Secondary data obtained from EPSE

Figure 20 shows in most cases, the demand forecast of Gasoline was more than the actual demand. However, there were occasions where shortage of product was witnessed. *The Mean Absolute Percent Error (MAPE) between the actual uplift and the forecast for Gasoline was 11.92%. It was mostly on the negative side (75% overstated). From this, we can tell the shortage was created, due to the fact that either the quantity ordered was not adequate thinking the forecast is overstated or the order was not placed timely or there was delay of a vessel.*

There was shortage of Gasoline in the two main supply terminals on the months specified on table 7 and product was supplied from NPRDA depots. This does not mean that the shortage was only during these periods. For example, there was shortage of Gasoline in November, 2016 for a couple of days, but product was not supplied from NPRDA depots.

Table 7: Periods where there was shortage of Gasoline at the main supply point

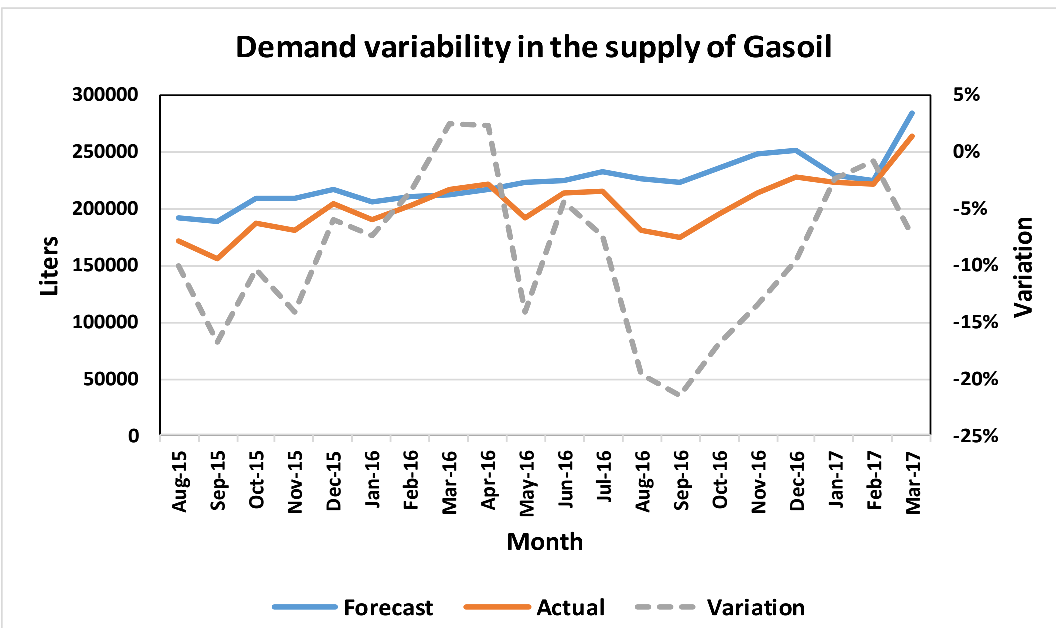
	2015			2016					
Month	Oct	Nov	Dec	Jan	Feb	Apr	Jul	Aug	Oct
Liters (in MC)	**465***	11,693	2,349	**6,136***	1,801	1,801	1,674	2,317	717

* The forecast was understated

Source – Secondary data from EPSE

b) Gasoil forecast versus actual uplift

Figure 21 – Demand variability in the supply of Gasoil



Source– Secondary obtained from EPSE

As indicated in Figure 21, except in February & March, the forecast was above the actual demand. February & March is the period where the budget for the finical year will be released; new construction projects commence and the existing projects resumes. Oil Companies assumed the uplift would increase gradually, but customers uplifted more fuel to replenish their stock reserve.

The Mean Absolute Percent Error (MAPE) between the actual uplift and the forecast for Gasoil was 11.02%. 90% of the time, it was on the negative side; the forecast was overstated. The variation reached the highest point around September where Oil Companies assumed the slack season has ended and the uplift will start to grow or at least will remain the same, but to the contrary it continued declining.

There was shortage of Gasoil for few days in the months indicated on table 8 and product was supplied from NPRDA depots. This does not mean that the shortage was only during these periods, for example there was shortage in November, 2016 for a couple of days and product was not supplied from NPRDA depots, and it returned to normal once the vessel arrived.

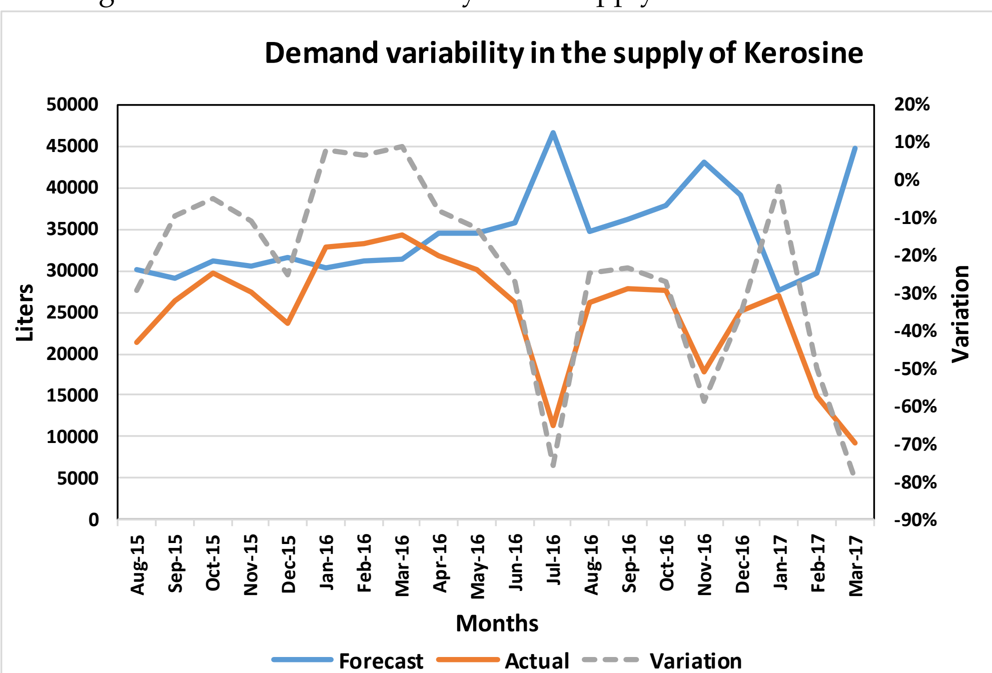
Table 8: Periods where there was shortage of Gasoil at the main supply point

	2015	2016			
Month	Dec	Apr	Jul	Aug	Oct
Liters (in MC)	369	18,486	4,356	332	1,527

Source – Secondary data from EPSE

c) Kerosene forecast versus actual uplift

Figure 22 – Demand variability in the supply of Kerosene



Source – Secondary data obtained from EPSE

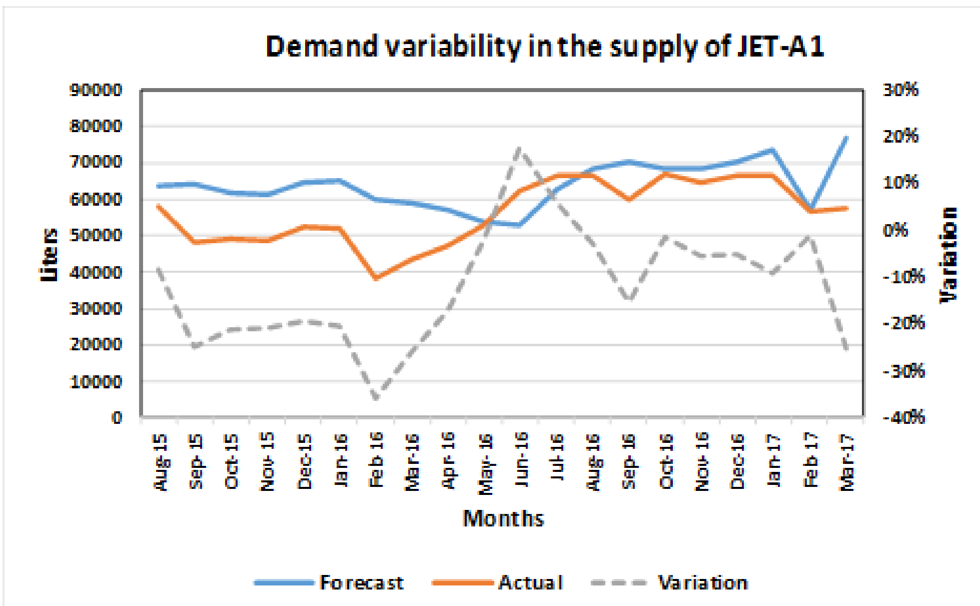
As indicated in Figure 22, except in Feb and March, the forecast was far away from the actual. There was high demand for the product than the uplift made. However, since there was a concern that the product is not used for the intended purpose (as a source of energy for cooking), rather for contaminating Gasoline and Gasoil by some of the stakeholders involved in the distribution process, EPSE reduced the supply of Kerosene intentionally. Thus, the shortage was made deliberately to discourage the act of contamination.

