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School of Mechanical and Industrial Engineering

Graduate Program in Industrial Engineering

A Master's Thesis on

Performance Evaluation and Optimization of supply chain distribution of the Lubricant

The case of Total Ethiopia Company

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Submitted by ……Abera Mekonta

ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING

INDUSTRIAL ENGINEERING STREAM

Evaluation and Optimization of supply Chain distribution of Lubricant

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled **Evaluation and Optimization of Supply Chain distribution of Lubricant** is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been accordingly acknowledged.

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Acronyms

ATF	Automatic transmission fluid
ESLES	Ethiopian Shipping and Logistics Enterprise
μ =	Mean
$e^{m}_{(t)}$	Misplaced error during period t
$e^{s}_{(t)}$	Shrinkage error during period t
et	Total error
$e^{T}_{(t)}$	Transaction error during period t
h	Holding cost
$I_a(t)$	Actual physical amount of inventory at time t
K	Fixed counting cost
Km	Kilometer
KPI	Key Performance Indicator
Lt	Liter
LTL	Less Truck Load
Mp	Misplaced
N	Inventory counting period
PDM	Physical distribution management
PLC	Private limited company
RFID	Radio frequency identification
SC	Supply chain
SCM	Supply chain management
Sh	Shrinkage
SKU	Stock keeping unit
Tr	Transaction
WMS	Ware house Management System

Abstract

The study was aimed at evaluating and improving the supply chain distribution of lubricants in general, and Total Ethiopian Share Company in particular in a qualitative and quantitative survey. The research has identified the challenges facing the supply chain and analyzed the extent to which the challenges have affected the performance of the supply chain distribution of lubricants. The findings showed that challenges facing the performances of the supply chain distribution of the lubricants were due to shortage of foreign currency, Inventory counting practice, ware housing and transportation. The researcher has identified the trends in warehousing operations, the nature of the relationship between inventory counting practices and warehousing operations. In addition to this the research indicated how the transport system, inventory counting practice and ware housing system influenced the customer services level and delivery cost. On other hand the study indicated option to overcome the challenges observed in supply chain distributions.

Finally, the research has recommended how to benefit from opportunities and overcome the challenges as well as the optimization of the supply chain distributions

Keywords: Lubricant, Supply chain management, performance evaluation, improvement, inventory counting, warehousing, transportation.

Chapter 1

1.1 Background of the Study

A Company needs to have performance measurements to be able to evaluate the efficiency of the Supply chain. Taylor, states that one cannot manage if he/she cannot measure (Anthony Osoro, 2015).

Organizations may need to carry out performance evaluation for various kinds of reasons: identifying success, identifying whether they are meeting customer requirements, helping them understand their processes, identifying where problems bottlenecks, waste, etc., exist and where improvements are necessary, ensuring decisions are based on facts, not on supposition, emotion or intuition; and showing if the planned improvement actually happened" (Turan Erman Erkan, 2011).

On the other hand the success of any business depends on the success of its supply chain management (SCM). Supply chain management is being heralded as a value driver because it has such wide ranging effect on business success or failure" (Javad Sofiyabadia, Mohmmad mahdi movahedia and Sakineh Noori NasabbJavad ,2012). By SCM, firms are able to compete in a local scale or globally and this can be an advantage for a Company, because now days the business environment is entirely competitive.

The Ethiopian industries are operating today in a business environment characterized by unpredicted competition and technological change. In order to overcome the problem of being unable to be competent in the market and technology, the concept of supply chain management is important for the firms. Supply chain management has become a universal approach to cost effectiveness, timely delivered and the creation of growth oriented exchange system in goods and services.

Supply chain management ultimately aims to satisfy the customers preferably on the most cost effective level through supplier-buyer integration and cooperation. In addition to this, the supply chain operates as a network of the involved businesses based on the up- and downstream linkages where each player of the network focuses on their core business to create the highest value at the lowest cost for the final customer. Since the customers are increasingly demanding and they have to be taken more and more into account.

The recent periods' global economic trends and the oil industry have turned out to be inseparable and they have a great impact on each other. The supply of oil has become a necessity for the national economies and shows a growing demand tendency. With globalization the trade barriers have also been eased for smoother trade and technology development has clearly intensified. Faster delivery, reliability and lower cost have also appeared as a need from the customers' point of view. All these factors create a strong competition among the oil industry players. In a competitive market the companies aim to be more effective, more efficient and more profitable than their competitors.

The oil market is also exceedingly volatile because of various unpredictable factors. One of the main factors is the frequent price fluctuation and the frequent political changes. Obviously these factors keep causing changes in the demand and supply which has an impact on the whole supply chain and its management. Volatility can be the result of unforeseen events as well, such as a natural disaster or broken down equipment. The result is tremendous uncertainty surrounding the industry which makes the supply chain manager's job and supply chain optimization more challenging. The high level of uncertainties actually is one of the main reasons for the oil industry adopting a unique supply chain management approach.

Supply chain optimization is the biggest opportunity for most companies to significantly reduce their cost and improve their performance. Optimization is the act of achieving the best possible result under given conditions. The goal of all such decisions is either to minimize effort or to maximize benefit. Optimization strives to achieve the most efficient in an optimal way to manage the supply chain in order to satisfy customer needs at the lowest cost.

Ethiopian oil industry currently comprises both international and domestic companies and including : Oil Libya, Total Ethiopia, National Oil Ethiopia, Yetebaberut Beherawi Petroleum, Kobil, Dalol Oil, WadiAlsundus (a Sudanese Company), TAF Oil Nile Petroleum and All way Plc ([1]). The first four mentioned companies constitute 89 percent of the entire oil distribution in Ethiopia. Total and Oilibya has upstream sources in supplying their branded lubricants, the other indigenous ones have different import sources for the products. Hence the industry has become the area characterized by stiff competition especially in the lubricant wide products line (Oils and greases) through time. This thesis

evaluates performance of the existing supply chain distribution of the case Company (Total Ethiopia), and determines the method of improvement of the supply chain distribution.

1.2 Statement of the Problem

The oil industry faces many problems setting several constraints and challenges for the industry. It is a very complex chain compared to other industries due to several reasons. The distance from the oil production/refinery point to the final consumers could often be thousands of kilometers (km) which is the main reason for the oil supply chain having longer lead time than in other industries. The long lead time also indicates the involvement of various means of transport such as ships, pipelines, rail and road as well as high transportation cost.

The main challenges in oil industries in Ethiopia are import/export facilitation, ware housing, challenges in domestic and international transportation management, information technology, unstable political environment, oil supply uncertainty, long lead times, and fluctuating global oil prices, customer demand for quality, in adequate storage capacity for inventory, improper ware house allocation and distribution center and inability to deliver the product whenever demanded by customer. In developing countries, the number of new Oil Company joining the market is increasing from time to time which could lead to high competition in the industries.

In Ethiopia, until 2002 when National Oil Ethiopia and Yetebaberut Beherawi Petroleum joined the Ethiopian oil distribution market, it was dominated by four companies; Mobil, Agip, Shell and Total Ethiopia with less competition. Later, with increasing number of Oil Company joining Ethiopian oil industry, Mobile, Agip and Shell companies were challenged to stay in the market and they were forced to leave the industry.

However Total Ethiopia is still running with high level of competition though due to(with some challenges of) non availability of product due to shortage of foreign currency, poor Inventory control or stock level control, ware housing and transportation problems delivery delays, supply interruption, high picking time and customer complain are some of the challenges observed in a Company. The stock level control system is a monthly based manual physical counting. During such monthly counting, all warehouses pause operations (i.e. all ware houses do not give services for one and half days to two days

per month or eighteen to twenty four days per year); and this has caused customer complaint. Due to this, the sales department has been challenged by the customer during their visit to the customers. On other hand, the location of the ware houses, limited storage capacity, product arrangement in the ware house were another challenge for the company. Products are stored wherever space is available, and the item tracking is dependent on the memories of warehouse staff and causing long picking time. In addition to this Products are placed one over the other due to limited storage area.

1.3 Research Questions

This research will address the following questions:

1 .What are the factors that affect the performances of supply chain distribution of the lubricants in the Oil Industries?
2. Which factor along the supply chain distribution of Total Ethiopia affects the performance of the Company?
3. To what extent does the existing supply chain distribution system of Total Ethiopia affect the performance of the Company?
4. What are the possible solutions to optimize the supply chain distribution of Total Ethiopia? How can the Company benefit from it?

1.4 Objective of the Study

1.4.1 General Objective

The general objective of this research is to evaluate the performance and optimize the supply chain distribution of Total Ethiopia Company through analysis of the primary data and the literature review.

1.4.2 Specific Objectives

a) To assess and evaluate the current supply chain distribution system of the Company
b) To identify the main problems related to supply chain distributions which affect the performance of the Company.
c) To identify the sources of the problem and propose solutions

d) To develop model for optimizing supply chain distribution for the Company.
e) To recommend the developed model for optimizing supply chain distribution of oil to the Company

1.5 Significance of the Research

The research focuses on the performance evaluation and optimization of supply chain distribution system of Total Ethiopia Company. It develops a model for optimizing and improving towards a more cost effective and customer focused supply chain. The research lays a base for further research on other similar companies in the oil industry that would be used in optimizing the supply chain iteratively due to the ever changing of the supply chain. The regular reevaluation of the results is also suggested due to the dynamic nature of supply chain management and the oil industry.

1.6 Scope of the Research

The research focused on reviewing all the activities and process along the supply chain distribution system of Total Ethiopia. It evaluates the current performance of the Company in line with supply chain distribution system and develop model for optimizing and improving it towards a more cost effective as well as customer satisfaction that would possibly to increases sales volume, company profit and smooth flow of the operation along the supply chain distribution.

Chapter 2

Literature Review

2. Supply Chain Management

2.1 Supply Chain Management

Different authors have defined supply chain management in different ways. For example one author has defined the supply chain management as follows. Supply chain management is a network or chain of facilities and distribution options of products, the transformation of these products into intermediate and finished goods, and the distribution of these finished goods to customers (Luc Wijffels and Philip Woodall, 2016).

Supply Chain Management involves managing the flow of materials from suppliers to customers in order to reduce overall cost and increase responsiveness to customers (Reidand Sanders, 2011).As Reid and sander (2011), the network of entities that are involved in producing and delivering a finished product to the final customer is known as supply chain. The objective is to have everyone in the chain work together to reduce overall cost and improve quality and service delivery.

Supply chain management requires a team approach, with functions such as marketing, purchasing, operations, and engineering all working together. This approach has been shown to result in more satisfied customers, meaning that everyone in the chain profits.

The supply chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage to the end user (along with the associated information flow). For Robert and Ernest (1999), Supply Chain Management is the "integration of these activities, through improved supply chain relationships, to achieve a sustainable competitive advantage.

The basic objective of supply chain management is to optimize performance of the chain to add as value as possible for the least cost possible (Sahoo and Mishra, 2013). Matiwos (2013) the objective of

supply chain management is to maximize the overall value generated, minimize the cost, effective and timely distribution of products needed by ultimate customers. Managerial efforts are directed towards setting the level of the logistics activities so as to make products and services available to customers at the time and place required, and in the condition and form desired, in the most profitable and cost-effective way.

Distribution refers to the steps taken to move and store a product from the supplier stage to a customer stage in the supply chain. Distribution is the marketing function that ensures that goods and services are made available at the points of need, for the consumers (Nwaizugbo 2004:150). While corroborating this assertion, Perrault/Cannon and McCarthy (2010:248) stated that distribution also known as place is concerned with making goods and services available in the right quantities and locations, when and where on demanded by customers.

2.2. Supply Chain Distribution in Petroleum product downstream

According to the international energy agency annual outlook, the oil and gas reserves shall be enough for a significant period of time to meet world demand. With regard to this point the main challenge for petroleum downstream industry is manufacturing and delivering products to customers through the most efficient way with the lowest cost.

Supply chain management in downstream industry is complex and challenging because of increasing global demand of oil and its derivation along with inflexibility of petroleum supply chain and easiness of international commerce. In addition, petroleum downstream SCM has specific characteristics that distinguishes it from other supply chains.

- Petroleum is a process industry which is different from discrete industry. A process industry is defined as products that are produced in such a way that there is no chance for the products to return into the basic material once they are put together, i.e. you cannot take them apart.
- Products in this industry are flammable and this characteristic increases the risk of manufacturing and handling

- Products are manufactured and handled in mass volume that causes high inventory carrying cost. In other words, the flexibility in terms of volume does not exist.
- Transportation cost is high compared to discrete industry. Crude oil must be transferred from the production sites to refineries and from refineries to consumers. These transportations have different modes like pipelines, trucks, trains, barges, etc.

"Despite the importance of supply chain management and its growing complexity, the petroleum industry is still in the development stage of efficiently managing their supply chains. Oil and gas industry benefit from optimizing its supply chain more than any other companies. The industry is involved in a global supply-chain that includes domestic and international transportation, ordering and inventory visibility and control, materials handling, import/export facilitation and information technology" (Saba Norouz ,2013).

2.3 Supply Chain Performance

Supply Chain Performance refers to the extended supply chain's activities in meeting end-customer requirements, including product availability, on-time delivery, and all the necessary inventory and capacity in the supply chain to deliver that performance in a responsive manner.

A supply chain performance evaluation system represents a formal, systematic approach to monitor and evaluate the performance of the supply chain (Handfield, et al. 2009). It should however be noted that it is often difficult to develop measures that direct behavior or activity exactly as intended. Some firms rely on measures that do not support long term performance. Over time, the workplace's view of performance measurement has become more humane and do not view employees as highly reliable, predictable machines, and exaggerated types of monitoring and control methods have fallen out of favor, and replaced by a focus on a measuring a business' performance rather than that of the individual (Lapide,2000).

According to Handfield et al. (2009) there are a number of reasons for measuring and evaluating supply chain activity and performance. Measurement can lead to better decision making as the firm would understand the areas in which performance falls short. Performance measurement can result in better communication across the supply chain.

2.4: Measuring supply chain performance in Oil industry

Companies need to be competitive to survive. Today, it is not companies that are competing but the supply chains. A Company's performance is based on its capacity to avail products and the timely responsiveness in delivering products with competitive price. This performance measurement should be able to evaluate the efficiency of the Supply chain. Taylor (2014), states that "you can't manage if you can't measure".

A performance measure or a set of performance measures is used to determine the efficiency / effectiveness of an existing system, or to compare competing alternative systems. Measurement provides the opportunity for performance feedback which then supports the prevention or correction of problems identified during the performance measurement process. Lastly, measurement also motivates and directs behavior towards a desired end result. Performance measures are also used to design proposed systems, by determining the values of the decision variables that yield the most desirable level(s) of performance (Anthony Osoro, 2015).

Supply chain performance crosses both functional lines and Company boundaries. This thesis considers the supply chain performance with in the boundary of the case Company. To achieve the goal, performance measures are needed for assessments and eventual improvements. They must show not only how well one is serving its customers but also how well one is handling its business with regard to speed, inventory and financial metrics.

An important component in supply chain design and analysis is the establishment of appropriate performance measures. A performance measure or a set of performance measures is used to determine the efficiency / effectiveness of an existing system, or to compare competing alternative systems. Performance measures are also used to design proposed systems, by determining the values of the decision variables that yield the most desirable level(s) of performance.

In addition to this, performance measurement provides information for management and decision making, enable identifying the success and potential of management strategies and facilitating the understanding of the situation. Beside to these, performance measurement assists in directing

management attention, revising company goals. Supply chain performance measurement is helpful in the continuous improvement of SCM.

2.5 Factors affecting supply chain performance in oil industry

Despite the importance of the petroleum industry in daily life and the operational challenges it experiences, the topic of challenges affecting supply chain management in the oil marketing companies has received very little attention in operations and supply chain management literature. In order to achieve efficient supply chain management for activities of the oil marketing companies in Ethiopia, the organizations need to understand the challenges affecting their supply chain management.

The oil marketing companies are involved in a global supply-chain that includes domestic and international transportation, ordering and inventory, visibility and control, materials handling, import/export facilitation and information technology (Waleed K.Abduljabar and Razman M.Tahar, 2012). The challenges facing supply chain management in the oil marketing companies in Ethiopia occur in one or more of the supply chain components ; transportation, material handling ,import facilitation ,inventory control ,ware house facilities. Identifying the challenge facing the SCM in oil marketing companies and determining the extent to which the oil marketing companies are adopting best practices to manage challenges in their supply chain is very important. In other study unreliable warehouse facilities and transportation systems are the main challenge faced in supply chain management (Wihdat Djafar,Yousef Amer and Sang Heon lee, 2013).

2.5.1 Transportation

One of the main characteristics of transportation is the movement of products from production sites to the set destination, taking into account procedures that minimize costs and optimize resources. In this process, it should paid attention and care to reduce damages. In contrast, the operations must be performed in order to meet customer demands, observing the operational capacity of delivery and availability of transportation information (Radrigo Durate Soliani,2014).

This process should be economically justified, since the movement of goods spent money, time and environmental resources. Transportation requires financial re-sources - in the form of internal costs for

transportation of goods own rolling stock and external costs for this purpose commercial. Thus, function defines the main transport its goal - delivery of goods to their destination as quickly as possible, cheaper, and with the least damage to the environment. It is also necessary to minimize the loss and damage of goods transported while fulfilling customer requirements for timely delivery and to provide information about the goods in transit.