The Mean Absolute Percent Error (MAPE) between the actual uplift and the forecast for Kerosene was 63.75%. Mostly, it was on the negative side.

Effective February 8th, 2017, the price of Kerosene has been fixed to the price of Gasoil. Since then, although there is adequate product, the uplift of Kerosene has decreased significantly. The price used to be lower than Gasoil and Gasoline and the difference was so high, it was used by irresponsible parties to adulterate the two products (i.e. mixing a certain amount of Kerosene to the product and selling the mixture as a pure product). The adulterated product will have a negative impact on the performance of truck (km/liter) and on the life time of the engine. Now the risk has reduced significantly, since mixing kerosene with gasoil will not give any benefit to those involved in this wrong act; now the price difference between Gasoil and Kerosene is zero and the price difference between Kerosene & Gasoline reduced significantly.

d) JET-A1 forecast versus actual uplift

Figure 23 – Demand variability in the supply of JET-A1



Source – Secondary data obtained from EPSE

In the case of Jet-A1 (fuel used to power aircraft engines), Oil Companies' make demand forecast mainly based on the demand forecast obtained from Ethiopian Air Lines (EAL) at the beginning of the contract and seasonality of the demand. This demand constitutes up 80%-90% of the total JET-A1 demand of the country. As indicated in figure 23, except the peak season of the year (June and July), the forecast was above the actual demand; the uplift of EAL was reduced significantly than the contract amount. This was mainly since the local price of the product was significantly higher than the prevailing global price and consequently EAL was uplifting from oversea. Thus, it was quite difficult for the Oil Companies to get a good estimate. Subsequently, in some of the incidents, once the vessel arrived, EPSE was facing ullage problem. In such circumstance, to avoid demurrage fee, EPSE asked a support from Oil Companies to uplift more product than they actually need.

The Mean Absolute Percent Error (MAPE) between the actual uplift and the forecast for JET-A1 was 17.91%.Almost on the negative side (90% of the time), except from June-July which is the peak season and EAL increased its uplift beyond Oil Companies expectation.

If there is a delay of shipment for long time or BRVs unable to enter or exit from Djibouti (such as due to flood or due to road traffic), since JET-A1 is not held at NPRDA depots, the maximum days EAL can be supplied is four-five days (i.e. from the stock reserve of Oil Companies). Thus, the distribution process of Jet-A1 totally depends on the availability of product at Djibouti and stock reserves of the three Oil Companies (Oilibya, NOC & Total) in the distribution of JET-A1.

During holidays, the stock position of Oil Companies always depletes to the lowest level, for the following reasons:

i) Oil Companies have limited storage capacity (maximum of 4-5 days consumption).
ii) Most of the drivers prefer to stay at home one day before the holiday and up to two days then after.
iii) Daily loading capacity of Horizon. When drivers return from holiday, since most of the trucks arrive at Djibouti at the same time, some of the trucks must wait two to three days to be loaded.

Based on the contract amount signed between EAL and Oil Companies which is usually expressed in terms of market share of the total annual demand of EAL, Oil Companies commit to dedicate adequate number of Fleet for the loading of JET-A1. This fuel is subject to stringent quality requirements necessitating special equipment and handling. Along the distribution chain, the supply chain members need to ensure that the fuel quality has not deteriorated to unacceptable levels.

If the storage tank used at different stage of the chain is not adequately protected then perforations can occur in the walls and the base, with consequent damage to the interior. In addition to the deterioration of the tank if a suitable coat is not applied, the stored product often becomes contaminated, making it unfit for purpose. It is clearly essential to apply the right criteria in selecting the coating, that resist the aggressive chemical action associated with the product with which it is in contact and to provide effective corrosive protection. Thus, trucks that are used for transporting JET-A1 must be painted with special coating. Once these trucks are painted, they will be dedicated for loading of JET-A1 or Kerosene only; cannot be used for loading of Gasoil, Gasoline, etc. Whenever EAL uplift product from overseas, these trucks will be idle for some time and since they cannot be used to load other products. This will impact both the transporters and Oil Companies.

Recently, the uplift of EAL has improved significantly since MoT has started adjusting the price monthly close to the global price.

e) LFO and HFO forecast versus actual uplift

HFO & HFO are a residue from the crude oil refining process. As indicated in figure 24 and 25, there is a major difference between the actual uplift and forecast of LFO and HFO. *The Mean Absolute Percent Error (MAPE) between the actual uplift and the forecast for HFO & FFO were 115.9% and 43.79%* respectively. During the last two years, the demand for HFO has reduced by 70% (12,570 MC to 3,944 MC) since factories has started to change their source of energy to coal and peat cook.

When these factories reduce or stop using the product, they do not inform to Oil Companies timely. Moreover, Oil Companies do not review the trend and revise their forecast accordingly. For example, the average monthly demand for 2016 was 3568 MC per month, but the forecast submitted throughout the year was not below 6268 MC which is almost double.

Figure 24 -Demand and variability in the supply of HFO

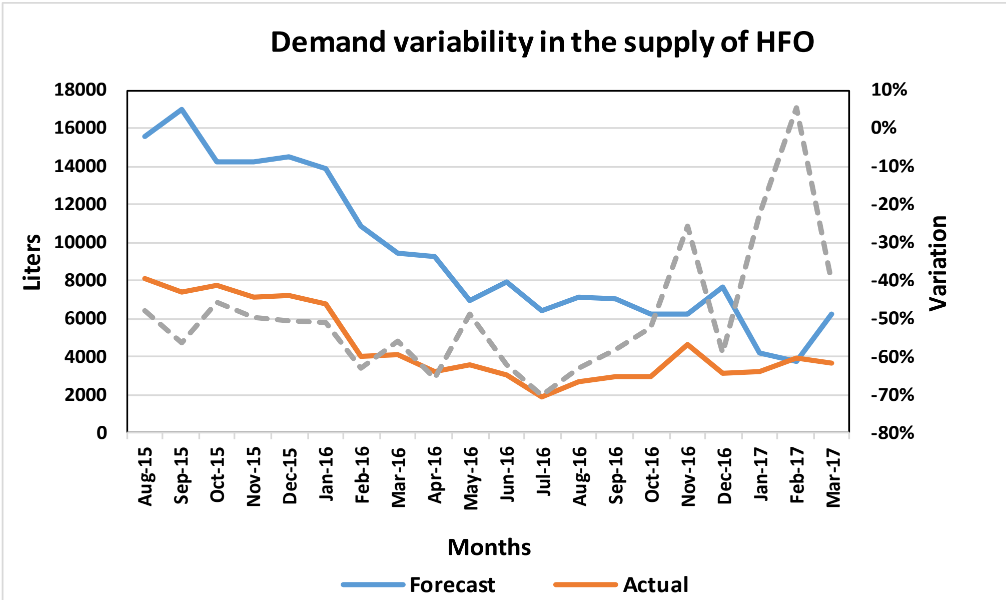
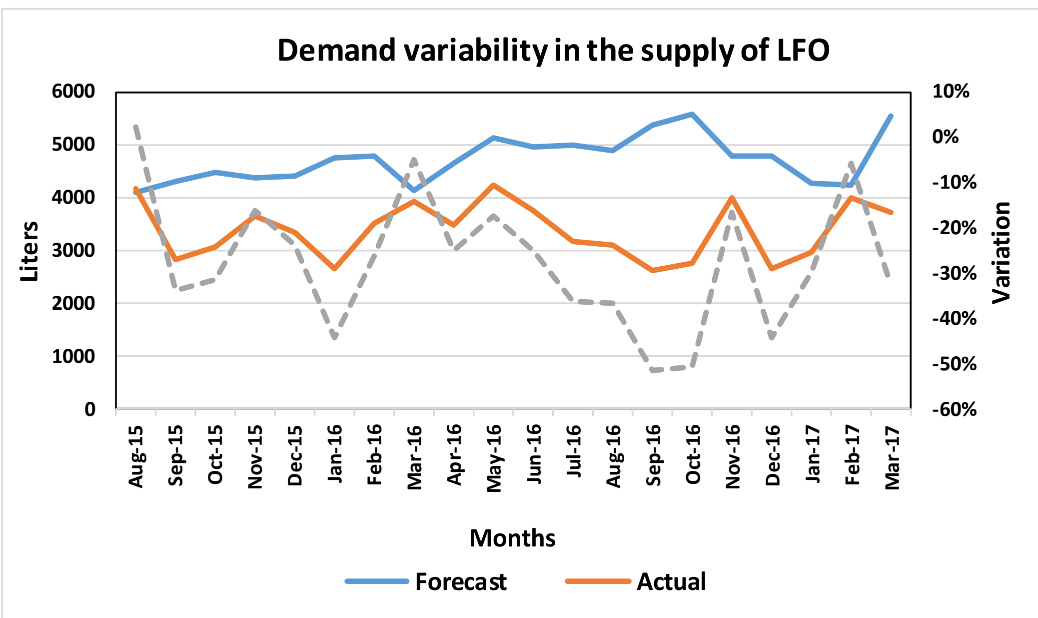


Figure 25 – Demand variability in the supply of LFO



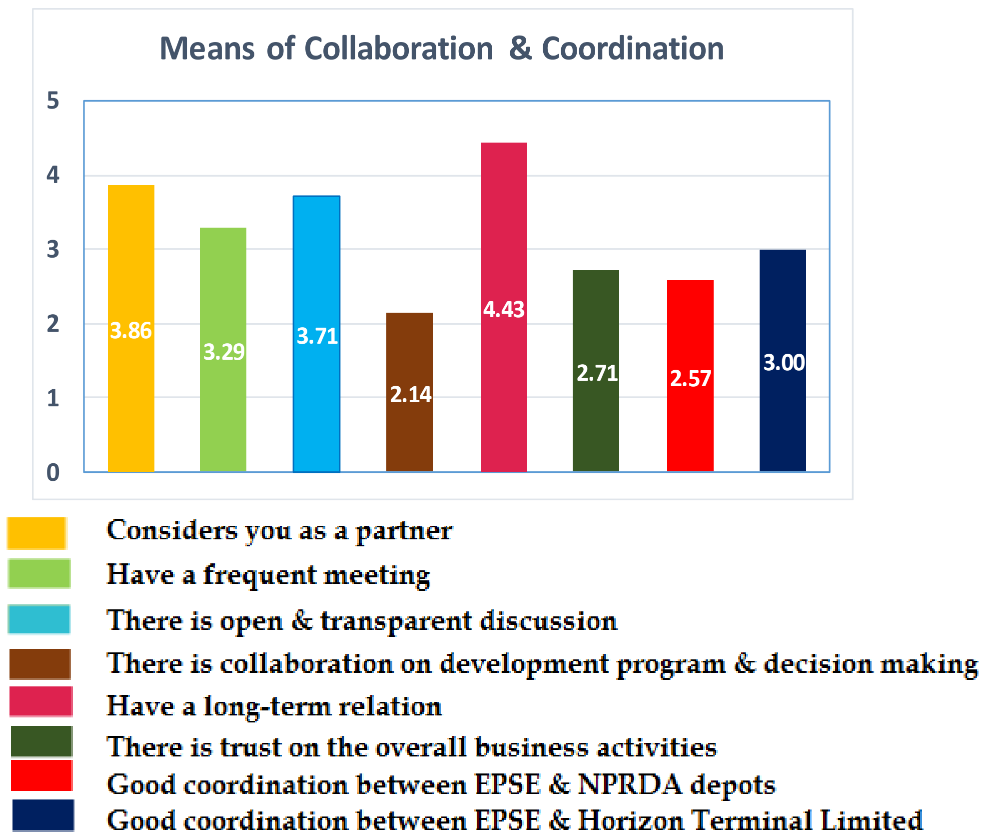
Source –Secondary data obtained from EPSE

4.2.2 Coordination and collaboration between EPSE and Oil Companies

Respondents (Oil Companies) asked to rate the factors of supplier integration with EPSE on coordination and collaboration that leads to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree" to 5 =" Strongly Agree". It is discerning enough from figure **26** that there is a gap in some of the areas and more needs to be done to close these gaps. The highest rated factor was 'Have a long-term relationship' =4.43 (n=85) while 'There is collaboration on development program & decision making' = 2.14 (n=85) was the least rated factor.

Furthermore, the relative importance index (RII) shows that they have a long-term relationship = .89 followed by EPSE considers you as a partner = .77 were ranked high and there is collaboration on development program & decision making =.43 was ranked the least.

Figure 26- Means of Collaboration & Coordination (EPSE and Oil Companies)



Source: (Author's own field survey, 2017)

Since EPSE is the sole importer and bulk distributor of Oil into the country, none of the respondents disagreed that there is a long-term relationship between EPSE and Oil Companies. Five out of seven respondents agreed that EPSE considers them as a partner. None of the respondents agreed that EPSE collaborate with them on its development program & decision making.

Only one of the respondents agreed the level of coordination between EPSE & Horizon and between EPSE & NPRDA is good. Moreover, only one of the seven respondents agreed that there is trust between EPSE and Oil Companies on the overall business activities.

EPSE and Oil Companies make a regular monthly meeting to discuss on the monthly performance (demand forecast vs actual uplift). The meeting is not focused on how proactively EPSE and Oil Companies as a team can avoid reoccurrence of shortage of product in a sustainable way, such as through knowledge sharing, resource sharing, sharing best practices etc.

4.2.3 Process integration between EPSE and Oil Companies

The distribution process assumes Oil Companies will hold stock reserves in their depot and EPSE will do the same at Djibouti and Sudan. Moreover, EPSE holds additional stock at NPRDA depots that will be used whenever there is a force major that hinders the normal distribution process.

As per the regulation of the country, each Oil Company is expected to have a depot with a minimum storage capacity of 500 MC. The fuel demand of the country has been increasing from time to time, but the prerequisite storage capacity has not. Furthermore, those with the adequate storage capacity will try to minimize their stock as much as possible, to reduce the impact of price reduction, tied up capital in stock reserve and operational lose which have adverse impact on their bottom line; erodes the low profit margin their getting from fuel.

Table 9: Tank Capacity of the Key Oil Companies – ground fuels

Oil Companies	MGR	AGO	Kerosene	Ethanol
Total	2,100 MC	4,200 MC	650 MC	400 MC
Oilibya	1,700 MC	2,130 MC	1,000 MC	200 MC
NOC	1,500 MC	1,500 MC	-	200 MC
Nile	2,190 MC	-	-	150 MC
TAF	-	600 MC	-	-
YBP	500 MC	-	-	-
Dallol	100 MC	300 MC	200 MC	

Source: Primary data from the respondents, 2017

Oil Companies are expected to transport fuel from supply points using their own transporters. Table 10 shows fleet size by company.

Table 10: Feet size of the respondents 'companies

Oil Companies	Fleet Size	Product Uplifted in March, 2017	Vehicle Efficiency in MC*
Total	550	69,604 MC	127
Oilibya	567	89,335 MC	157
NOC	785	119,214 MC	152
YBP	250	38,094 MC	152
Nile	45	1,632 MC	36
TAF	167	20,158 MC	121
Dallol	45	2,694 MC	112

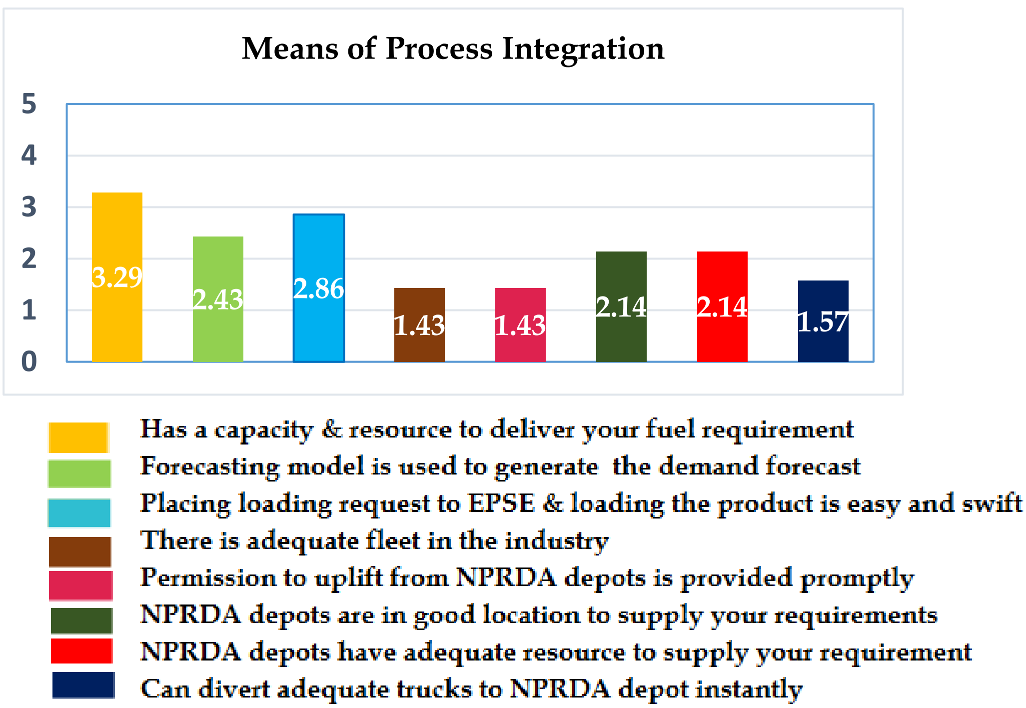
* Product Transported in MC per truck for the month of March, 2017

Source: Primary data from the respondents and secondary data from EPSE, 2017

Respondents (Oil Companies) asked to rate the factors of supplier integration with EPSE on process integration that leads to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree" to 5 =" Strongly Agree". *It is discerning enough from Figure 27 that there is a gap in some of areas and more needs to be done to close the gap. The highest rated factors were 'EPSE has a capacity & resource to deliver your fuel requirement' = 3.29 (n=85), while 'Permission to uplift from NPRDA depots is provided promptly'=1.43 (n=85), and 'There is adequate fleet in the industry'=1.43 (n=85) were rated low.*

Furthermore, the relative importance index (RII) shows that, EPSE has a capacity & resource to deliver your fuel requirement = .66 was ranked highest and permission to uplift from NPRDA depots is provided promptly and permission to uplift from NPRDA depots is provided promptly = 0.29 were ranked the least.