The transport involves with the movement of goods, routing and use of the operational potential of the vehicles The concept of Arnold (2009) shows that the transportation system uses a number of methods for handling their raw materials or their final products, perceived as the higher cost of the distribution process, generally representing between 30% and 60% of distribution costs. Pipe, ship, rail and road are the modes of transport used in the petroleum products distribution. The method of transportation that is used to transport product is strongly influenced by demand, geographical barriers, the risks associated with different transport modes as well as the relative costs of transportation. In each case, the choice of transportation has its own strengths and weaknesses.

Due to an increasingly competitive market, transportation operations are usually considered as one of the major bottlenecks in the oil industry. Thus, petroleum companies are eager to find ways to pursue efficient transportation schedules within their operational planning so as to organize their activities to achieve better competitive advantages. To efficiently manage the available resources is, in other words, to have their products at the right price, in the right quantity, at the right place and at the right time (Waleed K.Abduljabar and Razman M.Tahar,2012).

Sea and road transports are the common transport mode used in Ethiopian oil Industry .Ethiopia is one of the landlocked countries in the world that is located in Eastern Africa bordering the Sudan, Eritrea, Djibouti, Somalia, and Kenya. Ethiopia is dependent on seaports of other countries for its export and import. Although, due to the existing circumstances the country is depending mainly on port Djibouti, future possibilities of using Port Sudan, Berbera, Assab, Massawa and Mombasa may be investigated with respect to the available transport infrastructure and geographical. From the Djibouti port to Addis Ababa and other parts of Ethiopia goods or products are transported by trucks (Fikadu M.Debela 2013).

With the intention of providing one stop logistics solution and to minimize huge cost the country incurs in relation to port related and transit charges, the government of Ethiopia established commercial enterprise called (ESLSE) Ethiopian Shipping and Logistics Service Enterprise that will provide sea transport.

The major problem with road transport is the risk of road accidents, shortage of trucks and possible hijackings and truck transportation cost. The results of road accident incidents are mainly loss of product due to theft or spillage and damage.

Shortage of trucks causes supply disruption. Supply disruption affects the normal flow of goods and materials within a supply chain. This caused firms within the supply chain to operational and financial risks.

Transportation costs become critical components because products are distributed in a long distance with various vehicles and transited in many sites with different capabilities. Transportation costs are all the costs involved in the movement or transport of a shipment. Logically these costs have correlation factors such as, physical characteristics of goods delivered, goods delivery quantities, distance and the used transportation mode. (Wihdat Djafar ,Yousef Amare and Hean Sang Healn Lee, 2013)

Transportation cost can be reduced by using various alternatives of vehicles (such as, less truck load/LTL, full truck load/FTL, etc.) or warehouses (as distribution center or transit-terminal consolidation). Considering various facilities will provide more options to store and to transport the products in small or large quantity which depend on the number of orders and also provide more possible ways to minimize distribution costs without lose the potential demand (Wihdat Djafar, Yousef Amare and SangHeon Lee, 2013).

Another research paper indicated an increasingly competitive context, the effective manage transportation operations has been becoming one of the major factors for oil companies to survive and to maintain competitive advantages (WaleedK.Abdul Jabar, 2013).

Hughes (1971) sets up a network model to determine where to locate the terminals with respect to customer distribution sites. This study is mainly aimed at developing a decision support system to

investigate and improve the combined inventory and transportation system in a representative oil supply operation (Waleed K.Abduljabar and Raziman M.Tahar, 2012).

The fleet is optimized to ensure that the most cost effective route used for the delivery is selected and the trucks are used effectively. The truck deliveries are organized into zones determined by the logistic team in line with the geographical locations of the retail customers and the amount of the volumes to be delivered.

Logistics Outsourcing is a common type of traditional truck outsourcing, which is widely used by oil companies in Ethiopian oil distribution industry.

According to Sink and Langley (1997), outsourcing is a business strategy that a company gives its inner non-core activities to external service providers to facilitate company control over their resources and share risks. Another study indicated outsourcing ‘’is a management strategy by which major non-core functions are transferred to specialist, efficient, external providers’’. Accordingly, usually firms have outsourced their non-core activities. However, outsourcing does not necessary mean that the outsourced function is less important to company’s performance as argued by Holcomb and Hitt (2007).

2.5.2 Warehousing

Warehousing can be defined as the process in which three main functions are accomplished: Receiving products from a source, storing products as long as necessary until they are requested (internally or externally) and delivering the products when they are demanded (Queirolo et. al. 2002).Warehouses are a crucial part of supply chains, and their main role is to facilitate movement of goods through the supply chain. It is one of the most important levels of the supply chain, although, it is an activity of high Financial cost for companies.

Thus, by improving its internal operations, the performance of the company is also improved. A good warehouse management is a prerequisite for achieving a high level of customer service (Ramaa.A,K.N.Subramanaya and T.M.Rangaswamy,2012). Another study indicated the process of warehousing involves a series of sequential activities, namely: reception of the goods put away, storage, order picking, sortation, unitizing and shipping.

Warehouse management should focus on ways to improve the efficiency of processes, both internal and external supply chain and continuous monitoring and evaluation of the results.
It is necessary to allocate warehouse resources efficiently and effectively to enhance the productivity and reduce the operation costs of the warehouse. Warehouse costs are all the costs to management costs of the facility, material handling costs, labor costs, storage costs and maintenance cost.

2.5.2.1 Storage conditions of lubricants

Lubricating oils and greases are formulated to satisfy specific kinds of service. If not handled and stored properly, it can deteriorate or become contaminated and, as a result, provide inadequate
Lubrication or become waste which requires disposals. So to avoid these following storage conditions are recommended.

- The lubricants should be stored in a dry environment at temperatures above 0°C and below 35°C with limited exposure to temperature changes. Temperature changes will cause the packs to "breathe" and as such inhale contaminants like dust and water.
- Preferable the lubricants should be stored indoor. If indoor storage is not feasible, the lubricants should be stored under a cover to avoid direct sunlight and ingress of water.
- Lubricant barrels should be stored tilted, on their side, or bungs-down like indicated on picture below. This prevents moisture being drawn into the barrel through leaking seals when the internal pressure changes due to variations in temperature.

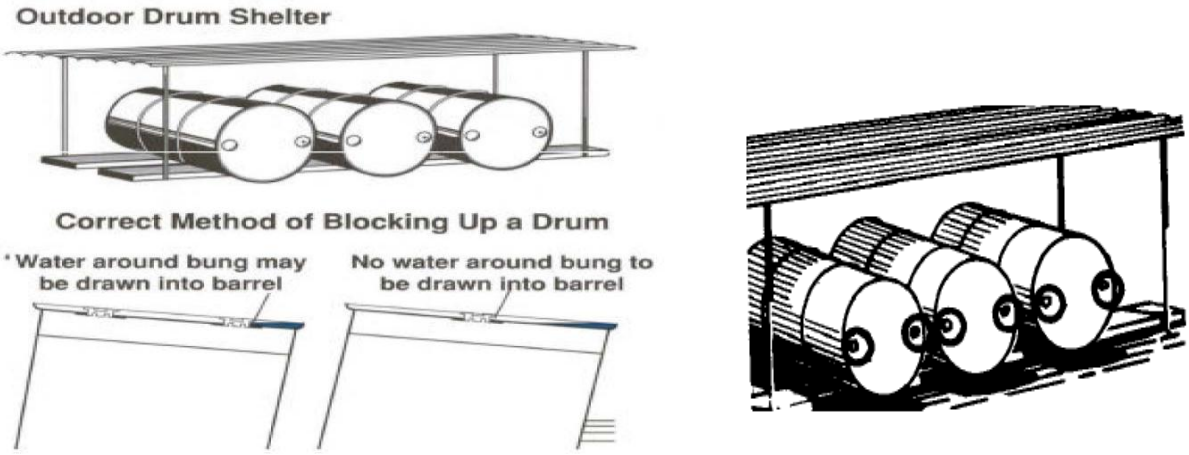

Fig. 2.1 Storage conditions of lubricants

- In every case, barrels should be stored off the ground on pallet or in racks, well clear of surface water.
- Barrels should be regularly examined for signs of corrosion and for evidence of weakening seams or seals.

According to this study if the storage condition of the lubricant is not full fill the above mentioned storage conditions, the product may become instable with the risk of additives dropping/plating out resulting that the lubricant will no longer meet its designed performance level (Atlascopco 2018).Other study indicated that the best place to store lubricant is indoors. Storing lubricants outdoors is poor practice. If lubricants must be stored outdoors, however, take certain precautions to minimize harmful effects. A temporary shelter, lean-to, or waterproof cover will protect the drums from rain and snow. Place the drums on blocks or racks several inches above the ground to prevent moisture damage.

2.5.2.2 Warehouse Performance Measurement in oil industry

Measuring warehouse metrics is critical for providing managers with a clear vision of potential issues and opportunities for improvements. Metrics are tied directly to the business strategy and operation's success drives the financial results of the organization. If warehouses are going to contribute to be a source for adding value to the supply chain then they need to measure their performance with perfect metrics.

The metrics for measuring performance in a warehouse fall into three main categories which includes order fulfillment, inventory management and warehouse productivity (Ramaa.A,K.N.Subramanaya and T.M.Rangaswamy, 2012).

Another study indicated Total delivery cost, on time delivery, storage facility and number of delivery are the key performance indicator of the ware house. Such performance indicators are regard to the customer perspective and should be considered as key factors for process improvement initiatives across the organization (Adam Kolinski and Boguslaw Sliwczynski, 2015).

There are many suitable methods of handling packed lubricant product, but the most widely accepted are**:**

- Forklift truck (either horizontally on the standard fork, or vertically with a single or four barrel handling attachment)
- Two-wheel hand truck
- Triangular drum dolly
- Manual elevator

Most lubricants have the potential for combustion and explosion in certain circumstances. The hazard is related to the flash point of the product. Therefore, oil stores must be equipped with CO2, dry chemical or foam type extinguishers, and with sand filled fire buckets.

2.5.3 Inventory Management

Inventory management is a complex aspect of Supply Chain Management that is frequently discussed and debated due to the fact that it has a high impact on customer satisfaction as well as financial performance. Inventory management has become necessary in modern businesses in order to achieve excellent customer service, Cost reduction, Enhancing supply chain competitiveness and performance, Gaining market share, growth and expansion of businesses as well as Profitability.

Inventory is the stock of any item or resource used in an organization. An inventory system is the set of policies and controls that monitors the level of inventory and determines what levels should be maintained, when stock should be replenished and how large orders ought to be.

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In an inventory, items flow into the system, remain for a time and then flow out. Inventories occur whenever the time an individual item enters is different from when it leaves. During the intervening interval the item is part of the inventory.

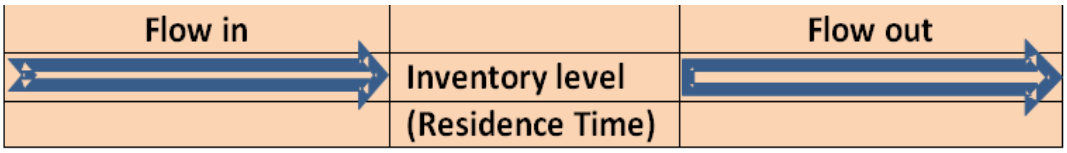

Figure 2.2 A system component with inventory

Inventory management is a critical area of physical distribution management (PDM) because stock levels have a direct effect on levels of service and customer satisfaction. The optimum stock level is a function of the type of market in which the firm operates. Few companies can say that they never run out of stock; but if stock-outs happen regularly then market share will be lost to more efficient competitors. The key point is in determining the re-order point. Carrying stock at levels below the re-order point might ultimately mean a stock-out, whereas too high stock levels are unnecessary and expensive to maintain. Stocks represent opportunity costs that occur because of constant competition for the Company's limited resources. If the Company's marketing strategy requires that high stock levels be maintained, this should be justified by a profit contribution that will exceed the extra stock carrying costs. Sometimes a Company may be obliged to support high stock levels because the lead-times prevalent in a given market are particularly short.

An important aspect of good inventory management is:

- Effective use of information. Knowing how to use information effectively also enables a manager to decide what data to collect, buy and store, and what information technology to invest in. Note that information has no value, if it is not used effectively.
- To quantify the value of information. A manager may need to invest in a technology that collects and stores information relevant for effective inventory management. The cost of obtaining information is often not difficult to analyze. Quantifying the benefits, however, requires thorough analysis and modeling. Consider, for example, the recent tracking technology known as Radio Frequency Identification (RFID)
- To coordinate decentralized operations. The coordination of information and inventory management has become increasingly more difficult with recent increases in supply

chain complexity. Such complexities are the result of dramatic changes in manufacturing and distribution, including globalization and outsourcing.

2.5.3.1 Inventory Control Strategy

Inventory control is the activity, which organizes the availability of items to the customers of the organization (Hussin Abkhar Mohamud, 2016).Inventory control systems play a crucial role in enhancing effectiveness and efficiency in handling inventory of business firms. The effectiveness of inventory control is typically measured by how successful a Company is at reducing inventory investment, meeting its customer service goals, and achieving maximum through put and cost control.

Different scholars have looked at inventory control strategies differently. Cycle counting is one of the current inventory control strategy applied in most ware houses (Lilian Tundura,Daniel Wanyoike,2016).

2.5.3.2. Cycle counting Inventory control strategy

Cycle counting is the process of counting inventory items throughout the year on a schedule so that all items are counted at least once a year, especially because of financial asset reporting requirements with the primary focus on items that move more frequently and less attention given to items that move less frequently (LilianTundura,DanielWanyoike,2016). Conducting cycle counts (i.e., periodic inventory auditing) is a common approach to correcting inventory records.

Cycle counting is conducted for a number of reasons:

- To achieve accuracy in inventory records
- To keep optimal inventory levels in the organization
- To monitor inventory on continuous basis
- To ensure continuous and uninterrupted business operations
- To facilitate process improvements and to achieve optimal operational costs

A variety of cycle counting strategies can be used based on their needs and inventory types. Such inventory cycle counting strategies include:

Random sampling cycle counting: In random sample cycle counting the random sample from the population of inventory record is generated and associated items are counted.

Opportunity based cycle counting: Opportunity based cycle counting is performed at particular counting key events in the process. Counting might be scheduled for when an item is reordered, when balance drops below thresh hold, and when an item is issued.

Transaction based cycle counting: In transaction based cycle counting, counting is scheduled based on the number of transaction experienced by SKU (Stock-Keeping-Units)**.**

Process control cycle counting: This method involves methods of counting only items that are easy to count. This methods depend on inventory record having an item count by multiple location and that the listing available to the counter during counting. The inventory accuracy is the based on those SKU that were actually counted and included in the sample. Process control cycle counting is faster and requires significantly less counters since less items may be counted.

Location based cycle counting: It is very similar to cycle counting except that the counter is not given the record count and has no discretion with respect to the ease of counting. Sample area is chosen and every item in that area must be counted.

The disadvantage of this method (as well as process cycle counting) is that the characteristics of the items are not used to form the sample. The sample is formed by location. The location may be irrelevant with respect to the needs of production or distribution function.

ABC cycle counting: ABC classification is a method of classifying inventory items according to the money value to a firm. Class A items though smaller volumes but tends to generate higher sales value followed by the class B items. The class C items are of a very large volume but generate a very small sales value. For inventory items, A, B and C classification the criterion is frequently the annual dollar usage of the item. However, it has been generally recognized that the traditional ABC analysis has a serious drawback that may inhibit the effectiveness of the procedure in some situations. Using one criterion only may create problems of significant financial loss. For example, class C items with long lead time or class A items prone to obsolescence may incur financial losses due to a possible interruption of production and/or huge inventory levels. Therefore, it has been considered that multi criteria ABC classification, such as lead time, criticality of a stock out of the item, the rate of obsolescence, the scarcity and order size requirement of the item, can provide a more comprehensive managerial control and to take other important criteria into consideration.

There are four distinct roles that need to be performed as part of a cycle counting program:

- **Cycle Counters** perform the scheduled counts to the WMS. These individuals should have the authority to post inventory changes that are within the pre-defined acceptable variance. A Cycle Counter should not have the authority to adjust an on hand value outside of the predefined acceptable variance.
- **Warehouse Operators** conduct zero count confirmations as part of their normal daily operations. The warehouse operators should have no inventory count update authority at all outside of the normal adjustments that results from selecting and placing products into and out of slot locations. If a warehouse operator discovers a count discrepancy while doing a zero confirmation, that location will be flagged for slot verification regardless of the variance amount. The only inventory update authority a warehouse operator should have is to confirm a zero on hand quantity.
- **Inventory Control Specialists** perform slot and SKU verifications. Inventory control specialists should have the authority to make slot level inventory adjustments within the WMS and free up slots that are flagged for investigation. The inventory control specialists should have the authority to complete and clear out both slot verifications and full SKU verifications.
- **Inventory Control Manager** approves and releases inventory adjustments. This has a critical role because the approved adjustments will update the on hand quantities used to make purchasing decisions, and these adjustments will also be used to calculate the annual accounting entries for posting the annual general ledger inventory adjustments.

While inventory cycle counting is popularly used in inventory management, there are a number of challenges faced by organizations. These challenges are:

- Inefficient staffing that usually results from underestimation of counts required within a given operating period.
- Diversion of attention and effort to other operational areas in the organization giving very little attention to inventory counting.

- Ignoring error creation in the system thereby leading to buildup of errors in the stock counts. This challenge can be tackled through employee training.
- The last challenge is poor motivation among staff involved in stock counting

2.5.3.3 Effect of cycle counting frequency on system performance

The major goals of cycle counting programs are to identify process problems and to correct inventory data. But the type of cycle counting as well as the frequency of counting affects the ware house system performance. Some of the cycle counting effect during designing or selecting the type and frequencies of cycle counting were discussed below.

Cost of counting Physical Inventory: The cost of conducting a physical inventory can be measured in many different ways depending on the purposes of the inventory manager. The counting cost has a fixed component k and variable components. One study considers manpower costs associated with the actually performing the physical inventory. In this study manpower costs are derived as a function of the number and respective pay grades of personnel who would actually perform the physical inventory (Steven M.Elkins,1994).

Another study has considered total counting and holding cost per period to find the optimal reconciliation frequency (cycle counting) and the corresponding discrepancy of inventory to protect against discrepancies (Angelica Burbano,Behlul Saka and Ronaldo Rardin ,2009). This study considered how to minimize the total expected costs that included inventory holding cost for buffer stock and the cost for physical inventory counts. The cost of buffer stock and inventory counting are related to the study of buffer stocking policy and frequency of stock counting.

Disruption of ware house operation: Inventory record inaccuracies are an issue in both retail and warehousing and can lead to considerable costs due to stock-outs and excess inventory. In order to ensure that inventory record inaccuracies are minimized, warehousing organizations conduct inventory checks on items in the warehouse to identify and rectify the misalignment between the data record and actual physical items. The challenge is that inventory checks are extremely time consuming and stop ware house operations (Luc Wijffels,Philip Woodall,2016). Finding more effective cycle counting frequency which would result in a lower number of ware house disruption days to avoid the probability of sale lose and customer complain , is therefore, very desirable.

Probability of Sales loses: The requirement to close activities during inventories to ensure accurate counts affects the sales activities. In addition to this, it affects customer service levels. The probability of sales lose was based upon projected warehouse downtime due to counting of physical inventories. To derive the metric which represents the period of operational disruption, two statistics were required. The statistics are total time required to count all items in ware house, and the designed number of counting frequencies implemented at the Company.

2.5.3.4. Inventory Record Accuracy

An inventory stock record is accurate when the information on the stock record is in agreement with the actual physical situation (Lilian Tundura,Daniel Wanyoke,2016).To measure the accuracy of the inventory, setting of tolerance level should be determined. Tolerance level is set to determine whether or not a count on record is accurate. If the physical count is within counting tolerance then the record is considered accurate. Different authors give different tolerance level to determine the accuracy of the inventories. For example, Kang and Gershwin (2005) found in their study that the best performance warehouse on inventory accuracy is 75% - 80% matches between inventory records with actual inventory (Shiau Weichan,Li ping yaw Binti Ismali,2017). In another study, the inventory record of a SKU is considered accurate if it agrees with the actual stock within the interval of 5 units deviation (EvsenKorkmoz, 2008). Also other study explains as inventory discrepancies is not allowed to be more than 2% in inventory levels ([13]). In addition to this, another study defines the accuracy of inventory within the following tolerances using ABC classification system; class A items, plus or minus 1% quantity variance from perpetual balance, class B items, plus or minus 3% quantity variance from perpetual balance and C items, plus or minus 5% quantity variance from perpetual balance (Lilian Tundura and Daniel Wanyoike, 2016).

Table2.1 Inventory allowable discrepancies from the point of different authors and research papers

No	Authors and year	Title	Inventory accuracy setting tolerance level (allowable discrepancy)
1	Lilian Tundura and Daniel Wanyoike, 2016	Effect of Inventory Control strategies on Inventory record accuracy in Kenya Power Company	Class A-items = 1% Class B-items = 3% Class C-items = 5%
2	Shiau Wei Chan, Tasmin, Binti Ismail & Li Ping Yaw ,2017	Factors Influencing the Effectiveness of Inventory Management in Manufacturing SMEs	Not more than 2%
3	Adzhar Kamaludin,2010	A simulation approach for modeling and investigation of inventory inaccuracy in warehouse operation	20% - 25%
4	Evsen Korkmaz 2008	Deciding on RFID Tagging Level of Inventories	5units deviations
5	James anman,2005	Inventory Management Improvement Techniques, Masters Theses	Not more than 5%

2.5.3.5 Inventory Inaccuracy

Inventory record inaccuracy refers to the discrepancy between physical inventory held in stock and the record of inventory stored in the information system of a firm. Inaccurate inventory information leads to ineffective replenishment decisions, which, in turn, result in poor service levels and higher inventory costs. This is a major issue affecting supply chain performance in manufacturing, distribution and retail settings.

Discrepancy within an inventory record's quantity field undermines the operation of inventory control policies. Most policies are designed to utilize the current state of the inventory (inventory position = amount on hand + amount on order - amount backordered) to determine when and how much to order. If the current information on the state of the inventory system is inaccurate, then inadequate inventory control may result. This may lead to excessive inventory or poor customer service due to lack of adequate inventory. Despite best efforts to maintain accurate records, it is very difficult for firms to ensure that all inventory records (across the different stock keeping units (SKUs)) will be accurate all of the time.

Inventory discrepancy has begun to be well documented empirically. DeHoratius and Raman (2004) found that 65% of the inventory records at one retailer were inaccurate. Kang and Gershwin (2005) found that the best performing store in their sample study could have only 70-75% of its inventory record matching physical inventory during its annual inventory audit. Examining two retailers, Raman et al. (2001a) found that 35-65% of the inventory records were inaccurate. Raman et al. (2001b) reported that, at the stores of one retailer, two-thirds of all SKUs have inaccurate inventory records upon physical audits.

Rinehart (1960) in the first step of a discrepancy study (Sampling Inventory Project), found 2000 discrepancy items among a random selection of 6000 items over a period of 6 months. Emma (1969) in Morey (1985) examined the issue of inventory inaccuracy in a Naval Supply Depot Report, and reported that in a sample of 714 items out of 20,000 line item types, 25% of the item types had accumulated inaccuracies of up to 24 units after one year.

Raman et al. (2001) in their study found discrepancies in 65% of the nearly 370,000 inventory records from multiple stores of a leading retail chain. This means that only 35% of inventory records have no difference compared to physical stock. This disappointing figure occurred in the inventory of a leading Company that intensively used information technology in their modern distribution centers and their retail shops. This scenario also occurred for another leading retailer where 16% of the items in a store could not be found by customers who approached a sales assistant or customer service to help. This problem may come from misplaced item issues.

2.5.3.6 Causes of inventory inaccuracy

Inventory inaccuracies are caused by the occurrence of errors in the inventory management in supply chain flow, warehouse operations or retail shops. The errors may come from either physical stock or from the information systems or from both.

Atali et al. (2006) define three sources of inventory inaccuracies: product misplacements, shrinkage and transaction errors. Product misplacements in the inventory record are also called physical errors (de Kok, van Donselaar, & van Woensel, 2008), because the book of inventory is correct but the product cannot be found at its correct stocking locations (for instance, it is in a different aisle). Retailers define shrinkage as the sum of employee theft, shoplifting and vendor dishonesty, all of which result in depleted physical inventory without correspondingly updated book inventory.

Shrinkage also known as stock loss, may be due to theft by shoppers or employees, and spoiled and damaged inventory. The impact of shrinkage on the actual inventory is one-sided: it always reduces the actual inventory. Thus, the inventory record is always greater than or equal to the actual inventory when shrinkage is the only reason that causes inventory inaccuracy. It is more challenge than transaction error (Hau Lee, 2007).

Transaction errors refer to errors caused by misidentification of the items or miscounting of the items in inbound and outbound processes (Atali,A.Lee.H,2005). Transaction errors mostly occur when new product is received or when products are sold to customers. The two most common causes of transaction errors at the receiving end of a Company is either the discrepancies between the shipment record and the actual shipment received and the discrepancy between shipment received and the shipment booked into

the Company's inventory system. If either of these discrepancies passes the receiving clerk, the actual inventory will not equal the inventory of the system. Transaction errors also occur at the selling end of a Company. Here, discrepancies occur when the checkout registers do not accurately keep track or register which items and how much is sold to a customer. This may be due to a lack of concentration, skill or training. This error may lead to incorrect checkout of certain products and will lead to inaccurate inventory records.

The transaction will make the actual inventory larger (smaller) than the nominal inventory. Thus, the impact of transaction error on the actual inventory is two-sided: it may increase or decrease the actual inventory. The inventory system implements a base-stock policy and the objective is to find the cycle-count frequency that minimizes inspection and inventory holding costs subject to a pre-specified inaccuracy probability. The difference between physical inventory and inventory record can be positive or negative. The study finds that the extent of errors increases with sales volume and product variety. There are recent papers that investigate optimal and effective inventory and inspection policies for single-stage model.

Misplaced or inaccessible inventory refers to inventory that is physically at the facility, but its exact location is unknown. The impact of misplaced inventory is also one-sided: it reduces actual inventory levels. However, unlike shrinkage, misplaced inventory is not permanently lost; it may be recovered and added to the actual inventory after a cycle count.

These error sources would be undetected between consecutive inventory audits without a tracking technology such as RFID. We denote by e_t^m ,e_t^s, e_t^T the accumulated error terms due to misplacements, shrinkage and transaction errors since the last inventory audit. The manager performs a physical counting of inventory every N period. After the inventory audit, misplaced items are returned to inventory; accumulated error terms are set to zero; and the on-hand inventory record is set equal to actual on-hand inventory; i.e., $x_t^r = x_t$. The difference between these two measures before an inventory count constitutes the total error $e_t = e_t^m + e_t^s + e_t^T$ (Atali,A .Lee.H,2005).

2.5.3.7 Measurement of Inventory Inaccuracy

The measurement of inventory inaccuracy is not determined by the value of errors occurrences such as number of items lost or frequency of misplacement, but it is related to the overall quality and accuracy of inventory measurement. Ballard (1996) discussed inventory monitoring and measurement or stock monitoring and control which should provide the management with information to improve operations and reduce errors. He also described the relationship between inventory management and inventory monitoring and measurement. The author mentioned that any errors occurring in inventory monitoring and measurement will influence inventory management effectiveness and efficiency.

Fleisch and Tellkamp (2005) list 2 categories of performance measurement of a supply chain: monetary performance indicator and non-monetary performance indicator. The monetary performance indicators are related to inventory inaccuracy and include cost for out-of-stock items, inventory holding cost, cost for misplaced items, handling cost for misplaced or missing items and unsalable items due to misplaced or missing. The non-monetary performance indicators consist of inventory inaccuracy and out-of-stock values which can be calculated by dividing the number of observation products that out-of-stock by all observation products.

Chapter 3

Research Methodology and data collection

3.1 Introduction

In previous chapter a related literature review on performance evaluation and Optimization of supply chain distribution has been presented. In this chapter (3) the research design and methodology used in the study has been described. The research design, Target Population and Sample Size, the participants of the study, the type of data source, and the research instrument used to collect the data, the methods of data collection and analysis were presented.

3.2. Target Population and Sample Size

The target population is said to be a specified group of people or object to which questions can be posed or observation is made to develop the required data structures and information.
The research has followed a purposeful sampling targeting professional who have been in the same function or role for at least two years in the Company.

The target populations within the company were Managers, supervisors and experts whose functions are directly related to supply chain of lubricants from departments including Sales & Marketing, Lubricant technical support, International purchasing department, Transportation, Customer services, and Warehouse & Inventory Management. The research identified the participants based on their expertise of supply chain distribution of lubricants to ensure that their answers would help for the study.
Multiple types of sampling strategies and techniques are available to achieve the goals of a qualitative research. Acharya, Prakash, Saxena, and Nigam (2013) posited purposive sampling for study design as less expensive than random sampling and more conducive to the study. Accordingly, this research has used a purposive sampling technique to gather participants for the study. A purposive sampling technique is a nonprobability sampling technique where the gathering of participants focuses mainly on individuals who could provide valuable insights regarding the phenomenon considered in the study

(Bhattacharya et al., 2014; Evans & Buehner, 2011; Gligor, Holcomb, & Stank, 2013). Purposeful sampling is used for selecting those units from which the research can learn a great deal about the issues that are important to the evaluation (such as 'key informants'). It does allow for 'analytical generalization' (i.e., making projections about the likely transferability of findings based on a theoretical analysis of the factors producing the outcomes and the effect of context (UNICEF Office of Research – Innocenti, September 2014).

The purposive sampling technique is typically designed to pick a small number of cases or participants that will yield more information about a particular phenomenon (Corbin, 2014; Evans & Buehner,2011; Yin, 2014). According to Corbin (2014), there is no sample set size necessary for qualitative studies. However, it is critical to ensure that the sample size is not too small to achieve data saturation or too large that it is difficult to conduct data analysis.By considering all indicated advantages of purposive sampling techniques, this research has used the same method for the study.

3.3 Data collection method

In order to assess the performance measurement and improvement of supply chain distribution of Total Ethiopia, data collection has been carried out using different tools. Both primary and secondary data were collected by using a well-structured questionnaire, face to face interviews, direct observations, and secondary data, mainly literature reviews.

The designed interview questions were based on the research objectives. Its aim was to get general information about the supply chain distribution system of the lubricants. The interview questions were conducted not only the case company but also the company's customers.

Most of the interview questions conducted in this research were focusing on the performance of the existing supply chain distribution of the lubricants. In addition to this, the interview pointed the challenges and opportunities of the current supply chain process at the company. The interview questions were developed based on occupation, educational level and experience of the interviewees about the supply chain.

The questionnaires were developed in order to gain vital information regarding the performance of the supply chain distribution of the lubricant at the case company. Similar to interviewes questions, the

questionnaires were developed inline with the responders' educational level and work experience at the company. The questionnaires were grouped in to three and contained 28 main questions and other sub questions.

Observational evidence is often useful in providing additional information about the topic being studied. The researcher has used direct observation method for collecting the required data by visiting the existing facilities of the company and the supply chain process. Accordingly, the ware house operations, product arrangement, storage condition of the lubricants, loading and unloading activities have been observed. Furthermore, important documents of the company such as inventory counting reports and inspection data have been reviewed.

As common for most researches, relevant information from secondary sources was gathered and used in this research . The secondary sources of data,which the research used were different relevant books, Journals, Articles, manuals, available documents of the case Company, organizational chart, brochures and Company's manuals so as to develop and understand the concepts of supply chain distribution of the lubricants.

3.4 Validity and Reliability

Validity and Reliability are terms that refer to the quality of the measures used in a research study.
Validity refers to the accuracy of the measure. Validity is concerned with whether data is believable and true and whether it is evaluating what it is supposed to evaluate. In this regard, Burns (1999, p. 160) stressed that "validity is an essential criterion for evaluating the quality and acceptability of data."

This research has used triangulation method to test the validity of the collected data. Data triangulation is the use of a variety of data sources. It is a strategy for increasing the validity of data and research findings. It enhances the validity and reliability of existing observations about a given data. It provides an important way of ensuring the validity of the research. The triangulation of data strengthens the research and allows the researcher to write a better research paper because of the following benefits.

- Additional sources of information often give more insight into the topic.

- Inadequacies found in one-source data is minimized when multiple sources confirm the same data
- Multiple sources provide verification and validity while complementing similar data
- More comprehensive data is obtained.
- Data and information is supported in multiple places/types of research, which makes it easier to analyze data to draw conclusions and outcomes.

Reliability: The reliability deals with the consistency, dependability and replicability of "the results obtained from a piece of research" (Nunan, 1999, p. 14). Lincoln and Guba (1985, p. 288) point out that instead of obtaining the same results, it is better to think about the dependability and consistency of the data. In this case, the purpose is not to attain the same results rather to agree that based on the data collection processes the findings and results are consistent and dependable.

Triangulation can reduce or eliminate personal and methodological biases and increase the probability of generalizing the findings of a study as the data is gathered from different angles and by different methods (Decrop, 1999). There are multiple triangulations that can be used in a research including: methodological triangulation- the use of multiple methods of data collection, data triangulation- the use of a variety of data sources in a study and respondents triangulation-the use of a broad range of informants.

In this study, the researcher has collected data from primary sources of different respondents including case company, customers and direct observations. In addition to , the study has triangulated data from the case Company through interviewing different groups of employees: managers, supervisors and experts on supply chain distribution of lubricants. This triangulation has resulted in more reliable and dependable information and data from different sources of respondents of the case Company.

Similarly, data triangulation has been made by comparing the responses of the service providers/case company and service receivers/customers on the supply chain distribution of lubricants. The third triangulation data method employed in this research was direct observation of the researcher that included visiting storage facilities, product arrangement, loading and unloading system, and stock counting practices of the case company.

3.5 Data organizing, cleaning and analysis

The different data collected from primary and secondary sources by using different methods were initially organized according to their information relation. This has followed by cleaning biases or subjective information of the respondents through the triangulation of different data sources.

The cleaned data has been analyzed by using excel both in tabular and graphical forms. The graphical and tabular presentation of data has enabled the researcher for fast interpretation of the collected data from different sources. The interpretation from the graphical and tabular depiction of data has been further compared to the existing literatures/theories. Based on the results of the analysis and interpretation obtained, conclusion has been drawn followed by recommendations for the case company.