Figure 27 - Means of Process Integration (EPSE and Oil Companies)



Source: (Author's own field survey, 2017)

There is a standard product loading process at Horizon Terminal, from submitting the loading request by Oil Companies up to loading the truck by Horizon staff. The process is supported by a system where all activities are captured into and Oil Companies can monitor the status of their loading request. This makes the loading process visible to all parties involved in the process and networked to the system. *However, only two out of seven respondents mentioned that the loading process at Djibouti is easy and swift (especially at the stages of the process that involves manual intervention).*

Six out of the seven respondents mentioned that at present, they disagree that EPSE has the capacity & the resource required to deliver the fuel requirement of the country. They feel that a major upgrade needs to be done in this area as early as possible.

One of the seven respondents mentioned that they are using a forecasting model to generate the monthly demand forecast to be submitted to EPSE. The rest of them stated they totally depend on personal intuition.

When there is product shortage at the main supply point, the last option is to supply from the NPRDA depots. *All respondents mentioned that knowing that there is shortage of product at the main supplying points, the approval for loading from NPRDA is not obtained promptly*. EPSE waits for some time assuming the issue will not be that much severe so long as the shortage is only for a couple of days and Oil Companies are supplied part of their requirement. Usually, the stock reserve of most of the stations will not last more than 1.5 days. Subsequently, some of the stations will be out of product on the second day. Here, when motorists notice some of the stations do not have fuel, they will to be panicked and start to purchase more than they used to do. This will aggravate the issue further and all stations will be out of product much faster than expected.

When there is shortage of product, EPSE e-mails Oil Companies to uplift from NPRDA depot. Since the communication is not done timely, when they receive the e-mail, most of the trucks had already passed the location of NPRDA depot or reached at Djibouti. Thus, to uplift from the depot, they must drive backward which is difficult to deploy since transporters are not to be paid for backhaul cost. If they had the information timely, Oil Companies could have informed the transporters to stop the BRVs where they are and wait for further instruction. In addition, uplifting from NPRDA depots other than Sululta and Awash depots is very challenging since Oil Companies can use only those trucks found in the town where the depot located. *Thus, all respondents mentioned that it is not easy to divert adequate trucks to NPRDA depot instantly*.

Under normal circumstance, the loading at Djibouti and Sudan is done based on First Come First Served basis (FCFS). However, when there is product shortage, the loading sequence is also affected by the daily quota assigned for each Oil Company by EPSE which is determined based on market share of the company or the monthly demand forecast provided by each Oil Company.

When it comes to loading from NPRDA depot, the loading process is not supported by a system. Rather, Oil Companies simply e-mails to EPSE. Sometimes, the email will be lost somewhere in the process.

Except one respondent, all mentioned that there is shortage of trucks in the industry.

The demand of fuel has increased significantly, but the capacity of these depots, especially the loading capacity, has not been upgraded accordingly. Thus, it will be difficult to distribute at the speed required and thereby to alleviate the shortage immediately**.** This problem is mainly observed in Awash NPRDA. *Thus, all respondents mentioned that NPRDA depots do not have adequate resource to supply their requirement*.

4.3 Fuel supply chain integration between Oil Companies and Fuel Stations

At present, Oil Companies purchase fuel from EPSE and distribute to their station. Fuel Stations serve as an interface between the Oil Company and customers. It is through these networks that Oil Companies reaches to their ultimate end customers. Dealers have a responsibility to ensure that stations do not run dry out and they are open 24 hours a day.

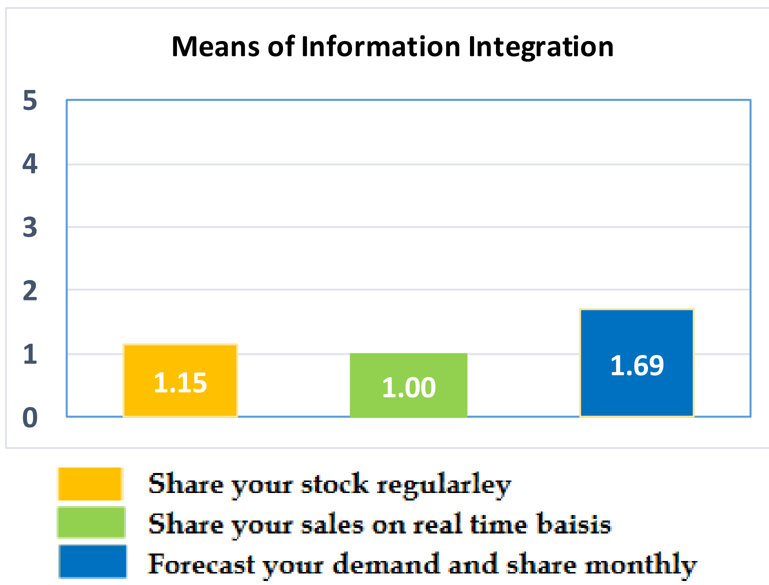
Dealers purchase and sell product at the price set by MoT. The retail sector of fuel operates in an environment that is characterized by low profit margins and high stock turnover. The profitability of fuel stations has been declining since the margin has changed from 4 cents to 6 cents during the last 20 years while the average price of fuel has increased from 2.5 Birr to 17 Birr.

4.3.1 Sharing demand forecast & stock position between Oil Companies and Fuel Stations

Respondents (Retail Stations) were asked to rate the factors of supplier integration with the Oil Company on information integration with fuel stations that leads to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree" to 5 = "Strongly Agree"). It is discerning enough from f*igure 28 that there is information gap between Oil Companies and Fuel station. Almost all factors were rated low; 'Share your sales on real time basis'=1.00 and 'Share your sales on stock regularly'=1.15(n=85) and 'Forecast your demand & share monthly'= 1.69 (n=85).*

Furthermore, the relative importance index (RII) shows that, all factors are rated with the following sequence: forecast your demand & share monthly = 0.33, share your stock regularly = 0.23 and share your sales on real time basis and = 0.22.

Figure 28 - Means of Information Integration (Oil Companies and Fuel Station)



Source: (Author's own field survey, 2017)

82% of the respondents mentioned that they are not requested to forecast their fuel demand and submit, instead the Oil Company simply communicates with them the target set for them as part of the annual planning process which is based on the previous year sales volume trend and the expected industry growth. The industry follows a push type of marketing strategy as Oil Companies has a responsibility to ensure all stations stay wet. Moreover, they strive at least to maintain their market share from the growing fuel demand of the country, despite the growing competition due to new entrants into the industry and increasing number of fuel stations.

In Ethiopia, all stations are branded; they can operate only under the umbrella of one of the Oil Companies. As part of the dealership agreement, the dealer must ensure that the station is always wet. *All respondents mentioned that they do not share their stock position on real time basis*.

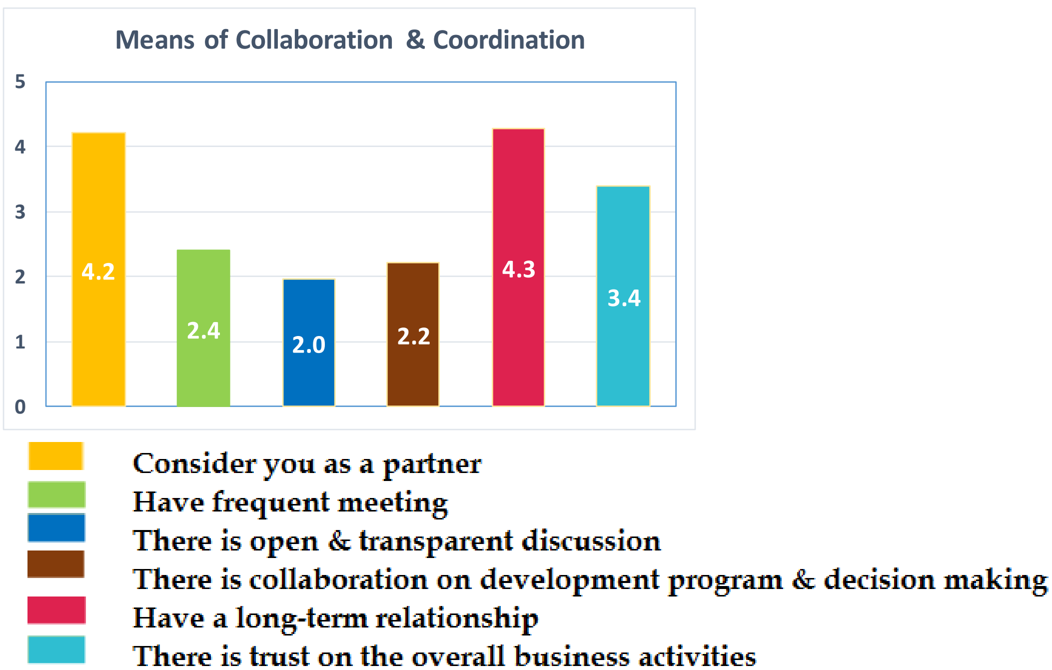
To get the stock information, Oil Companies must call each station and inquire or visit each site, which is tiresome and time taking. *In addition, they also mentioned they do not share their sales volume on real time basis*. This two information could have helped the Oil Companies to give a sort of alert message on those fuel stations that need to place order so that they will not run dry.