Chapter 4

Over view of Total Ethiopia Company

4.1 Total Ethiopia

Total Ethiopia is one of the biggest and oldest Company and is active in the field of trading, storage, sales of fuels and lubricants in Ethiopia. It was established in Ethiopia in 1950 as a petroleum product distributer Company, and developed its activities by merging with Mobil Oil East Africa in 2006. Today, the Company has 173 operational Retail Network Stations and about 800 general trade and specialties customers'. It owns one oil depots at Akaki and three aviation depots at Bole International Airport, Mekelle and Bahir Dar respectively. It is also building one depot at a cost of 10 million euro around Dukem Oromia Regional state, 37 kilometers southeast of Addis Ababa. This depot has the capacity to store more than 4,200m^3 of benzene, 2,100m^3 of diesel, 650m^3 of kerosene, 650m^3 of lubricants, 400m^3 of ethanol and 100 tons liquefied petroleum gas (LPG) stored in gas cylinders. This thesis considers the supply chain and inventory controlling system of lubricant and grease of the case Company.

Due to the stiff competition resulting among the different brands of both automotive and industrial grade lubricants of different companies, which is highly forcing companies under the petroleum umbrella to design a differentiated competitive strategy is ultimately believed to be the gap to be narrowed to achieve market leadership.

Total Ethiopia Companies are adopting a more customer-oriented approach where they are likely to focus on creating brand awareness through print and visual media. For example promotional campaigns and trade shows offering gifts to their customers are methods of driving sales of automotive lubricants.

4.2 Mission and vision of the Company

4.2.1Vision

Total Ethiopia has the vision of winning recognition from its customers and partners for the quality and safety of its operations, while creating value.

4.2.2 Mission

- To be the lead energy Company by the quality of products and services
- To focus on the fulfillment of customer satisfaction
- To integrate sustainable development in our business activities and to have an active participation in the local life (community and public at large)

4.2.3 Value principles of the Company

- Quality and safety matters are given due attention in Total Ethiopia. As a world class energy Company, the Group has issued very strict regulations regarding its activities. Discover Health, Safety, Environment and Quality charter.
- The Company strives to meet customers' expectations while continuously improving the quality of its products and services with the application of "best practices" as a philosophy.
- The Company is committed to protecting environment through a permanent dialogue with local authorities, customers and partners in a responsible, ethical and transparent manner.

4.2.4 Company Objectives

- To be first-in-class in operational excellence, safety, and professional behavior.
- To be the leader in Ethiopia, in product quality and services.
- To build strong teams, with shared goals, at units, departments and subsidiary level.

4.3 Some products profile of the case Company

- Power Generation engine oil (Aurelia TI4045): This type of oil used for passengers' cars petrol or diesel, all motorcycles and other two wheels transporters and Heavy duty such as trucks, buses and off road machinery (cranes, excavators, scrapers, tractors, agricultural, and all other machinery which are not operated on commercial roads and highways) .

- Gear oils (Carter EP 150, 220, 320, 460): It also used for passengers cars, heavy duty (trucks, buses and off road machinery) and motor cycles.
- Hydraulic (Azolla ZS 32, 46, 68): used for off road machinery (cranes, excavators, scrapers, tractors, agricultural, Fork lifts and other machinery)
- Compressor oils (Danis 46, 68): used for both industrial and portable compressors.
- Heat transfer oils(Seriola) :
- Turbine oils (Preslia 32, 46, 68):
- Textile oils (Texinol FC):
- Greases (Ceran GEP, Multis Complex EP2 and EP3):

4.4 Supply chain process of lubricant at the case Company

The current supply chain steeps of the lubricants at the case company consists the following steeps.

Step 1. **Orders placed by customers:** Marketing and Sales department of the case company receives orders from the customers as well as order for stock (by considering last month sales record and for cast for the next month demand).

Step 2. **Requesting of quotation and placing an order**.

Once the order quantity has been known the international purchasing department request quotation from supplier. Based on purchase request, the supplier gives quotation to international purchase department. The international purchase department forwards the quotation to marketing and sales department to check against to the request. If it is ok the marketing and sales department forwards the quotation to international purchase department. The international purchase department request letter of credit (LC) or foreign currency approval. Once the letter of credit is allowed, the international purchase department places an order. This department also communicates expected and actual arrival times.

Step 3. **Arrivals of products to Djibouti Port:**

All shipping documents, including the list of consolidated products, are received from the supplier before the arrival of products to Djibouti Port. After detailed screening of all documents, international purchase department sends these documents to customs clearance service provider. The products are imported from different countries (The

supplier is either from Dubai or France). The products are transported to the Djibouti Port by Ethiopian shipping and logistics service enterprise.

Step 4. **Transport of products from Djibouti port to Modjo dry port**.

The products are transported from Djibouti port to Modjo dry port by Ethiopian shipping and logistics service enterprise by using trucks transport.

Steep 5. **Processing custom clearance**

Once the product arrived Modjo dry port, the international purchasing department processed the custom clearance .After the custom clearance is completed the products are transported to Addis Ababa by truck.

Steep 6. **Deliveries of products to company warehouse (main ware house).**

From Modjo dry port the products are transported to Akaki ware house (main warehouse) by truck contractors. Once Akaki warehouse supervisor receives information from M&S department to transfer products to Warehouse, the internal transfer in SAP system is made. After all mandatory procedures such as inventory, unloading and stock updating in SAP system take place; products are distributed to all ware houses based on their capacity for temporary storage.

Step 7. **Unloading and storing of products Warehouse**.

By using fork lift the products are unloaded from the truck and stored at ware house.

Step 8. **Deliveries of products to customers**

Based on the customer request and demand; customer service department deliveries product from Warehouse to customers. Some customers directly picked the product from the ware houses but for customers who have contractual agreement with the company; customer service department transporting the product from company ware house to customer site.

Step 9. Once the supply chain process is completed according to the above procedures; to place the next order the company performed monthly inventory counting to know the availability of the actual physical items in the stock, collect past sales data, collected current customer requested and estimate the next demand.

Chapter 5

Data collection, Analysis, Result and Discussion

5.1 Data collection

For this study data has been gathered through the collection of procedural documents, face to face interviews, well-structured questionnaires and visiting case Company ware house. This research presents the data collected from the semi-structured interviews conducted with employees of the Company, company's customers, visual observation as well as data from the Company's profile.

When it comes to data collection the most important things are where and who is involved in the interview to answer the questions. For the purpose of this research, experts who have adequate knowledge of the supply chain, ware housing, inventory management, transport, sales and marketing were chosen.

The first research question was to identify the factors that affect the performance of supply chain distribution in oil industries. The literature review indicated that import/export facilitation, ware housing, domestic and international transportation management, Inventory control, Information availability, Storage facility, oil supply uncertainty, long lead times, and fluctuating global oil prices, customer demand for quality are factors that affect the performance of supply chain distribution of lubricants in oil industries. Similarly, the data collected from the case company to evaluate the performance of supply chain distribution of lubricants indicated that most of these factors have affected the company's performance.

The second research question was to identify factors, along the supply chain distribution of Total Ethiopia, that affect most the performance of the case Company. Seven key performance indicators (KPI) have been identified for the case Company during this research. These were: supply reliability, on-time delivery, product picking time, one-stop shopping, product availability, maintaining the quality of the product and Cost. When the existing supply chain distribution of the lubricants is evaluated by these seven key performance indicators; it needs an improvements. Factors that affected the supply chain distribution of the lubricants at the case company was indicated in fig 5.1

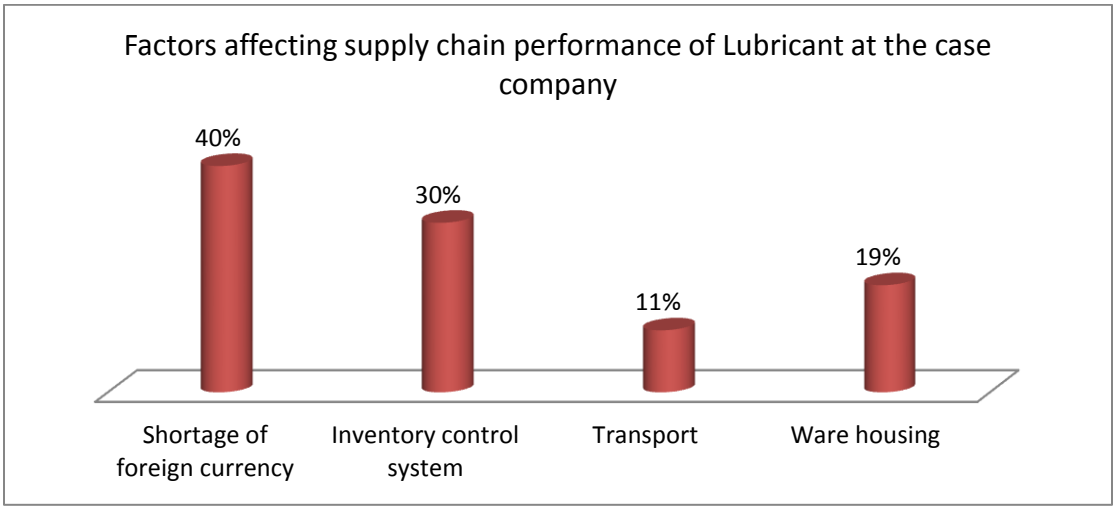

Fig 5.1 .The factors influencing supply chain performance

Shortage of foreign currency is considered as leading factor that would negatively influence the supply chain performance of the case company. It is an external factor that is very least in control of the company. The inventory control system, Ware house facility and truck transports are the factors within the boundary of the case Company that challenges the performance of supply chain distribution system. Therefore, these internal factors were analyzed for further investigation to improve the performance of the company.

To understand the effect of inventory control system on supply chain performance the question asked was ″ what type of inventory controlling strategy does your Company use? ″. Based on the respondents' answer, the summery of the result is shown in fig 5.2.

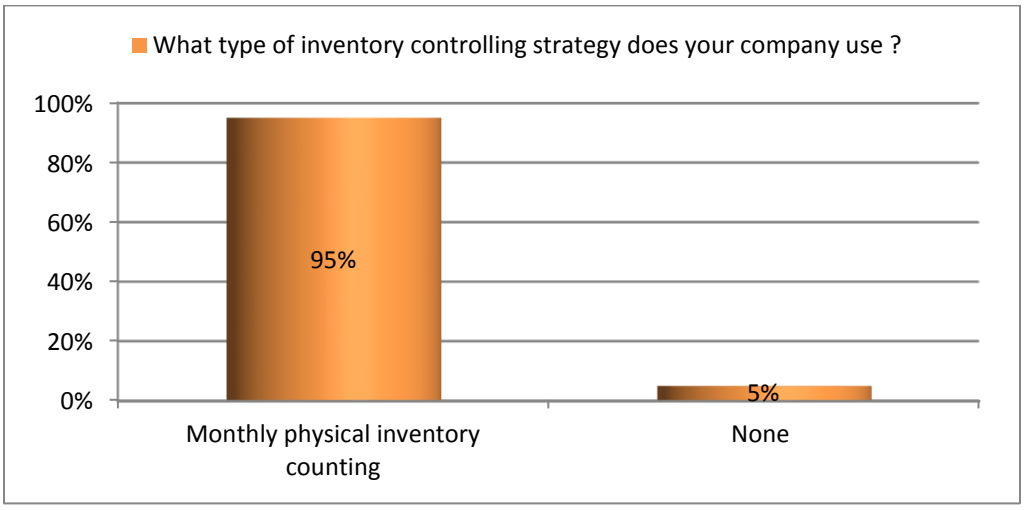

Fig 5.2 Type of inventory controlling strategy used by the Company

The next question asked was ″what is the reason to take monthly inventory stock counting?″ Based on the respondents, the summery of the results were listed below.

- To check the accuracy of inventory
- To verify the records
- To trace the cause of in accuracy, if it exits
- To take remedial actions

The third question asked was ″ how many days does it take to complete the monthly stock counting″? Based on the participant response, the summery of the result is shown in fig 5.3.

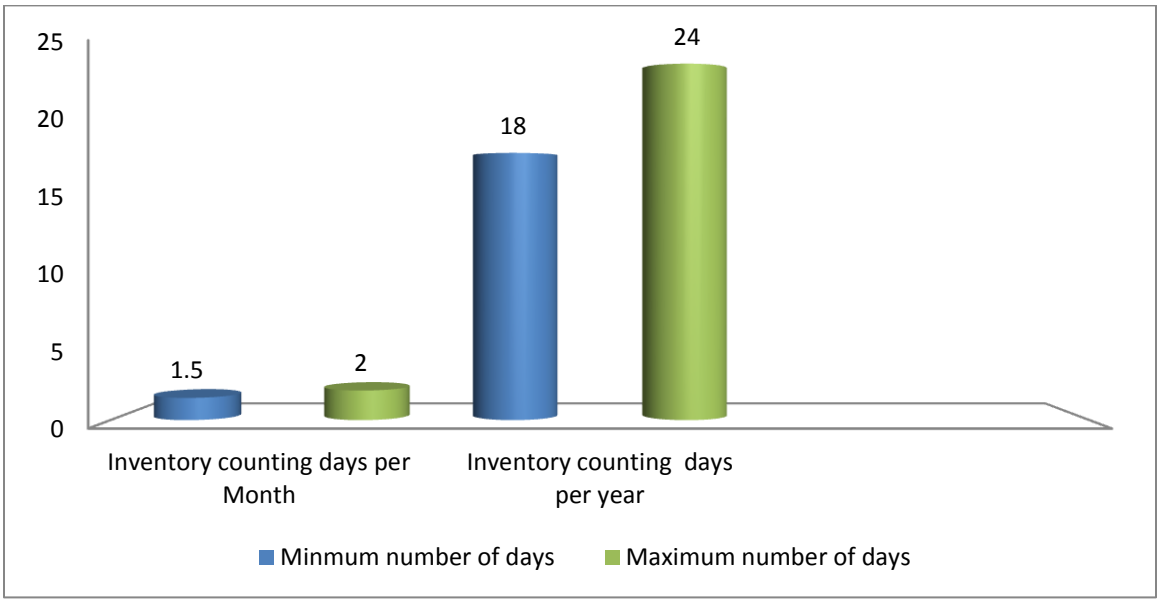

Fig 5.3 Number of days required for monthly and annually inventory counting

The fourth question asked″ how many employs are involved in monthly physical stock counting?″ Based on the participant response, the summery of the result is shown in fig 5.4.

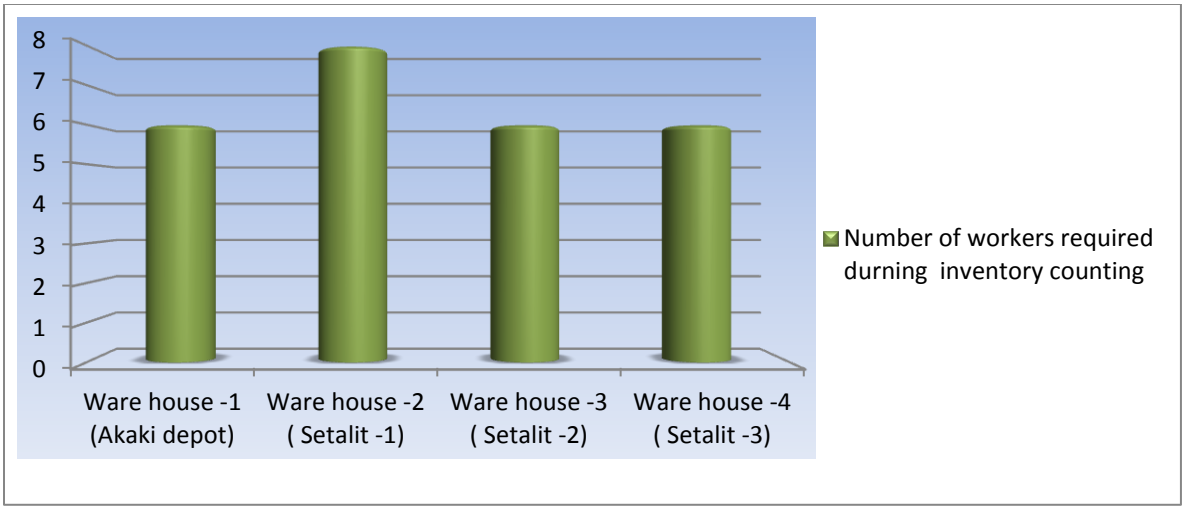

Fig 5.4 Number of employees involved in monthly Inventory counting at different ware houses

5.2 Analysis, result and discussions

5.2.1 The effect of Inventory control system on supply chain performance

Total Ethiopia Share Company has a monthly manual inventory counting practice to counter check the amount of the physical stock match to the amount official inventory records. The aim of this monthly inventory cycle counting is counting the inventory items, verification of the records and tracing the causes of the inaccuracies and taking remedial actions.

Although the monthly cyclic inventory counting is one approach of inventory controlling system of the case Company, it has its own draw back on performance of supply chain distribution of lubricants. The controlling mechanism is based on manual inventory counting systems. This manual monthly inventory controlling system is characterized by the following challenges.

- The process is tedious and consumes more man hour
- The operations of all ware houses are stopped for a physical inventory counting
- There are sales lost due to closing of ware house during inventory counting
- Delivery of the product (lubricant) may delay due to closing of the ware house, leading to customer dissatisfaction (affected on time delivery of product).
- The process is manual and is exposed to wrong inventory counts and errors

The deviation in inventory records tend to decrease with increasing frequency of a periodical inventory counting process and thus the total error incurred also decreases as the frequency of a periodical inventory counting becomes large. However, when the inventory counting frequency increases, the total cost for periodical inventory counting activities become increased. In addition to this due to the interruption of the ware house operation the internal supply chain of the Company is challenged from the customer. Here one key question in this research is, is any feasible problem (inventory inaccuracy) that forced the Company to perform monthly cycle counting?

For this question the thesis could not get any answer from the participants. To understand the extent of the inventory inaccuracy problem at ware house of the case Company the following question was developed and asked.

Did the physical inventory vary from the inventory record system during monthly inventory cycle counting in the last 12months?

To answer to this question, the monthly cycle counting for the last 12 months of the inventory discrepancy and cause of the error data was collected as shown in table 5.1.

Literature indicates the following main causes of inventory inaccuracies (Wihdat Djafar, Yousef Amer, and Sang-Heon Lee ,2013).

Shrinkage: stock loss, may be due to theft, spoiled and damaged inventory

Transaction errors: misidentification of the items or miscounting of the items in inbound and outbound processes.

Misplaced: Inventory that is physically at the facility, but its exact location is unknown.

N.B: the following notations are used in table given below.

Sh: For Shrinkage errors,

Tr: For Transaction errors

Mp: For Misplaced inventory,

IRI = Inventory record in accuracy (the deference b/n record and actual inventory)

COI= Cause of in accuracy (Shrinkage, Transaction errors and Misplaced).

Table 5.1 Monthly inventory discrepancy from Aug 2016 t0 July 2017(Source: Survey results)

no	Item code	Monthly inventory Cycle counting result (stock discrepancy) and cause of discrepancy or in accuracy (COI)											
		Aug 2016		Sept 2016		Oct 2016		Nov 2016		Dec 2016		Jan 2017	
		discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI
1	BF_{01}	-		-		-		-24pcs (1package)	sh	-		-	
2	BF_{02}	-2	Tr	-		-		-1	tr	-		-	
3	EOP_{01}	-		-		-		-		-		-1	Mp
4	EOD_{01}	-		-		-		-		-		-1	Mp
5	EOP_{02}	-		-		-1	tr	-		-		-	
6	EOD_{02}	-		-				-		-		-	
7	EOD_{03}	-		-		-		-		-		-	
8	EOD_{04}	-		-		-		-		-		-	
9	EOD_{05}	-		+1	Mc								
10	Total discrepancy	2		1		1		25		0		2	
11	Average number of items in store	150,000		150,000		150,000		150,000		150,000		150,000	
12	% of discrepancies	0.0013		0.00067		0.00067		0.017		0		0.0013	

no	Item code	Monthly inventory Cycle counting result (stock discrepancy) and cause of in accuracy(COI)											
		Feb 2017		March 2017		April 2017		May 2017		June 2017		July 2017	
		IRI	COI	IRI	COI	IRI	COI	IRI	COI.	IRI	COI.	IRI	COI
1	BF_{01}	-		-		-		-		-		-	
2	BF_{02}	-		-		-		-		-		-	
3	EOP_{01}	+1	Mp/ Mc	-		-		-		-		-	
4	EOD_{01}	+1	Mp/ Mc	-		-		-		-		-	
5	EOP_{02}	-		-		-		-		-		-	
6	EOD_{02}	-		-2	tr	-		-		-		-	
7	EOD_{03}	-		-		-		-24pcs (1package)	Sh	-		-	
8	EOD_{04}	-		-		-		-		-		-1	Tr
9	EOD_{05}	-		-		-		-		-		-	
10	Total discrepancy	2		2		0		24		0		1	
11	Average number of items in store	150,000		150,000		150,000		150,000		150,000		150,000	
12	% of discrepancies	0.0013		0.0013		0		0.016		0		0.00067	

As it is shown in table 5.1 the Company performs monthly cycle counting, but there were little errors within the inventory records between audits were observed; in addition to this , the firm incurs additional risk (in terms of customer service, lose sales and counting cost) due to closing of the ware house. Therefore, in order to overcome this risk, designing an optimal inventory counting strategy/ appropriate inventory counting policy is advisable.

As data collected and shown in table 5.1 the total discrepancy between the actual stock levels that physically exist in warehouse and inventory records in information system from August 2016 to July 2017 are 60 items. The distribution of discrepancies in each month is variable. The maximum discrepancies observed during monthly inventory counting are 25 items and the minimum discrepancies of items observed is zero (i.e. no discrepancies). For the sake of visualization, Figure 4.7 shows distribution of discrepancies in each month. The discrepancies of items are associated with demand of an item, weight of an item and volume of an item, which suggests that these items are exposed for inappropriate use.

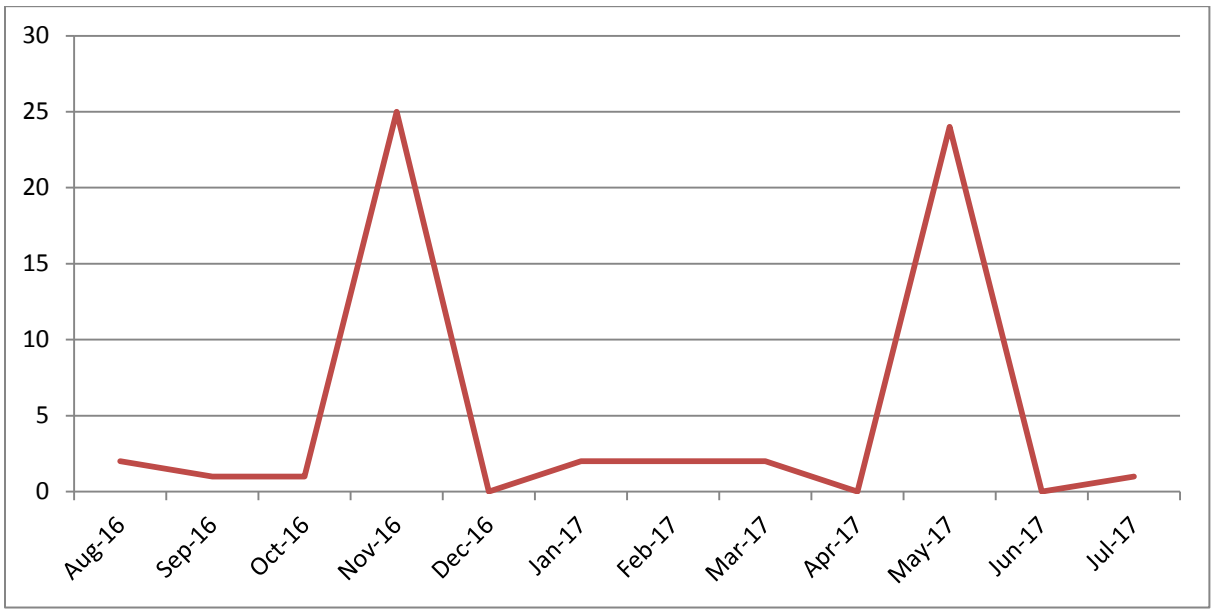

Fig 5.5 Inventory discrepancy observed (Source: Survey result)

As shown in figure 4.5, from Aug 2016 to Oct 2016 the difference between the inventory record and the actual inventory is very low. But In the fourth month, November 2016 the discrepancy of the inventory become increase up to 25 items and back to zero in fifth month ,December 2016. For three months from Jan 2017 to March 2017 the in inventory record and actual inventory are all most similar in each month and the discrepancies are very low and become zero in the next month, April 2017. But in the tenth month, May 2017 the discrepancy become grow up to 24 items and back to zero in the next month, June 2017. In general the discrepancy observed for ten months are very low except for the months of

November 2016 and May 2017. For these two months, even though the percentages of the inventory errors were below 1 %, the exceptional discrepancies figures were registered. The thesis collected more data and interviewed the concerned persons on the issues of the exceptional discrepancies observed in November 2016 and May 2017for further investigation. According to the collected data and interview result, unfortunately the items lost during these two months were a package not a single item unlike to the other months. Each of packages consists of twenty four items. But the study comperes the discrepancies of pieces of items observed in monthly counting practice. This is the main reason for exceptional discrepancies figures were registered during these two months. Hence the discrepancies observed during these two months were abnormal; these discrepancies are excluded during determining the average and standard deviation of the data.

As the oral interview results indicate, the discrepancies were due shrinkage. The cause of discrepancy was either theft or miscount. During visiting, the study was raised this issue to the concerned persons. They assumed that the discrepancy may be due to theft or miscounted items during loading activity or during dispatching .This was proved by this study. While visiting the work site it was observed that there was only one ware house supervisor who controls all loading and unloading activities as well as paper work for dispatching. On other hand, ten to twelve laborers were performing loading and unloading activities. Due to work load, it was a challenge for the supervisor to control all loading activities effectively. By considering this, it is assumed that the inventory discrepancy observed was caused either by theft or miscounted during loading activities.

In general, as obtained from the interview results and collected data; items having more transaction, light and easily picked are exposed to the discrepancies.

From the inventory data collected, the mean and standard deviation for the aggregate error was determined and shown in table 5.2.

Table 5.2 Average and standard deviation of inventory error

		Total error accumulated (e_t)	Remark
1	Aug 2016	2	
2	Sept 2016	1	
3	Oct 2016	1	
4	Nov 2016	25	exceptional
5	Dec2016	0	
6	Jan 2017	2	
7	Feb 2017	2	
8	Mar 2017	2	
9	April 2017	0	
10	May 2017	24	exceptional
11	Jun 2017	0	
12	July 2017	1	
		μ = 1.1	

As shown from table 5.2 the average inventory error accumulated was 1.1≅ 1 units (0.00073%). The average discrepancies observed during the monthly counting were (0.0007%) and the total annual inventory discrepancy observed was 0.04%. On other hand different inventory accuracy setting tolerance levels (allowable discrepancies) indicated in literature review were summarized as below.

Table 5.3 the mean of the inventory allowable discrepancies indicated in the literature review

No	Inventory allowable discrepancies (in %)	Frequency	Sum	Remark
1	1	1	1	
2	2	1	2	
3	3	1	3	
4	5	2	10	
5	20-25	1	-	exceptional
6	5 unit deviation	1	-	Not considered
Total			16	
Average			3.2	

As indicated in table 5.3the mean of the inventory accuracy setting tolerance level (allowable discrepancies) indicated in the literature review was 3.2%.Now the research compered the mean of the allowable discrepancies stated in the literature review to the actual discrepancy observed in monthly cycle counted at the case Company. The mean of the inventory accuracy tolerance setting level (allowable discrepancies) indicated in literature review was 3.2%.Therfore; the average of the discrepancies observed was 4383.5 times, i.e.($\frac{3.2}{0.0007} = 4383.5$), less than the mean of the allowable discrepancies indicated in the literature review. The gap between the allowable discrepancies explained in the literature review and the average of the actual discrepancies observed was very big. Also the total annual discrepancy observed was 80 times ($\frac{3.2}{0.04} = 80$) less than allowable discrepancy .These indicate that, the discrepancies observed in the existing inventory auditing practice was very low when compared to the allowable discrepancies indicated in the literature review and total number of transactions. Therefore, the discrepancies observed in monthly counting practice were not feasible to conduct monthly inventory auditing.

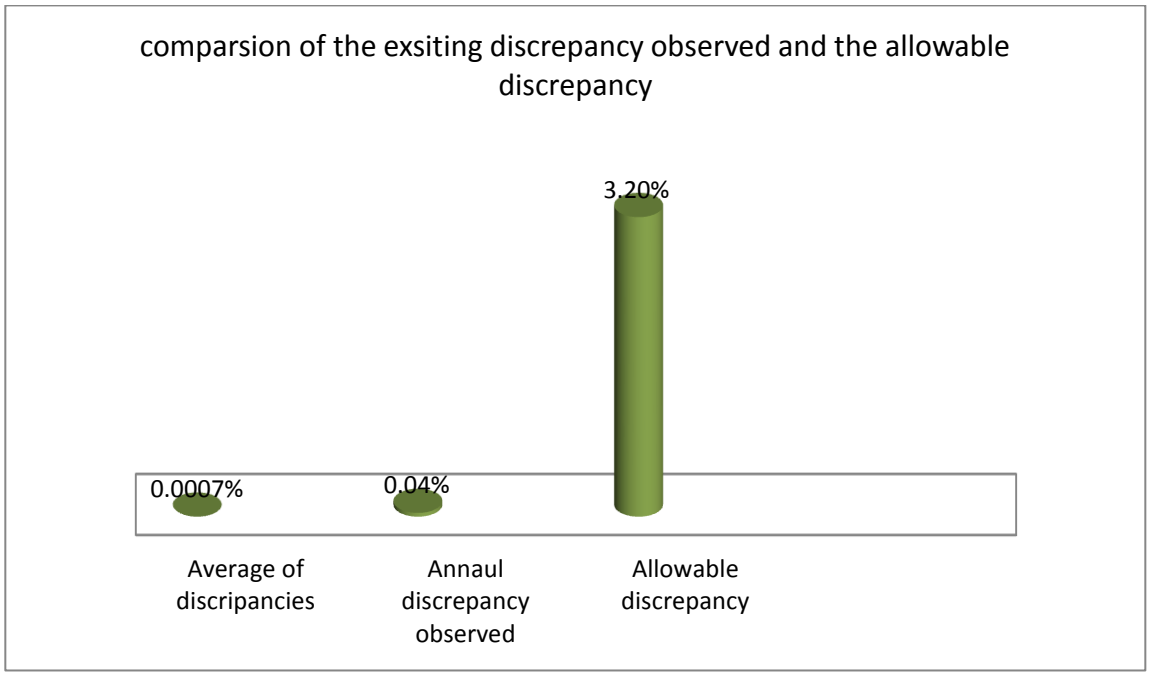

Fig.5.6. Comparison between the mean of monthly and annual discrepancy observed with the mean of allowable discrepancy indicated in the literature review.

As discussed in literature review, the causes of inventory discrepancy between the actual stock level that physically exist in warehouse and inventory records in information system are shrinkage, misplacement and transaction errors. The discrepancies between the recorded and actual on-hand inventory quantity, 13.33% were due to Transaction errors, 6.67% were due to misplaced error (Products that were physically present at the store but not visible for sales) , and 80% were due to shrinkage (products that are not available on the sales floor).

For the sake of visualization, Figure 5.7 shows percentage distribution of source of inventory error observed at the case company. The shrinkage error is major of inventory discrepancy, and the amount of shrinkage error has been found to be quite significant.

Fig 5.7 Percentages distribution source of inventory error observed in case Company (source: Inventory data collected from Aug 2016 to July 2017)

5.2.1.1 Individual Effect of Misplacement, Shrinkage and Transaction Errors

This section illustrates the individual impact of each of the error sources on the system performances.

Effect of Misplacement: In the first group, misplacement errors are considered as the reason of inventory inaccuracy. Misplacement reduces the level of sales-available inventory, but at the same time leaves physical inventory unchanged.it actually differs by making the inventory manager to take the holding cost for misplaced item into account. As indicated in table 4.1 above, in January 2017 two items were registered as shortage and were not available for sales. On other hand during the next inventory monthly counting (i.e. February 2017), these items were registered as overage and became visible on sales floor. These errors affected sales due to invisible of items. In addition to this, the company incurred holding cost of items between the two auditing periods. But due to low frequencies of error and product returned back to the inventor after auditing, its effect on both sales and holding cost was very small.

Effect of Shrinkage error: In the second group Shrinkage errors are considered as the reason of inventory in accuracy. As it indicated in figure 4.9, the discrepancies occurred due to shrinkage errors were registered four times during monthly inventory counting. These were covered 80% of the total discrepancies observed at the case Company. After an audit, these loses did not returned back to inventory .Due to these two reasons, its effect on sales and direct cost of an items were very big. Therefore, this source of an error affected the performances of the system more than the other source of inventory errors observed at the company. Instead of correcting, prevention is advisable for such errors.

Effect of Transaction Errors: In the third group transaction errors are considered as the reason of inventory in accuracy. As it indicated in figure 4.9.the discrepancies due to the transaction error was 13.33%, but the frequency of the error was very high as compared to other cause of the discrepancies.

The total discrepancies happened at the company during monthly inventory counting for twelve months were registered twelve times. Among these, the transaction errors were registered for six times. However, the frequency of the error was very high; it did not affect the physical inventory.

The high frequency error indicated that, there were high transactions of an item**.**

In summary, the case Company's inventory counting practices has caused supply interruption of products due to the closure of ware houses during stock counting. This practice has caused inconvenience to the customers and affected the reliability of supplies when products are needed by the customers. Beyond negatively affecting the customers, the inventory counting practices have also negatively affected the case company by incurring counting cost.

5.2.1.2 Optimizing inventory cycle counting frequency as a function of counting cost, error accumulation and ware house operation days

By observing the existing inventory cycle counting practice, the thesis developed six assumptions to perform inventory cycle counting at the case Company. The assumptions have made by varying the inventory cycle counting frequency from every 30 days (one month) to 360 days (one year)

These assumptions are as follows:

1. Assumption1: Perform cycle counting twelve times per year.
2. Assumption 2: Perform cycle counting six times per year
3. Assumption 3: Perform cycle counting four times per year

4. Assumption 4: Perform cycle counting three times per year
5. Assumption 5: Perform cycle counting two times per year
6. Assumption 6: Perform cycle counting one time per year

The first assumption is the highest cycle count frequency of the assumption which is made by considering the existing inventory counting practice of the case Company as well as complains on this practice. The sixth assumption is the largest cycle count interval (less cycle count frequency) that is made by considering annual inventory counts (Financial closing report).