4.3.2 Coordination and collaboration between Oil Companies and Fuel Stations

Respondents (Retail Stations) were asked to rate the factors of supplier integration within their industry on coordination and collaboration that leads to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree‟ to 5 =" Strongly Agree‟. *It is discerning enough from figure 29 that there is a gap in some of the areas and more needs to be done to close these gaps. High rated factors were 'Have a long-term relationship= 4.3 (n=85)' followed by 'Consider you as a partner'=4.2 (n=85) while 'Open and transparent discussion' =2.0 (n=85) followed by 'There is collaboration on the development program & decision program'=2.2 (n=85) were rated low.*

Furthermore, the relative importance index (RII) shows that, have a long-term relationship = .72 was ranked high followed by there is trust on the overall business activities = .68 and permission to uplift from NPRDA depots is provided promptly and there is open & transparent discussion = 0.39 ranked the least.

Figure - 29 means of coordination and collaboration (Oil Companies and Retail Station)



Source: (Author's own field survey, 2017)

84% of the respondents agreed that they have a long-term relationship with Oil Company and they have been working together for 2 or more decades.

80% of the respondents agreed that the type of relationship between the Oil Company and Fuel Station is more of partnership; both know if they do not act as a single entity, they will lose the trust of the end customer and subsequently lose their business.

53% of the respondents disagreed that they have a frequent and regular dealers meeting at the company level. But all mentioned that a regular site visit is done by the Sales Representative. Some of the Oil Companies arrange an annual or semiannual meeting to review yearly performance and to share their development programs or new initiatives.

67% of the respondent disagreed that there is collaboration/consultation session to discuss on the development program or decision making process that affects them.

80% of the respondent disagreed that there is open & transparent discussion between the Oil Company & them.

13% of the respondents disagreed that there is trust on the overall business activities between Oil Companies ad dealers.

4.3.3 Process integration between Oil Companies and Fuel Stations

The existing distribution process assumes that dealers will ensure that their station is always wet. Hence, they must place order timely and settle their payment in line with the credit term stipulated in their contract agreement.

The generic order-to-transport payment process is as follows:

a) The dealer/the representative places order(s) to the Customer Service of the Oil Company, by calling or walk-in to the office.

b) The dealer/the representative settles the payments as per its Credit Term.

c) Scheduler assigns a truck to each order depending on the availability of truck. If the scheduler is stationed at the head office, sends the Scheduling Report in batch to Oil Company representative inside the terminal.

d) The Oil Company representative captures the loading request into Horizon system.

e) EPSE approves the loading request in the system.

f) Supplying depot loads the truck and provide a Delivery Note to the driver.

g) The drivers take the Delivery Note to the Oil Company representative inside the terminal. In return, capture the loading information in to the Company's system and print their own Delivery Note on pre-printed stationary.

h) On the next morning, the Oil Company representative sends a loading report listing all trucks loaded on the previous day to the Dispatch Team stationed at the Head Office of the Oil Company. Based on that report, the Dispatch Team confirm the loading in their system. This is done in the companies where the system used at Djibouti is different from the one used at the Head Office and they are not interconnected.

i) The driver takes the product to the intended station.

j) The dealer/the representative checks the quality of the product. Then measures the quantity and writes the quantity received on the document. If there is a loss of product, which is common to have, the loss will be written on the document and the driver signs on the document in confirmation of the loss.

k) The driver submits the delivery note of the transporter.

l) The transporter provides the delivery note to the Dispatch Office of the Oil Company.

m) The Company processes transport payment to the transporter.

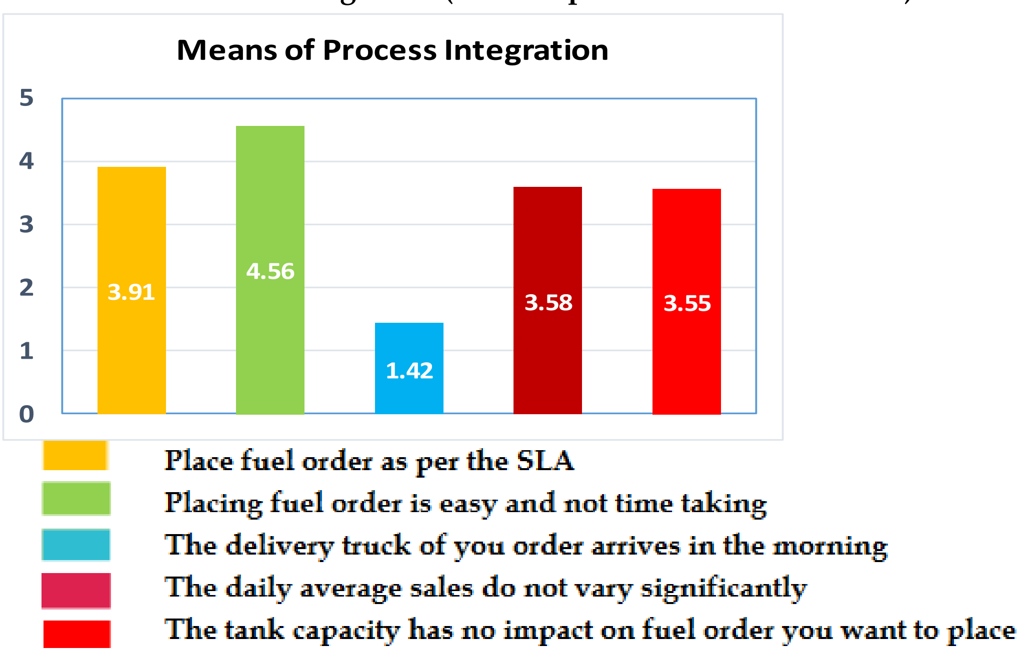
Three decades ago the average storage capacity of most of the Addis Ababa station was ranging from 20-30 MC. At that time, it was enough almost 2-4 days sales volume of the station. Recently, the average size has increased significantly and it ranges from 50-220 MC, but due to the growing fuel demand in the country, it accommodates 1-3 days consumption of the station. The storage capacity of those new stations within the last 2-3 decades is higher than compared to those old stations which were built some 3-4 decades ago (see Appendix C & D). There are many stations that were built three decades ago, but still have a storage capacity of 30 MC.

At present, product is delivered to customers using Bulk Road Vehicles (BRVs). The full capacity of a BRV ranges from 45 MC – 50 MC, a lorry from 21 MC -23 MC and a trailer from 23 MC – 27 MC. Besides the tank capacity, the order placed by fuel stations depends on the turnover of the product. The turnover of Gasoil is higher than Gasoline on the outskirt of Addis Ababa. The reverse is true for stations around the center of the city. Moreover, in Addis Ababa, since the lead time is not more than a day, some of the fuel stations prefer to order lorry/trailer only and increase frequency of the order regardless of their storage capacity.

Respondents (Retail Stations) were asked to rate the factors of supplier integration within their industry on process integration that leads to improved performance. The rating was a five point likert scale, ranging from 1 =" Strongly Disagree‟ to 5 =" Strongly Agree‟. It is discerning enough from figure 30 that in some areas there is some gap and more needs to be done to close the gap. High rated factors were 'Placing fuel order was easy and not time taking'=4.8 (n=85) followed by 'Place fuel order as per the SLA'= 4.5 (n=85) while 'The delivery trucks arrive in the morning'= 1.5 (n=85) scored the lowest.

Furthermore, the relative importance index (RII) shows that, placing order is easy and not time taking = .91 was ranked high followed by place order as per the SLA = .78 and the delivery truck arrives in the morning = 0.28 ranked the least.

Figure 30 - Means of Process Integration (Oil Companies and Retail Station)



Source: (Author's own field survey, 2017)

74% of the respondents agreed that they place order within the SLA (24 hours before it is needed). However, if abnormal demands comes from customers, for example, for some reason if the station before them on the same road is dry, they sell more product than the average volume. In such cases, they expect the delivery to be made on the same day.

In Addis Ababa, although there is limited number of fuel stations and the average quantity sold is nearly consistent, there is no pre-planned delivery schedule for a week or two by station so that the product as well as the necessary logistics will be availed upfront.

96% respondents agreed that placing order to Oil Companies is easy and straight forward, except getting the phone line to order.

91% of the respondent agreed that most of the drivers intentionally do not bring the loaded truck to the intended destination in the morning so that the product gets worm (expand) and the product loss will be understated.

Moreover, when stations place order for less than full truck (either due to tank capacity or thinking it will take more days to sell a full truck), the product is delivered in combination with other customers' order. Subsequently, the product for the second customer (loaded on lorry) reaches in the afternoon after discharging for the first customer (loaded on the trailer).

23% of the respondents (mostly those with storage capacity less 50 MC) agreed that the capacity of their storage tank is affecting their operation adversely, especially when the Oil Company cannot deliver them a product as per the SLA or when there is abnormal demand. At present, since there is shortage of fleet in the industry, sometimes Oil Companies unable to serve their customers as per the SLA.

The impact will be further aggravated when the office is closed for more than a day due to weekend or holiday. Thus, sometimes even though there is no product shortage at the main supply point, some of the stations will be out of product on Monday morning.