Each assumption has their own potential strengths and weaknesses. The potential strengths and weaknesses of each assumption were evaluated by the following Comparative tools. For this thesis purpose these comparative tools helps to determine effective cycle counting frequency. The effectiveness of the cycle-counting frequency is obtained by comparing the six assumptions given above with comparative tools given below.

These are:

- The magnitude of the inventory error accumulate(Inventory discrepancies)
- Inventory counting cost
- Number of ware house operation disruption days due to inventory counting).

5.2.1.3 Effect of cycle counting frequency on error accumulation

Cycle count programs are the most common approach to dealing with inventory inaccuracy in retail and distribution industries. If inspections are conducted more frequently, there will be the probable to obtain accurate inventory information. By considering the assumption given above and data collected the thesis analysis the effective cycle count frequency on error accumulation.

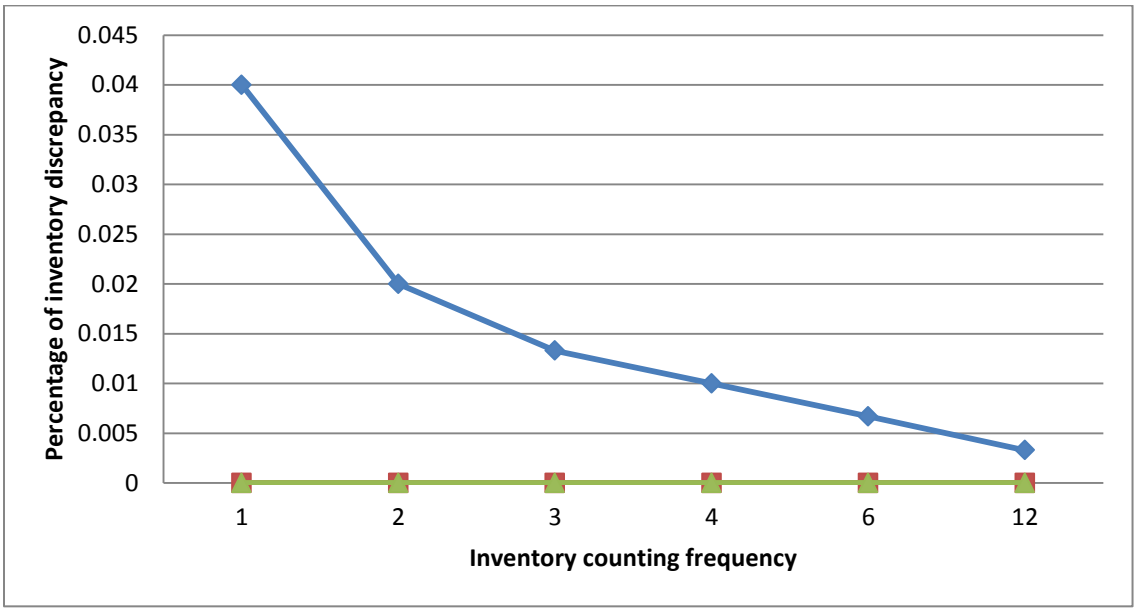

Fig 5.8 Inventory discrepancy versus cycle counting frequency

The values of error visibility will increase or decrease with respect to decreasing or increasing cycle counting frequency. Fig 5.8 illustrates how the cycle counting frequency can affect the inventory error accumulated. For example, increasing the counting frequency from one to twice per year reduce the percentage error accumulate from 0.04% to 0.02% similarly increasing the cycle counting frequency from one to six per year reduce the percentage of error accumulate from 0.04% to 0.0067% and also increasing the cycle counting frequency from one to twelve per year reduce the percentage of error accumulate from 0.04% to 0.0033%. However, this benefit comes at the expense of higher counting cost and more ware house off days due to inventory counting.

After analyzing the effect of cycle counting frequency on inventory error accumulation using the assumption given above; the assumption was checked against to the existing counting practice and the allowable discrepancy indicated in the literature review to determine the effective inventory cycle counting frequency.

These indicate that, the discrepancies observed in the existing inventory auditing practice was very low when compared to the allowable discrepancies indicated in the literature review and total number of transactions.

5.2.1.4 Effect of cycle counting frequency on inventory counting cost

There are costs associated with each inventory counting. The literature review indicated cost related to inventory counting are the total expected costs (fixed counting cost, man power costs and holding cost). Due to business confidentiality it is difficult to obtain the holding cost of an item at the case Company.
The primary cost factor associated with the physical inventory process at the case company Supply Activity is manpower cost. Manpower costs were estimated using a time study to acquire an average cost per man-hour per day.

Sixteen to Twenty different personnel were conducted to monthly physical inventory counting. Personnel who are familiar with the warehouse environment and with MHS system are selected for counting of physical inventory.
To determine the average cost per man-hour, the number and grade of the personnel available to conduct physical inventories was derived. The number and grade was then cross referenced to the pay scales to determine an average cost for the required personnel. For this research purpose the grade of the personnel conducted to the physical inventories was categorized in to three groups. The estimated man hour cost for each grade was determined in table 5.4 below.

Table 5.4 estimated man hour cost for each grade of personnel

Item	Grade of personnel conduct to inventory	Estimated number of personnel	Estimated labor cost per day(birr)	Total labor cost/ day/Grade (birr)
1	Grade-1	8	167.00	1336.00
2	Grade -2	8	458.00	3664.00
3	Grade-3	4	583.00	2332.00

Once, the man-hour cost per grade and per day was determined, the total direct labor cost associated with monthly physical inventories counting per month or per year was computed by multiplying the total labor cost per day with the total number of inventory counting days per month or per year. Table 5.5 reflects the estimated direct labor cost consumed due to physical inventory counting per month and per year at the case company.

Table 5.5 Estimated direct labor cost consumed due to physical inventory counting per month and per year

Item	Grade of personnel conduct to physical inventory	Estimated cost per day (birr)	Estimated monthly inventory counting days per month	Estimated total labor cost per monthly inventory counting (birr)	Estimated total labor cost/ /per year (birr)
1	Grade-1	1336.00	1.5 - 2	2,004.00- 2,672.00	24,048.00- 32,064.00
2	Grade -2	3664.00	1.5 - 2	5,496.00- 7,328.00	65,952.00- 87,936.00
3	Grade-3	2332.00	1.5 - 2	3,498.00- 4,664.00	41,976.00- 55,968.00
	Total			10,998.00- 14,664.0	131,976.00- 175,968.00

On other hand the research tried to determine the fixed counting cost. As it stated in the literature review, the fixed counting cost (k) per period, k = $\frac{1}{\alpha}$. (α is the probability of aggregate error varying the stock between inventory counts). Therefore, it is to determine the fixed counting cost at each counting period. Hence the fixed counting cost is direct proportional to the total expected cost; increasing or decreasing fixed counting cost will increase or decrease the total expected cost. Thus the thesis tries to find the effective fixed counting cost by varying the length of counting frequencies based on the six assumptions given above.

In order to observe the effect of the cycle counts frequency on fixed counting cost (k), the cycle counting frequency was varied from one month to twelve months (one year) as shown in fig 5.9 below.

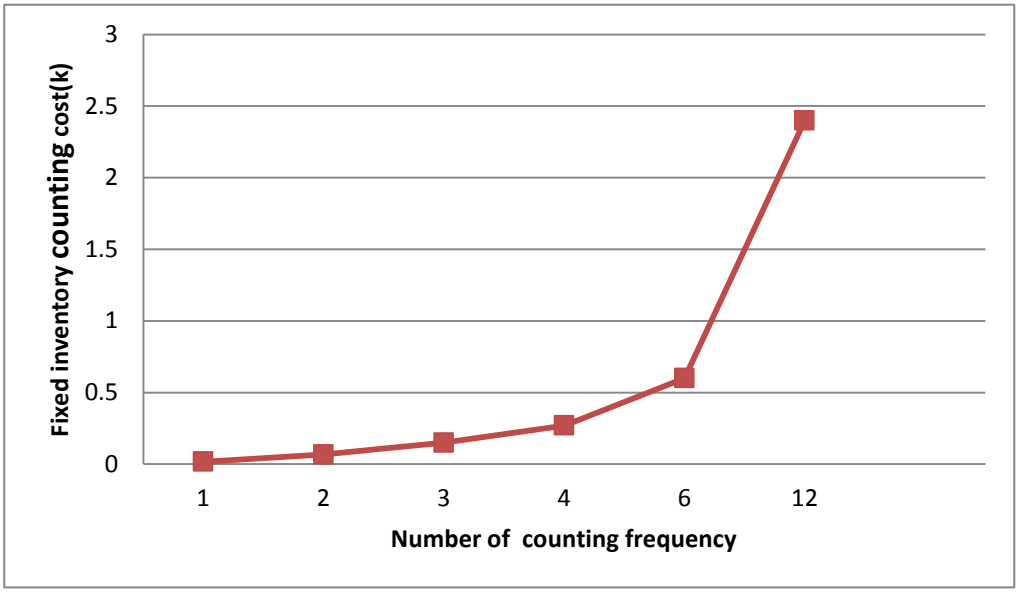

Fig 5.9 Fixed inventory counting cost versus cycle counting frequency

The values of fixed counting cost (k) will increases or decrease with respect to increasing or decreasing cycle counting frequency. Figs 5.9 illustrate how the cycle counting frequency can affect fixed inventory counting cost. For example, reducing counting frequency from twelve to six reduced the fixed counting cost from 2.4 to 0.6. In similar way reducing counting frequency from twelve to four, lowers fixed counting cost from 2.4 to 0.27. Reducing counting frequency from twelve to two reduce the fixed counting cost from 2.4 to 0.067.This shows that as the number of inventory cycle counting frequency increased the Company incurred more cost.

5.2.1.5 Effect of cycle counting frequency on ware house operation days

To address the problem of inventory record inaccuracies, the case Company performed inventory counting where all items in the warehouse are checked for accuracy against the inventory records in information system at the beginning of each month. During this monthly inventory cycle counting, the warehouses have stopped operation for one and half days to two days per cycle counts. Clearly, these are very time-consuming and increasing the disruption of supply activity. The total disruption of the supply activities was estimated 18 t0 24 days per year. Finding more effective cycle counting frequency

which would result in a lower number ware house operational disruption days to avoid the probability of sale lose and customer complain , is therefore; very desirable.

Increasing ware house operation days will increase the probability of on time delivery of product to the customer and lead to customer satisfaction. But when inventory cycle counting frequency is increased, the disruption of ware house operation days will be increased and on time delivery of product to customer is interrupted and leads to customer dissatisfaction.

Based on the six assumption of inventory cycle counting strategy given above, the effect of cycle counting frequency on ware house operation days is illustrated in figure 5.10 below.

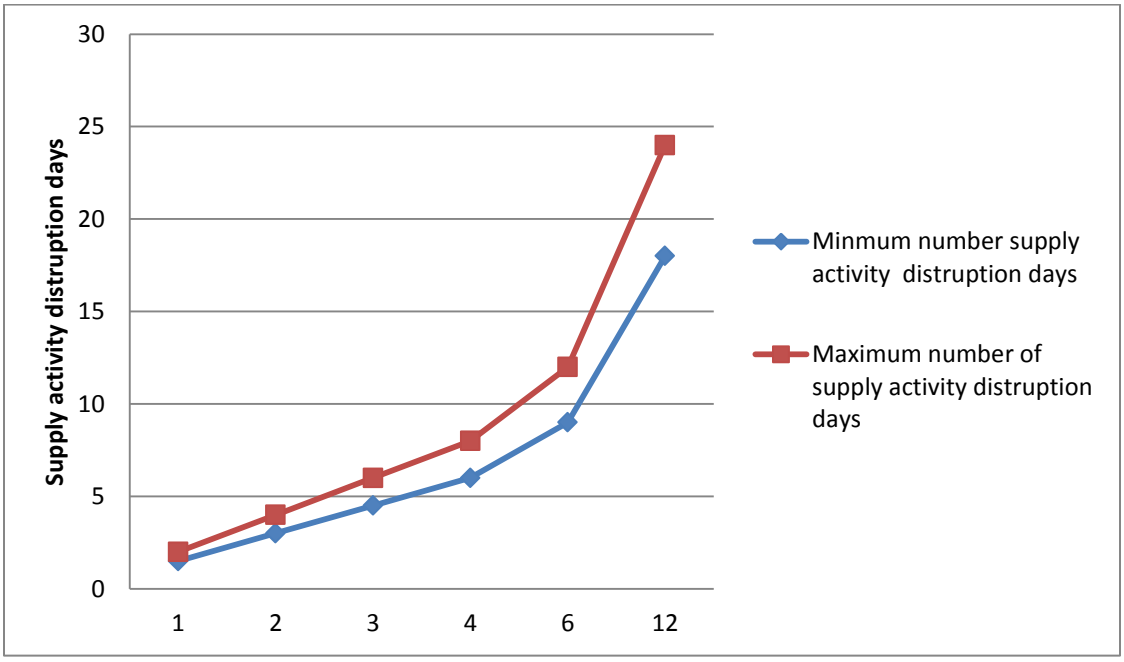

Fig 5.10 the effect of cycle counting frequency on supply activity (ware house operation days)

Fig 5.10 illustrates how the cycle counting frequency can affect the supply activities (ware house operation days). For example, increasing inventory counting frequency from one to two times per year increases the disruption of ware house operation days from one and half to three days. In similar way increasing the counting frequency from one to six times per year, increases the disruption of ware

house operation from one and half to nine days. Finally, increasing inventory counting frequency from one to twelve times per year increases the disruption of ware house operation minimum for eighteen days. These indicated that, as inventory counting frequency is increased to control the discrepancies, more disruption of ware house operation days will be registered. Therefore, the customer service may be affected and this leads to loss of sales.

5.2.1.6 Effect of cycle counting frequency on the probability of sales loses

The probability of sales loss was due to the disruption of ware house operation days during inventory cycle counting. To determine the probability of sales lose due to the disruption of ware house operation, the research forward two investigative questions in sequence for twenty five customers of the case Company. Accordingly the research interviewed Private garage, vehicle owners, Construction machinery owners, Company and organizations. These two questions were described below.

1. Are you Total Ethiopia customer?
2 .Total Ethiopia ware houses do not provide services for one and half days to two days per month due to monthly inventory cycle counting. During these days, do you wait for reopening of the ware house or do you go to another Company to buy oil?

According to the interview results, 44% of the respondents said that they cannot wait for the reopening of the warehouses; and hence they go to other companies. 56% of the respondents said that they would wait until the warehouse is opened. According to the data collected, the estimated daily sales volume of the Company is from eighty tons to ninety tons (i.e.$\frac{80+90}{2}$ tons = 85 tons per day).So the probability of sales lost at the case Company during inventory counting was about 37.4 tons (85tons *0.44 =37.4 tons) per day.

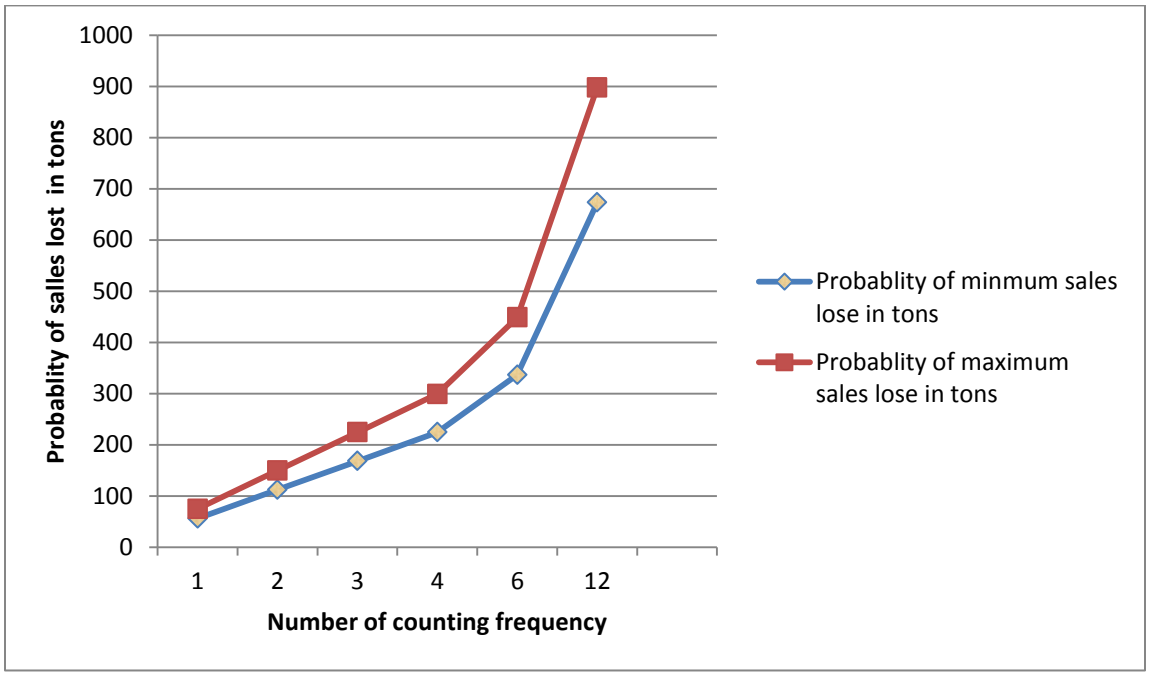

Fig 5.11 the effect of cycle counting frequency on probability of sales lose

Increasing or decreasing cycle counting frequency has the ability to increase or decrease the probabilities of sales lose. Figs 5.11 illustrate how the cycle counting frequency can determine the probability of sales lose. For example, increasing the inventory counting frequency from one to two times increase the probability of sales loses from 56.1 to 112.2tons. Likewise increasing counting frequency from one to six times increase the probability of sales lose from 56.1 tons to 336.6 tons. Increasing counting frequency from one to twelve times per year increase the probabilities of sales lose from 56.1 tons to 673.2 tons. This shows that if the number of inventory counting frequency increased; the Company will be exposed to more sales loses.

5.2.1.7 Analysis of inventory counting frequency based on qualitative methods

The qualitative methods of determining the counting frequency were based on interview and observations. Accordingly, persons who have inventory knowledge, who participate on inventory control and inventory counting activities, as well as staff from sales department were interviewed on the issues of inventory counting frequencies .The interview results indicated that, 60% of the

respondents suggested to perform inventory counting two times per year, 30 % of the respondents said that it is better to count three to four times per year, and 10 % of the respondents suggested monthly inventory counting. Therefore, the interview results indicated that, conducting inventory counting two times per year (every six months) has got more weight.

5.2.1.8 Summary of the section

Based on the discussion explained above Table 5.6 below summarizes the effect of cycle counting frequency on inventory error accumulated, counting cost and ware house off days.

Table 5.6: Summary of the effect of cycle counting frequency on inventory

Number of counting frequency per year	Inventory error accumulate	% of discrepancies	Direct labor cost	Fixed counting cost (k)	warehouse off days	Probability of sales lose (tons)
12	5	0.0033	131,976 - 175,968	2.4	18 - 24	673.2 - 897.6
6	10	0.0067	65,988.00- 87,984.00	0.6	9 - 12	336.6 - 448.8
4	15	0.01	43,992.00- 58,656.00	0.27	6 - 8	224.4 - 299.2
3	20	0.0133	32,994.00- 43,992.00	0.15	4.5- 6	168.3 - 224.4
2	30	0.02	21,998.00- 29,328.00	0.067	3 - 4	112.2 - 149.6
1	60	0.04	10,998.00 - 14,664.00	0.017	1.5 - 2	56.1 - 74.8

It can be seen from the table 5.6 above, increasing cycle counting frequency reduces the inventory discrepancies, but it requires high cost and more ware house off days. This issue is analyzed in this thesis and indicates the need to find an effective cycle counting method. Based on the assumptions made above, the length of counting frequencies were varied to observe their effect on counting cost, inventory discrepancies, and disruption of ware house operation days and probability of sales lose.

The effectiveness of cycle counting frequency was made by considering better counting cost; minimum ware house off days with reasonable discrepancies .According to data collected and analyzed, there is no justification on discrepancies that leads to conduct monthly inventory counting.

In similar way, the qualitative method result indicated, conducting inventory cycle counting within six months of interval was an effective. Therefore, by analyzing these quantitative and qualitative methods, the thesis emphasizes on the following observations.

- Effective counting cycle length can be obtained using the assumption in this thesis.
- Fixed counting cost, acceptable discrepancies, ware house off days and probability of sales lose are determined in each assumption.
- Finally, inventory record reconciliation of every six months (two times per year) yields effective fixed counting cost and effective ware house off days. Therefore, the fifth assumption is the better assumption to undertake effective counting frequency at the case Company.

5.2.2 The effect of Ware housing on supply chain performance

This sub section described the effect of ware house on supply chain performance of the case company. Because the problems associated with the operation of ware-houses, have a significant impact on the on the supply chain performance. Therefore, to understand the effect of ware house on supply chain performance the following sub questions were required to answer.

1. Does your company have its own storage facility or use rental?
2. What is the cost of rental ware house for the last five years?
3. Why your company did not build his own enough ware house?

4. Does your company have enough material handling equipment in all ware houses?
5. Is any other challenge that affects performance of the supply chain regarding to ware housing facility? Please specify

   ……

6. What measures your company has taken to solve the challenge?
7. What is your suggestion on the challenge and the measure that your company has taken to overcome the challenge?

Through observations, discussions and interviews, the above sub questions are determined as follows. From the observation during visiting and interview result indicated Shortage of storage facilities, material handling equipment (loading and unloading equipment) , storage condition, location of product and its arrangement and limited ware house capacity are the problem areas that need attentions regard to ware house. Other consideration includes the time it takes for delivery and locations of warehouse are also factors that should be given due attention.

i. storage facility

Currently the company has one its own lubricant storage facility and uses three rental storage facilities. Storage facility is a key component in the oil industry supply chain activities. When a firm owned its storage facility, they would have greater flexibility in planning for oil product receipts and releases. Lack of storage facility would mean that a firm had to rent the facility of another. This would ordinarily reduce the supply chain flexibility of the firm renting the facility. In addition to this when the company used rented ware house it incurred additional cost.

Due to confidentiality of the business questions number 2and number 3are not answered.

ii. Material Handling Equipment

The ware house of the case company used both a manual system and forklifts to carry, lift, and move the products. The type of material handling to be used was determined based on the size, packing mechanism and location of picking point or storing point of the product. To perform the manual handling of the product the daily laborers were employed. On other hand the loading and unloading activities which are not performed manual was carried out by fork lift. The interview result indicated that there is limitation on the number of forklift in all ware houses.

When the number of fork lift available and the arrived number of the trucks are not proportional the loading and unloading system was not efficient, it took more time to move products when products are received and shipped. In addition to this, sometimes the fork lift is failed to operate and go to garage for maintenance. During this the company forced to use rental fork lift and incurred additional cost. In addition to this; until to get the rental fork lift and make negotiation with the service providers for favorable rates the loading and unloading activities was delayed. Especially when bulk trucks are arrived to unload the product with limited fork lift or when the fork lift is under maintenance the unloading activity was delayed causing the company incurred demurrage cost. In generally the interview result indicated the profitability of using rental fork lift was not attractive due to non-availability of fork lift when it is needed and lack of flexibility of operator.

iii. Storage Condition and Product Arrangement

Product arrangement in the stores is also an important aspect of storage. When products are arranged systematically, tracing a specific product is easy, simplifying inventory taking and minimizing expiry. Proper storage of lubricant requires well designed ware house with adequate storage capacity.

Currently, the products at the company‘s warehouses are stored in open and closed stores. Lubricant packed in barrels are placed on a pallet and stored in open space. In such storing system the products are exposed to rain, humidity and direct sunlight. Varying outdoor temperatures, with consequent expansion and contraction of steams, may lead to leakage and wastage. The probability of contamination is also increased. Water can leak into even tightly closed drums by being sucked in past the bung as the drum and its contents expand and contract. Extremely cold or hot weather can also change the nature of some pounded oils and emulsions, making them useless. On other hand product stored in enclosed ware house are placed on floor pallet and the pallets are placed one on another. Rack storing system was not adopted. Due to such storing system product placed at bottom are exposed to damage due to over loading. The interview result indicated that 4liter (lt) and 5liter (lt) lubricant packed in plastic package are exposed to such damages. These damaged are most of the time observed at the neck of the plastic package. In similar way EP-2 and EP-3 grease packed in thin metallic packaged and 0.5 liter (lt) and 1 liter (lt) ATF brake fluid packed in plastic packages were exposed to this damaged.

In addition to these the stock arrangement at the warehouses also need attention .Stocks are placed using a fluid location system where individual items are stored wherever space is available within the four stores or within a single store. When the customer required different products, it may or may not available in a single store because the products are stored wherever space is available among the four ware houses. At different ware houses, the customer forced to go to two or more ware houses to collect the products and also needs two or more dispatch. This takes time because the ware houses are found around Gotera, Saris and Kality. The interview result indicated that this problems needs attention due to day to day customer complains. Even in single store the products are stored wherever space is available, in such storing system the item tracking is dependent on the memories of warehouse staff.

iv. Storage Capacity of the ware house

The storage capacity of the ware house is another challenge observed during the case study. In nature the oil company needs a big storage area due to high movement of the product. The interview result indicated that, there are an estimated 150,000 items stored at company ware house per month. But to handle these items the existing ware house was not enough due to limited ware house capacity. To solve this challenge the company rented three ware houses but it incurred additional costs.

v. Location of the Ware house

The warehouse owned by the company is located around Gotera. The other rental ware houses are located around Saris (one) and the other two are around Kality. The location of all ware houses are along Addis Ababa-Debre Zeit road. The selection of the location of the warehouses has considered the trucks route and access to facilitate custom clearance.

To understand the effect of ware house location on product delivery to customers, the research has interviewed thirty two respondents. The interview result indicated that 72% of the respondents use the lubricant available near to them, while 28% of the respondents go to the company's ware house to buy the product due to brand awareness.

vi. Safety and security of the warehouses

Safety is the most important issue in the ware house because it directly or indirectly affects the supply chain activity. For oil industries, safety must be a very serious issue since it is directly related to ware house. In total Ethiopia ware house‘s some measures are taken to improve safety and of ware houses. Among these,

- Cleaning of the ware house
- The availability of fire extinguisher
- And the availability of trained personnel on safety the strong side of the company.

The overall warehousing management of the case Company has shown that there is a long picking time of products from a given warehouse that are attributed to poor product arrangement. In addition, since products are kept in different ware houses that located at different areas (lack of one-stop shopping), customers are exposed to unnecessary costs and wastage of time to collect the required product from different ware houses. When bulk trucks are arrived to unload the product with limited fork lift or when the fork lift is under maintenance the unloading activity was delayed causing the company incurred demurrage cost.

5.2.2.1 Proposed ware housing management to improve supply chain performance

On analyzing the current warehouse operations, some areas for improvement have been identified in the inbound system. Some of these areas are product arrangement and storage condition, material handling equipment, increasing storage capacity and determining appropriate location of the ware house.

The storage area should be divided into different zones, designed with different letters and grouped according to the different products that are supposed to be stored in these areas. In addition to this also the products should be grouped in to family. These classifications of the products in to family help easily to access the location or zone of the products. Again the product family should be grouped in to subgroup based on their demand or volume of transaction to allocate appropriate space for items in the store and easily to access specific location of the products. Another point that should be considered in this product arrangement is assigning appropriate product at appropriate zone and specific location to

easily transport the product during storing and picking. Accordingly products those have high transaction should be placed at easily picking area. Once the storage area and the products arrangement is completed then each product family and each sub grouped product families should be distributed to each ware house based on their sales ratio .This helps the customers to collect different products from one ware house and increase fast customer service.

On other hand the stocking condition should need attentions. Products placed in open area should be stored under shade to protect from direct sun light, rain and humidity to avoid the contamination and water leakage in to inside of the products. Small packed products stored inside of the store should be placed on racks to avoid product damaging due to loading one over the other and also to make easy during picking.

The second area that needs improvement in ware housing environment is the availability of or the capacity of ware house. Since the existing ware houses are not enough to store and distribute the required quantity of demand. In order to solve these problems, the company rented three ware houses. The interview and survey result indicated that the current oil industry businesses and the demand of the products in the country are increased from time and time. So by considering these and some variables which was not seen by this research the company should build additional his own ware houses instead of using rented ware houses .But the number and size of the ware house to be build needs further study. The availability of adequate storage facility creates smooth flow of products that helps to achieve high customer service delivery resulting into high performance results. In addition to this building own ware house helps to minimize the rented cost.

The other issue in ware housing environment is the location of ware house. After determining the required number of ware house then the next question is where to place the ware house. This is done by considering different criteria. In the existing ware house the selection of the location was based on the truck route and access to facility custom clearance. In addition to these criteria the research proposed the company to consider other factor like service out let and high demand zone. The current business environment indicated that the business companies are forced to go to the customer rather than the customers go the company to increase customer service level and gain competitive advantage.

5.2.3 The effect of Transport system on supply chain performance.

As it shown in the current supply chain process of the case company, the company's products purchase are from different sources (Dubai or direct France) and imported and then are transported to Djibouti port, Modjo dry port or Addis Ababa, then stores them in bases at different points and then sell the products at the company ware house, with various kinds of agents and retail stations. The process of transporting the lubricants from supplier vis-a-vis the distributor to end user is performed by two mode of transport. From the supplier to Djibouti port sea transport mode was used and from Djibouti port to Modjo dry port truck is used. Both the sea transport and road transport from Djibouti port to Modjo dry port the transportation system is operated by Ethiopian Shipping and Logistics service Enterprise. Once the product is arrived at Modjo dry port the international purchase department of the company processed the custom clearance. After the custom clearance is completed the product is transported from dry port to company ware houses by truck owned contractors. Once the trucks arrived at the company ware house, the ware house supervisor received the product based on their free space or capacity of the ware houses and stored the products. This process completed the transporting system of the product from supplier to company ware house. In similar way the truck is used to transport the product from company warehouse to retail stations and customers site that have contractual agreement with the company.

Therefore, this section of the study described the effect of transport system on the supply chain performance of the case company. To explore this effect the research forwarded some questions for the respondents'. But due to business confidentiality some questions were not answered.

Transportation system challenges:

1. Is any challenge that affects supply chain performance regarding transportation system stated above? Please specify ……..

2. Does your company have its own truck or use rental to transport the product from Djibouti to company ware house and from ware house to customer?

3. Did your company experienced additional cost due to truck transport problem?

4. What is the truck transportation cost for the last five years in your company?

5. Is there any operational disruption due to truck transport problem?

6. Did your company received any customer complain due to truck transport?

7. Is any other challenge that affects supply chain performance regarding to truck transport? Please specify ……..

According to the respondent Perception, the interview result was summarized as below.

Currently the company used ship and truck to transport the lubricant from supplier to company ware house and from company ware house to end user. The transporting system starting from supplier to dry port was full Outsourced and controlled by Ethiopian shipping line. There was no eligible challenge observed in this transporting system except sometimes road accidents. From dry port to company ware house and from company ware houses to retailer station and to some of its customer's site that have contractual agreements with company used both rental and its own truck to transport the lubricant. All the transporting of the product from dry port to company ware houses also outsourced. The company owned trucks are used to transport the product from the company ware houses to the retail station and customer site. In cases where these trucks do not meet customer requirements, the company used rental trucks.

In transporting of the product from dry port to company ware houses there was no observable challenges except sometimes road accidents .But in case were delivering of the product to retail station and customer site ; non-availability of the truck when it required and inflexibility of the rented operator of the trucks are sometimes observed . Such problem affected on time delivering of the products.

In addition to the above the company incurred additional cost when it used the rented trucks. During This additional cost affected performances of the supply chain.

On other hand the company's truck was not dispatched on their rout until full load order is arrived. Due to this the customer who ordered small quantity of product is forced to wait until full load order is

arrived in his rout. This affects the on time delivery of product and cause customers complain. This is the main challenge observed in transporting system.

In summary, the transportation system of the lubricants of the case Company has affected towards maintaining the quality of the product (product damage), on the other hand, on-time delivery of products for case Company has been negatively affected by the existing transportation system.

5.2.3.1 Proposed Transport system to improve supply chain performance

Most of the problem related to transporting system is related to limitation truck, Full load and truck rout management and road accident. These factors cause customer complain due to delay deliver, damaging of product and company incurred additional cost. Therefore; to minimize these problems the research proposed some improvement on existing transporting system

i. Truck full load and route problem

The truck full load and rout problem can be improved by using different size or type of truck having different load capacity to be owned by the company. Various customers having different load size order at different time in the same rout are better served with smaller trucks instead of waiting full load of big truck. If the case company prefers to use the proposed transport system it improves customer service and at the same time minimizes fuel cost.

ii. Road Accident

Road accident is one of problem observed in truck transport. The results of such incidents are mainly loss of product due to damage or spillage and theft Therefore to minimize such problems the research proposed some measures to reduce such incidents by enforcing conditions in their contracts with truck operators. These conditions should include the use of drivers who hold valid driving certificates and ensuring that they work reasonable hours on the road to avoid fatigue. The vehicles should also be road worthy and be serviced regularly.

The overall proposed model of supply chain distribution of the lubricants is shown in figure 5.12.