71% of the respondents agreed that if the supply is consistent their average daily sales volume does not vary significantly. Here, if stock position of each customer is known, priority of delivery could have been given in line with their stock level and thereby alleviate the stock out situation. Moreover, a reminder could have been sent to customers to place order upfront, considering their stock level, average daily sales volume and the lead time. Also, could have helped the Oil Company to plan on the logistic required.

Usually Oil Companies maintain optimal stock reserve at their depot that minimizes the capital to be tied up to stock reserve, loss from price change and operational losses. Subsequently, daily they bring product that they believe that is enough for the daily average uplift of customers. Sometimes, when the requirement of dealers is higher than the daily average demand, although the Oil Company has a product inside their storage tank, they may not be able to serve some of the customers due to lack of empty trucks that are required to uplift the product from the depot and deliver to the customer. This is because once drivers deliver product to customers, unless the truck has a maintenance program, they always drive to Djibouti for the next trip.

The stock information also helps EPSE & Oil Companies to monitor that the product is delivered to the intended destination. Also, enables Oil Companies to monitor product that is not dumped into their station from other Oil Companies.

When dealers or Oil Companies suspect that there will be a price change that will affect them negatively they will try to minimize the risk by reducing or cancelling their order. As a result, during the price change, some of the stations will have very minimal stock that will not serve a day. Thus, after the price change, almost all stations place orders at the same time and it would be difficult for Oil Companies to supply all orders with the limited stock reserve and fleet they have at hand. Hence, sometimes, it will take 2-3 days to return to a normal distribution.

4.4 Fuel supply chain integration between Oil Companies and Commercial customers

Oil Companies have commercial customers that purchase fuel in bulk, either using their own BRVs or Oil Companies' contracted third party BRVs. Usual purchase is done based on a contract agreement which is signed after open tender process or through negotiation. The contract is a blank order for the total amount to be supplied during the contract period. In the contract agreement, the Oil Company specifies the lead time required between the supply point and customer site(s) and has an obligation to supply the customer accordingly.

4.4.1 Sharing demand forecast & stock position between Oil Companies and B2C Customers

Usually, Oil Companies do not request Commercial Customers to forecast their fuel demand and submit monthly. Instead, the customer simply place order in batch (usually 1-2 weeks requirement) and later advise the schedule as and when required.

Oil companies do not have a system that shows the stock position of these customers. To get the information, they must call each customer and inquire, which is tiresome and time taking. Subsequently, it would be difficult for Oil Companies to plan the need of these customers upfront. The customers always assume there will be a product and would be supplied as per the lead time, and they do not keep their tank full.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

The findings from the study indicate that there is lack of information sharing (such as on stock position, daily sales, etc.) among the supply chain partners of the Oil Industry in Ethiopia.

The study also reveals that there is significant difference on the monthly demand forecast provided to EPSE and the actual amount uplifted by Oil Companies; in most cases it was inflated. This is mainly since Oil Companies are not using a forecasting system/model that forecasts the demand based on the actual trend and other seasonal parameters; but rather using intuition and experience of individuals.

In addition, the study indicated that in the play field, each partner attempts to ensure that it has full filled its own obligation as an autonomous entity; rather than as a supply chain partner with unified objective of adding value to end customers. According to the respondents, although they have some meetings, they are more focused on firefighting or just to discuss monthly or annual performance, not on looking for improvements on the overall processes as a system.

Moreover, recently, the supply of Gasoline coming from Sudan started to reduce abruptly and subsequently causing depletion of the stock at Djibouti unexpectedly. Thus, frequently led to product shortage in the country that last for couple of days, unless the uplift from stock reserve was permitted immediately.

Besides, the finding point outs that in some of the areas of the supply chain there is capacity and resource constraints that hinders the smooth flow of product in the supply chain, such as: 1) the tank capacity of Addis Ababa stations as well as the number of stations available in some areas of the city is not enough to support the need of the customers. 2) Storage and loading capacity problem of Horizon Terminal and NPRDA depots. 3) The shortage of trucks in the industry.

More importantly, the study found out that although the main intention of a strategic reserve is to serve as a safety stock (i.e. to ensure there is continues supply to customers when there are events that inhibit the normal supply process), the approval process to uplift from the strategic reserve depot is lengthy and time taking. Usually, the approval is obtained after most of the station already runs out of product.

These issues cumulatively inhibited effective implementation and use of supply chain integration in the industry.

5.2 Conclusion

The study generally concludes that lack of information sharing among the supply chain members of the industry, the quality of the forecast provided by Oil Companies, and that EPSE does not have a well-integrated ERP system are the main factors that affected the importation of fuel into the country in line with the need of customers. Moreover, since the supply chain partners do not follow a collaborative approach on addressing the overall supply chain problem as a system, the solution usually comes from one side and it is mostly just to provide reactive solution, not to give a sustainable and proactive solution after jointly investigating and analyzing the root cause of the problem.

Although, the forecast was inflated, there was shortage of product at the main supply points. This shows that either EPSE has intentionally imported less fuel than the forecasted amount (thinking the figure is inflated) or the PO was not placed on time or there was shipment delay.

The study further concluded that there is incompatibility between the demand growth of fuel demand in the country and the logistics resource deployed to support the supply chain process. These constraints cumulatively have been obstructing smooth flow of fuel to the end customers.

5.2 Recommendations

a) Improve the coordination and collaboration effort among the members.

- Members of the downstream fuel Supply Chain should have a regular meeting to discuss openly & transparently on the entire supply chain problem and development program, and then make decisions jointly.
- Whenever there is a force majeure that hinders the normal distribution process, EPSE should communicate the problem upfront to Oil Companies and allow supply of product from NPRDA depots immediately.
- All stakeholders should discuss with open mind on how to address price change speculation through with win-win solution that takes into account all members of the supply chain. Some of the suggestions are:
    - MoT to measure the stock in hand of Oil Companies and either the company or MoT to reimburse depending on whether the price change is upward or downward respectively. Or
    - EPSE to use the storage capacity of Oil Companies and arrange throughput agreement with the Oil Companies as stock reserve for shortage to occur during price change. Or
    - After the price change, EPSE to supply from NPRDA depots for a couple of days.

b) Enhance visibility of information as well the quality of information shared.

- Oil Companies should improve their demand forecast using a system that makes some form of exponential smoothing. EPSE to have an integrated ERP system that will use the input provided by the Oil Companies and enables to manage its stock effectively.
- Oil Companies should install SBC (Single Board Computer) in each station so that they can have information on stock position and all transactions that occurs in the station (sales and receipt of product) as well as the stock position on real time basis. Access to the same the information to be granted to EPSE, so that they know the daily sales volume and stock position of each station on real time basis. This has been implemented in Tunisia, Morocco and South Africa by multinational Oil Companies.

c) Improve the process flow of fuel by addressing the existing constraints.

- Concerned government bodies to negotiate with Horizon Terminal Limited on increasing the storage capacity of the terminal and/or investigate the possibilities of using Port Sudan, Berbera, and Mombasa with respect to the available transport infrastructure and geographical proximities and availability of terminals.
- Encouraging Oil Companies through various incentives to increase the tank capacity of existing stations and/or increase the number of stations in line with the prevailing demand.
- Alleviate shortage of fleet in the industry:
    - Concerned government bodies should investigate the reason why entrepreneurs are not interested to invest in this sector and take the necessary action.
    - Speed up the connection of the railway to Horizon Terminal and AWASH.
    - If the rail way will not reduce the burden of road transportation as expected, to speed up the pipeline project stretching from Djibouti to Awash NPRDA depot.
    - Enhance the efficiency of the existing fleet so that more product can be uplifted using the same fleet size, such as by installing a FMS and monitoring the trucks effectively.
- Increase the loading capacity and efficiency of Awash & Sululta NPRDA depots.

5.3 Directions for further research

This study examined the supply chain integration challenges between EPSE and Oil Companies and then between Oil Companies and Dealers. The functional & internal integration within each organization are essential for the overall integration, but are not included in this study; need to be studied in the future. In addition, further study needs to be done on the effectiveness of the sourcing strategy of the existing contract signed between EPSE and International Oil Traders to identify areas of improvement that will enhance the overall integration between the members.

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Appendix A- Questionnaire – Oil Companies

a) GENERAL INFORMATION

1. How many stations do you have throughout the country? ______
2. How many stations do you have in Addis Ababa? ________
3. How many depots do you have (including Jet-A1)? _________
4. How many depots do you have for ground fuels (AGO, MGR, KEROSINE & ETHANOL) _________. Where is the location? _____________________________ , ____________________________

   a. Tank capacity of MGR ____________MC Average demand of _______ days of A.A. Customers
   b. Tank capacity of AGO ____________MC Average demand of _______ days of A.A. Customers
   c. Tank capacity of KERO ___________ MC Average demand of _______ days of A.A. Customers
   d. Tank capacity of ETHANOL_______ MC Average demand of _______ days of A.A. Customers

5. How many trucks do you have? _________

SD – Strongly disagree, DS – Disagree, NT – Neutral, AG – Agree, SA – Strongly agree

b) Information integration with EPSE	**SD**	**DS**	**NT**	**AG**	**SA**
1. Provide demand forecast to EPSE on a regular interval.	☐	☐	☐	☐	☐
2. Share orders placed by your customers to EPSE daily.	☐	☐	☐	☐	☐
3. The stock position of EPSE is instantly available to you.	☐	☐	☐	☐	☐
4. Information on product shortage and shipment delay shared to you promptly.	☐	☐	☐	☐	☐
5. Review the forecast regularly & share the revised forecast to EPSE.	☐	☐	☐	☐	☐
6. Share your stock level daily to EPSE.	☐	☐	☐	☐	☐

c) Collaboration and coordination with the oil company	**SD**	**DS**	**NT**	**AG**	**SA**
1. Considers you as a partner.	☐	☐	☐	☐	☐
2. Have a frequent meeting.	☐	☐	☐	☐	☐
3. There is open and transparent discussion during meetings.	☐	☐	☐	☐	☐
4. There is collaboration on their development program & decision making.	☐	☐	☐	☐	☐
5. Have a long-term relationship.	☐	☐	☐	☐	☐
6. There is a trust on the overall business activities.	☐	☐	☐	☐	☐
7. Good coordination between EPSE and NPRAD depot.	☐	☐	☐	☐	☐
8. There is good coordination between EPSE & Horizon Terminal Limited.	☐	☐	☐	☐	☐

SD – Strongly disagree, DS – Disagree, NT – Neutral, AG – Agree, SA – Strongly agree

d) Process and activity integration with EPSE	**SD**	**DS**	**NT**	**AG**	**SA**
1. Has a capability and resource to deliver your fuel requirement promptly.	☐	☐	☐	☐	☐
2. Forecasting model/system is used to generate the demand forecast.	☐	☐	☐	☐	☐
3. Placing loading request to EPSE & getting the product is easy and not time taking.	☐	☐	☐	☐	☐
4. There is adequate fleet in the industry.	☐	☐	☐	☐	☐
5. Permission to uplift from NPRDA depots is provided promptly.	☐	☐	☐	☐	☐
6. NPRDA depots are in good location to supply your customers.	☐	☐	☐	☐	☐
7. NPRDA depots have adequate resource to supply your requirement.	☐	☐	☐	☐	☐
8. Can divert adequate trucks to the NPRDA depot instantly.	☐	☐	☐	☐	☐

e) Open question

What are the main challenges of the industry?

a. ____

b. ____

c. ____

d. ____

Appendix B - Questionnaire – Fuel Stations

f) GENERAL INFORMATION

a. Tank capacity of MGR ________________________MC Average sales of __________ days

b. Tank capacity of AGO ________________________MC Average sales of __________ days

c. Tank capacity of KEROSINE _________________ MC Average sales of __________ days

SD – Strongly disagree, DS – Disagree, NT – Neutral, AG – Agree, SA – Strongly agree

g) Information integration with the Oil Company	SD	DS	NT	AG	SA
1. Share your stock position regularly.	☐	☐	☐	☐	☐
2. Share your sales on real time basis.	☐	☐	☐	☐	☐
3. Forecast your demand and share monthly.	☐	☐	☐	☐	☐

h) Collaboration and coordination with the oil company	SD	DS	NT	AG	SA
1. Considers you as a partner.	☐	☐	☐	☐	☐
2. Have a frequent meeting.	☐	☐	☐	☐	☐
3. There is open and transparent discussion during meetings.	☐	☐	☐	☐	☐
4. There is collaboration on their development program &	☐	☐	☐	☐	☐
5. Have a long-term relationship.	☐	☐	☐	☐	☐
6. There is trust on the overall business activities.	☐	☐	☐	☐	☐

i) **Process and activity integration with the Oil Company**	**SD**	**DS**	**NT**	**AG**	**SA**
1. Place fuel order as per the SLA (24 hours in advance).	☐	☐	☐	☐	☐
2. Placing fuel order is easy and not time taking.	☐	☐	☐	☐	☐
3. The delivery truck arrives in the morning.	☐	☐	☐	☐	☐
4. The daily average sales vary significantly.	☐	☐	☐	☐	☐
5. The tank capacity has no impact on fuel order you want to place.	☐	☐	☐	☐	☐

j) **Open question**

What are the main challenges of the industry?

a. ____

b. ____

c. ____

d. ____

e. ____

Appendix C - Tank Capacity of NOC's Addis Ababa Stations

Stations	**MGR**	**AGO**	**KERO**
ADDISU GEBEYA NOC	50,000	50,000	50,000
ASCO NOC	100,000	100,000	50,000
BEKLOBET NOC	60,000	60,000	30,000
BOLE NOC	90,000	80,000	30,000
CMC NOC	60,000	60,000	30,000
DESSIE ROAD NOC	50,000	100,000	50,000
FURI NOC	50,000	100,000	50,000
GERJI NOC	30,000	50,000	30,000
GOFA SEFER NOC	50,000	50,000	50,000
JEMO NOC	50,000	200,000	50,000
JIMMA ROAD NOC	30,000	200,000	30,000
KALITY NOC	30,000	120,000	NA
KERA NOC	60,000	60,000	30,000
KOLFE NOC	60,000	80,000	50,000
LEGEHAR NOC	50,000	50,000	50,000
LEM HOTEL NOC	60,000	60,000	30,000
NYALA MOTORS NOC	60,000	80,000	NA
PASTER NOC	100,000	50,000	50,000
SARIS ABO NOC	50,000	100,000	NA
SONSHINE NOC	60,000	50,000	30,000
WINGATE NOC	50,000	100,000	50,000

Appendix D - Tank Capacity of Oilibya's Addis Ababa Stations

Stations	MGR	AGO	KERO
EDEN STREET OILIBY	60,000	60,000	22,500
FIAT OM OILIBYA	30,000	60,000	30,000
AKAKI OILIBYA	30,000	60,000	-
MEXICO SQUARE OILIBYA	60,000	30,000	22,000
OLD AIRPORT OILIBYA	60,000	60,000	30,000
DEBREZEIT ROAD OILIBYA	30,000	30,000	30,000
JIMMA ROAD OILIBYA	30,000	30,000	30,000
KAFDEM KALITY OILIBYA	30,000	100,000	45,000
BASSEFA KALITY OILIBYA	-	190,000	-
AFRICA AVENU OILIBYA	120,000	30,000	-
KEBENA OILIBYA S/S	30,000	30,000	30,000
BOLE ROAD OILIBYA	50,000	20,000	30,000
GOJAM ROAD OILIBYA	30,000	75,000	30,000
PATRIOT OILIBYA	30,000	60,000	30,000
RAS TESSEMA OILIBYA	30,000	30,000	30,000
LEKEMPT ROAD OILIBYA	-	45,000	30,000
AFRICAN UNION OILIBYA	15,000	15,000	-
CASAINCHES TINISHU OILIBYA	30,000	30,000	30,000
GRAIN MARKET OILIBYA	-	45,000	30,000
ORBIS OILIBYA	45,000	22,500	-
RAILWAY OILIBYA	30,000	30,000	30,000
TEKLEHAIMANOT OILIBYA	30,000	35,500	22,500
CASAINCHES(S. MAKET) OILIBYA	60,000	30,000	-
LIEKEMPT ROAD OILIBYA	60,000	30,000	30,000
RAS MEKONNEN BRIDG OILIBYA	30,000	60,000	-
RAS OILIBYA	22,000	30,000	-
LAMBERET (NEW)OILIBYA	30,000	60,000	-
MESKEL SQ OILIBYA	60,000	60,000	-
WOLLEGA ROAD OILIBYA	50,000	200,000	
SULULTA OILIBYA	50,000	170,000	
ALEMGENA OILIBYA	30,000	90,000	

Appendix E - Forecasting using Volume to be imported using SPSS

Time Series Modeler

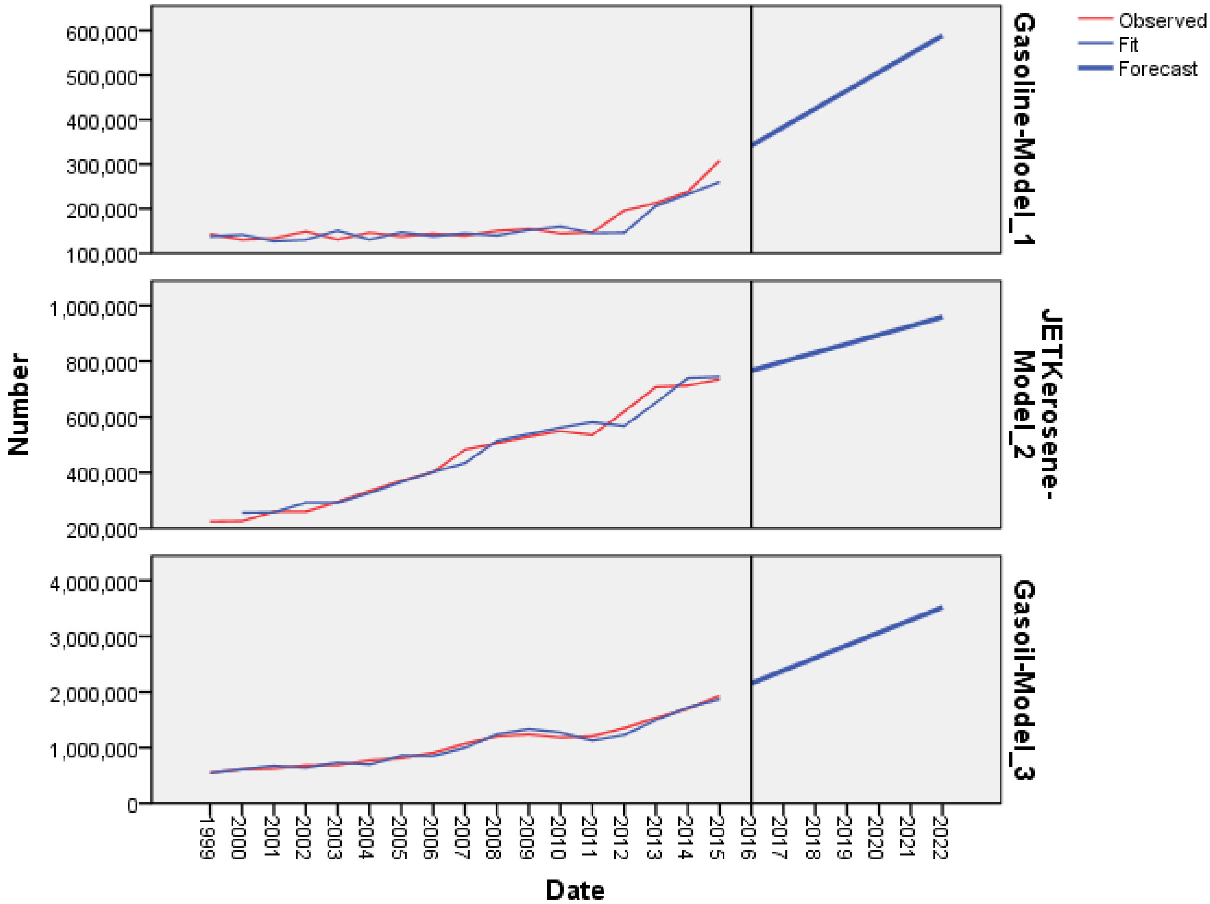
Model Description

			Model Type
Model ID	Gasoline	Model_1	Brown
	JET/Kerosene	Model_2	ARIMA(0,1,0)
	Gasoil	Model_3	Brown

Model Summary

Model Statistics

Model	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
		Stationary R-squared	Statistics	DF	Sig.	
Gasoline-Model_1	0	.299	.	0	.	0
JET/Kerosene-Model_2	0	-6.661E-016	.	0	.	0
Gasoil-Model_3	0	-.027	.	0	.	0



Observed
Fit
Forecast
Gasoline-Model_1
JETKerosene-Model_2
Gasoil-Model_3
Number
Date
600,000
500,000
400,000
300,000
200,000
100,000
1,000,000
800,000
600,000
400,000
200,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

Appendix F- Test- Retest result

QI-1 Vs QI2-1

Correlation

Descriptive Statistics

	Mean	Std. Deviation	N
QI-1	1.14	.363	14
QI2-1	1.21	.426	14

Correlations

		QI-1	QI2-1
QI-1	Pearson Correlation	1	.782**
	Sig. (2-tailed)		.001
	N	14	14
QI2-1	Pearson Correlation	.782**	1
	Sig. (2-tailed)	.001	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QI-2 Vs QI2-2

Descriptive Statistics

	Mean	Std. Deviation	N
QI-2	1.14	.363	14
QI2-2	1.07	.267	14

Correlations

		QI-2	QI2-2
QI-2	Pearson Correlation	1	-.113
	Sig. (2-tailed)		.700
	N	14	14
QI2-2	Pearson Correlation	-.113	1
	Sig. (2-tailed)	.700	
	N	14	14

QI-3 Vs QI2-3

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QI-3	1.50	.519	14
QI2-3	1.50	.650	14

Correlations

		QI-3	QI2-3
QI-3	Pearson Correlation	1	.798**
	Sig. (2-tailed)		.001
	N	14	14
QI2-3	Pearson Correlation	.798**	1
	Sig. (2-tailed)	.001	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-1 Vs QC1-1

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-1	4.57	.756	14
QC2-1	4.50	.855	14

Correlations

		QC-1	QC2-1
QC-1	Pearson Correlation	1	.952**
	Sig. (2-tailed)		.000
	N	14	14
QC2-1	Pearson Correlation	.952**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-2 Vs QC2-2

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-2	2.86	.770	14
QC2-2	2.86	.663	14

Correlations

		QC-2	QC2-2
QC-2	Pearson Correlation	1	.861**
	Sig. (2-tailed)		.000
	N	14	14
QC2-2	Pearson Correlation	.861**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-3 Vs QC2-3

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-3	1.93	.616	14
QC2-3	1.93	.616	14

Correlations

		QC-3	QC2-3
QC-3	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.000
	N	14	14
QC2-3	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-4 Vs QC2-4

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-4	2.57	.852	14
QC2-4	2.57	.852	14

Correlations

		QC-4	QC2-4
QC-4	Pearson Correlation	1	1.000**
	Sig. (2-tailed)		.000
	N	14	14
QC2-4	Pearson Correlation	1.000**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-5 Vs QC2-5

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-5	3.79	.579	14
QC2-5	3.86	.535	14

Correlations

		QC-5	QC2-5
QC-5	Pearson Correlation	1	.888**
	Sig. (2-tailed)		.000
	N	14	14
QC2-5	Pearson Correlation	.888**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QC-6 Vs QC2-6

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QC-6	3.64	1.082	14
QC2-6	3.71	1.069	14

Correlations

		QC-6	QC2-6
QC-6	Pearson Correlation	1	.969**
	Sig. (2-tailed)		.000
	N	14	14
QC2-6	Pearson Correlation	.969**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QP-1 Vs QP2-1

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QP-1	3.71	.611	14
QP2-1	3.71	.611	14

Correlations

		QP-1	QP2-1
QP-1	Pearson Correlation	1	.794**
	Sig. (2-tailed)		.001
	N	14	14
QP2-1	Pearson Correlation	.794**	1
	Sig. (2-tailed)	.001	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QP-2 Vs QP2-2

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QP-2	4.36	.633	14
QP2-2	4.43	.646	14

Correlations

		QP-2	QP2-2
QP-2	Pearson Correlation	1	.913**
	Sig. (2-tailed)		.000
	N	14	14
QP2-2	Pearson Correlation	.913**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QP-3 Vs QP2-3

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QP-3	1.43	.646	14
QP2-3	1.57	.756	14

Correlations

		QP-3	QP2-3
QP-3	Pearson Correlation	1	.877**
	Sig. (2-tailed)		.000
	N	14	14
QP2-3	Pearson Correlation	.877**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QP-4 Vs QP2-4

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QP-4	3.71	.726	14
QP2-4	3.86	.770	14

Correlations

		QP-4	QP2-4
QP-4	Pearson Correlation	1	.884**
	Sig. (2-tailed)		.000
	N	14	14
QP2-4	Pearson Correlation	.884**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

QP-5 Vs QP2-5

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
QP-5	3.50	1.160	14
QP2-5	3.50	1.286	14

Correlations

		QP-5	QP2-5
QP-5	Pearson Correlation	1	.954**
	Sig. (2-tailed)		.000
	N	14	14
QP2-5	Pearson Correlation	.954**	1
	Sig. (2-tailed)	.000	
	N	14	14

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix G- Storage capacity of Oil Company's depot

Oil Companies	MGR	AGO	Kerosene	Ethanol
Total	2,100 MC	4,200 MC	650 MC	400 MC
Oilibya	1,700 MC	2,130 MC	1,000 MC	200 MC
NOC	1,500 MC	1,500 MC	Nil	200 MC
Nile	2,190 MC	Nil	Nil	150 MC
TAF	Nil	600 MC	Nil	Nil
YBP	500 MC	Nil	Nil	Nil
Dallol	100 MC	300 MC	200 MC	

Appendix H- Product Imported in to the country

Year	Gasoline	JET/Kerosene	Gasoil	LFO	HFO
1997	122,995	252,302	557,640	107,576	0
1998	135,469	238,836	542,936	96,025	0
1999	142,526	224,177	548,787	61,566	54,954
2000	129,964	225,431	610,835	49,149	61,973
2001	133,111	259,786	623,197	40,688	80,894
2002	148,555	259,786	679,281	41,865	93,804
2003	130,416	294,699	688,527	40,770	90,078
2004	146,094	334,638	773,256	43,185	110,048
2005	137,193	370,401	811,689	41,521	117,198
2006	143,743	402,311	905,478	42,255	116,429
2007	139,093	482,173	1,073,148	49,692	138,059
2008	150,099	506,497	1,203,567	36,421	116,506
2009	155,806	529,857	1,237,922	10,714	100,967
2010	143,882	549,224	1,183,266	34,353	97,191
2011	146,670	535,304	1,206,216	36,492	107,964
2012	195,661	619,532	1,351,428	37,509	131,068
2013	212,802	707,761	1,537,319	38,286	125,187
2014	237,870	712,637	1,703,230	40,633	127,907
2015	308,035	735,348	1,930,539	37,858	71,023