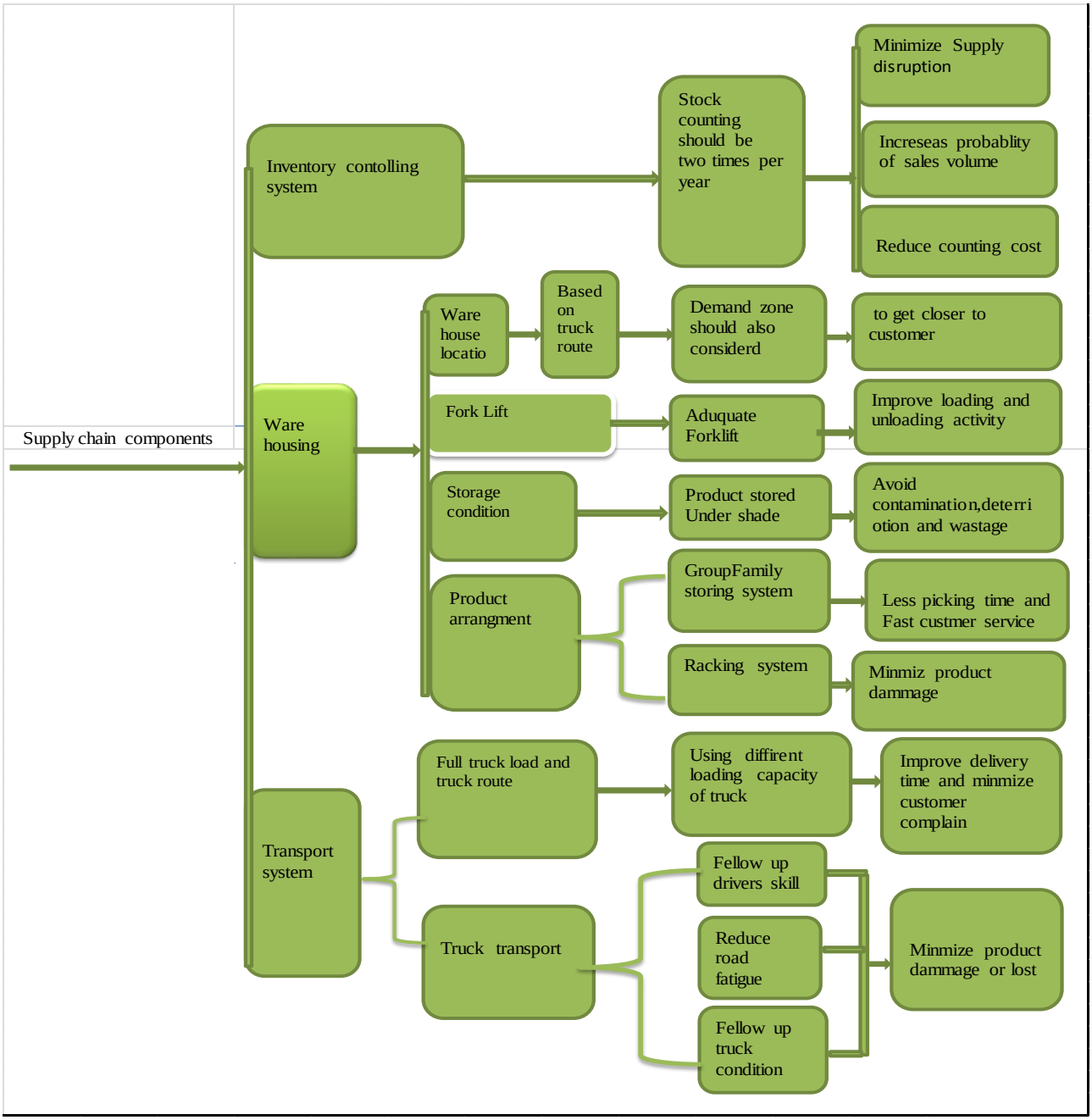

Fig.5.12 The proposed model of supply chain distribution of the lubricant

Chapter 6

6. Performance comparison of the existing and the proposed of Supply chain performance

In this chapter the study evaluates whether the new proposed supply chain distribution performance method performs better or worse than the existing supply chain distribution methods of the Company.
The literature review process revealed that Inventory counting method, ware house management and transporting system were considered from supply chain components of the case company

6.1 Inventory counting system

Regarding to inventory counting manpower costs, inventory accuracy, and ware house operational disruption times were the criteria to be used in evaluating different physical inventory methods.
Based on this key performance indicator the existing and proposed supply chains performances were evaluated. The proposed cycle counting method aims to identify inaccurate item using historical inventory checking data. This method has the ability to reduce the number of cycle counting frequency, fixed counting cost as well as the number of ware house operational disruption days due to inventory auditing. The existing cycle counting method used monthly cycle counting practice to control inventory discrepancy. Table 6.1illustrates the outcome of the existing and the proposed of inventory cycle counting methods.

	Comparison parameters	existing counting frequency per year	Proposed counting frequency per year
1	Number of cycle counting frequency per year	12	2
2	Direct Labor cost(birr)	131,976.00-175,968.00	21,996.00– 29,328.00
3	Fixed inventory counting cost (k)	2.4	0.067
4	Ware house off days due	18-24	3 - 4

	to inventory counting		
5	Maximum discrepancies per period	0.017%	0.102%
6	Probability of sales lose (in tone)	673.2 – 897.6	112.2 – 149.6

Table 6.1 Comparisons between the existing and proposed inventory cycle counting frequency

6.1.1 Compering counting cost between the existing and the proposed of Inventory counting method

After determining the new proposed inventory counting frequency, the research compared the value of counting cost between the Existing and new proposed inventory cycle counting methods. Hence the existing cycle counting method was made based on the first assumption (assumption one) given above; it is the highest cycle count frequency of the assumption. As it shown in literature review, inventory counting cost is directly relate to the number of cycle counting frequency high counting frequency yields high counting cost.

For example, in the existing inventory counting method, the number of cycle counting frequency is twelve with direct labor cost of 131,976.00-175,968.00 and fixed counting cost of two point four (2.4) .But in the new proposed inventory control strategy the number of inventory cycle counting frequency is two with direct labor cost of 21,996.00– 29,328.00 birr and fixed counting cost of zero point sixty seven (0.067). Since the desired goal is to obtain a low inventory counting cost with feasible inventory discrepancy, the amount of improved fixed counting cost should be determined. If the Company wants to implement the new proposed inventory cycle counting method, the total direct labor cost and fixed counting cost will be decreased by 83.3% $\frac{131{,}976.00-21{,}996.00}{131{,}976} * 100$ and 97.2% ($\frac{2.4-0.067}{2.4} * 100$) respectively compared to the existing inventory counting method . Therefore; the cost measure shows significant improvements.

6.1.2 Compering the disruption ware house operation days between the existing and the proposed of Inventory counting method

As it stated in literature review, cycle counting is one of the method used to improve the performance related to inventory inaccuracy problems in ware house. On other hand more frequency of cycle counting affects the ware house operations due to interruption of ware house operations during inventory counting. More cycle counting frequency yields more interruption of ware house operations days.

Similar to counting cost, the disruption of ware house operation days due to inventory counting was considered as criteria for performance comparison between the existing and the new proposed of inventory cycle counting strategies.

In the existing inventory control method, inventory counting was performed monthly that interrupted ware house operation for 18 days to 24 days per year. But the new proposed inventory counting strategy the total inventory counting days (the interruption of ware house ware house operation days due to inventory counting) is reduced to 3 to 4 days per year. If the new proposed inventory control method is implemented at the case Company, the total disruption of ware house operation days due to inventory cycle counting will be decreased minimum for 15 days and maximum for 20 days (18-3 = 15 days, 24-4 = 20 days).

6.1.3 Compering Probability of sales lose between the existing and the proposed of Inventory counting method

A higher number of available ware house operation days at the case Company, increase the probability that the customer will find and purchase the product and leads to increase in annual sales Volume.

According to the data collected, the estimated daily sales volume of the Company is from eighty tones to ninety tone .Increasing ware house operation days have the probability of increasing annual sales volume of the Company as well as service level. If the case Company wants to implement the new proposed inventory cycle counting method, the annual sales volume have the probability to be increased by 561 tone (15*37.4tone) to 748 tone (20*37.4 tone).

6.1.4 Comparing inventory discrepancy between the existing and the proposed Inventory cycle counting methods

This section compares the amount of inventory discrepancy observed during the existing and the proposed Inventory cycle counting methods.

The existing inventory cycle counting practice was made based on monthly cycle counting method and performed inventory audit twelve times per year. As it shown in section 5.1 the error accumulated in each period is vary from month to month. The distribution of the discrepancy is random, sometimes move up and sometimes back to zero. The maximum discrepancy observed was 0.017% and the minimum discrepancy is zero.

The new proposed inventory counting method was based on the qualitative and quantitative method of analyzing data collected and compered to mean allowable discrepancies indicated in the literature review. The expected maximum discrepancies during this counting method will be thirty one times less than the mean allowable discrepancies indicated in the literature review. Therefore the new proposed inventory counting method will helps to improve the performance of supply chain distribution of the lubricant.

6.2 Compering the existing and proposed warehousing management

In this sub section the existing and the proposed ware house management system were compared depending on their Storage Facility , Storage condition and product arrangement, Storage capacity, Location and Material handling equipment .The criteria considered in the comparison of the two systems are fast customer service, cost ,flexibility space utilization.

Table 6.2 Comparison between the existing and proposed ware housing

No	Descriptions	Proposed ware house Management	Existing ware house management	
1	Storage Facility	The number of facility should be two or more based on the size and location	One owned by company and three facilities are rented	
		Needs initial cost	High rented cost	
		High flexibility	Less flexibility	
2	Storage condition and product arrangement	Will improve picking time	Poor picking time	
		Increase customer service	Affect customer service	
		Reduce probability of product damage, contamination and wastage	Exposed to product damage, contamination and wastage	
		Better space utilization	Best space utilization	
3	Storage capacity	Needs Initial investment	High rented cost	
		Based on the size and number of ware house to be build	Not enough to hold demand stock	
4	Ware house location	Some of them may not be near to truck route	All are near to truck route	
		Some of them may not be near to custom facility	All are near to custom facility	
		More close to customer	Customer not considered	
		Focused on demand zone	Demand zone not considered	
5	Material handling equipment	Needs initial cost	Exposed to rented cost	
		Improve loading and unloading activity	Sometimes affected loading and unloading activity	
		High flexibility	Less flexibility	
		Reduce demurrage cost	Exposed to demurrage cost	

6.3 Compering the existing and proposed Transporting System

This sub section the existing and the proposed transporting system were compared depending on their, road accident, full load and route management at the case company.

The objective is to find cost effective transporting operation system, while satisfying customer demand.

Table 6.3 Comparison between the existing and proposed transportation system

No	Description	Proposed transporting system	Existing transporting system
1	Full load, route management and truck limitation	Needs Initial cost	Less initial cost but constantly increased
		Improve on time delivery of product	Cause delay on deliver of product
		Increase customer satisfaction	Affect customer satisfaction
		High flexibility	Less flexibility
2	Truck accident	Needs commitment	Practiced
		Needs the participation of all Stakeholders	Concerned department of the case company
		Minimize Driver death ,truck and product damage	Sometimes exposed to Driver death, truck and product damage

Chapter 7

7. Conclusions, Recommendations and Suggestions for Further Studies

7.1 Summary of the finding

This chapter presents the conclusions and recommendations of the findings on the performance evaluation and optimization of Supply Chain distribution of lubricants; and those factors that affect the performances of the supply chain distribution.

There were seven key performance indicators (KPI) used in this research: supply reliability, on-time delivery of products, product picking time, one-stop shopping of products, maintaining the quality of the product and cost.

The findings indicated that the performance of the supply chain distribution of lubricants was affected by both external and internal factors including shortage of foreign currency, Inventory controlling system, ware housing and transportation.

7.2 Conclusion

One of the objectives of this study was to find the factors that affect the performance of supply chain distribution in Oil Industries, particularly supply chain distribution of lubricants for the case Company, Total Ethiopia. The results showed that there are a many factors that affected the performance of supply chain distribution of lubricants which include import/export facilitation, ware housing, domestic and international transportation management, Inventory control, Capacity constraints, management and information technology and improper ware house allocation and distribution center.

The second objective was to determine factors along the supply chain distribution of Total Ethiopia that most affect the performance of the case Company. The findings of the study indicated that shortage of foreign currency, Inventory counting practice; ware housing and transporting systems are major factors affected the supply chain distribution performance of the case company.

Therefore; based on the key performance indicators (KPI) used in this research and the result of the analysis, stock counting practice, Ware house management and transportation systems are some areas that need improvement along the supply chain distribution of lubricants for the case Company.

7.3 Recommendation

The research assessed performance evaluation and optimization practices as well as Factors affecting supply chain performance, and finally concluded by proposing performance improvement model. The following recommendations help to improve the supply chain performance of lubricants.

- Ensuring customer satisfaction and quick delivery of products to ensure better supply chain operations.
- The existing inventory counting practices highly affected the supply operations and it has incurred the case Company an additional cost. Hence, in order to improve the supply operations the company, the company needs to minimize the number of inventory counting practice from monthly undertaking to twice a year
- High demand zone should be considered during site selection for warehouse location in order to get closer to customers.
- The company needs to have sufficient number of fork lifts to improve loading and unloading operations in the ware house and reduce demurrage costs.
- The product arrangement in the ware houses should be based on the product family group for ease of access, picking and control the inventory.
- The company needs to use different loading capacity and size instead of using the same loading capacity of trucks to minimize full load truck problem and give fast response to customers.

7.4. Suggestions for Further Studies

Based on the findings and conclusions of this research, the following areas are suggested for further study. Most of the data for this research were generated from interviews and secondary sources. However, the nature of some data/information were confidential as they are related to Company's

internal working procedures and costs, .Hence, based on the support and willingness of the case Company, further study shall be conducted if a documented and detailed cost related data can be availed from the case Company. Such cost related information would help to decide on whether to proceed with rental ware houses or build own stores; and whether to use rental loading/unloading forklifts or procure for the Company.

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9. Annex

9.1 Questionnaire

Dear respondents,

My name is Abera Mekonta; and I am working towards my Degree of Masters of Science in Mechanical Engineering under Industrial Engineering Stream. I am interested to conduct my research on your esteemed Company for the partial fulfillment of the requirements for my Thesis.

The information you are providing me will be used only for the academic purpose and will be treated with utmost confidentiality. Your participation and assistance with this regard is highly appreciated.

Please indicate your opinion in performance evaluation and optimization of supply Chain distribution of oil in your Company based on the following questions.

First trip interview

1. What is your name?
2. Is there any challenge in your Company related to supply chain distribution of oil?
   If your answer is yes, what are the challenges?
3. Which challenge does affect your Company's performance more?

Second trip

Questionnaires

A). Inventory control strategy

1. What type of inventory controlling strategy does your Company use?
2. What are the reasons to take monthly inventory stock counting?
3. How many days does it take to complete the monthly stock counting?

3. How many employees are involved in the monthly physical stock counting?

4. Does your ware houses give service during physical stock counting?

5. Do you evaluate the impact of your monthly physical inventory counting on your customers as well as on your Company's performance?

6. Does the current inventory accuracy controlling system create challenges to your Company?

7. What are the challenges facing inventory control system in your Company?

   a).....

   b).....

   c).....

   d).....

   e).....

8. Did the physical inventory vary from the inventory record system during monthly inventory counting in the last 12months?

   a) If your answer is yes please fill the table given below.

   b) Please select one item which is continuously and has high inventory discrepancies value from the table and fill the following costs

   - Estimated back order cost of Item----------
   - Estimated monthly counting cost of Item ----------
   - Estimated purchase cost of item ----------
   - Estimated daily demand of item ----------

   c) What is the estimated daily demand of all products?…….

   d) What is the estimated monthly available stock? …….

9. What are the major causes of the discrepancies between physical inventory and inventory records in your opinion?

10. What measures / solutions the inventory control system can take to solve problems in your Company?

.....
.....

11 .Are discrepancies between physical and inventory records investigated and resolved?

If your answer is no, why?

B) Ware housing operation:

1. Does your company have its own ware house or use rental?
2. If the answer is "rental", what is the cost of rental ware house for the last five years?
3. Why has not your company build its own enough ware house yet?
4. Does your company have enough material handling equipment in all ware houses?
5. Is there any other challenge that affects the performance of the supply chain regarding the ware house facility? Please specify

   ……
6. What measures have your company taken to solve the challenge?
7. What is your suggestion on the challenge and the measure that your company has taken to overcome the challenge?

C). Transport system challenges:

1. Does your company have its own truck or use rental to transport the product from Djibouti to company ware house and from ware house to customer?
2. Have your company experienced additional cost due to truck transport problem?
3. What is the truck transportation cost for the last five years in your company?
4. I s there any operational disruption due to truck transport problem?
5. Have your company received any customer complain due to truck transport?
6. Are there any other challenges that have affected supply chain performance regarding to truck transport? Please specify

   ……..
7. What measures have your company taken to solve the challenge?

8. What are the suggestions/or mitigation measures for your company to overcome the challenges?

D) Other challenges in the above supply chain process. Please *specify*

.....
.....
.....
.....

9.2 Main causes of inventory inaccuracies

- **Shrinkage**: stock loss, may be due to theft, spoiled and damaged inventory
- **Transaction errors**: misidentification of the items or miscounting of the items in inbound and outbound processes.
- **Misplaced**: Inventory that is physically at the facility, but its exact location is unknown.
- **N.B**: Please write letter
- **Sh**: For Shrinkage errors,
- **Tr**: For Transaction errors
- **Mp**: For Misplaced inventory, to justify the cause of inventory in accuracy in table given below

IRI = Inventory record in accuracy (the deference b/n record and actual inventory)

COI= Cause of in accuracy (Shrinkage, Transaction errors and Misplaced)

9.3 Monthly inventory Cycle counting result (stock discrepancy) and cause of discrepancy or in accuracy (COI)

no	Item code	Monthly inventory Cycle counting result (stock discrepancy) and cause of discrepancy or in accuracy (COI)											
		Aug 2016		Sept 2016		Oct 2016		Nov 2016		Dec 2016		Jan 2017	
		discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI	discrepancy	COI
1	BF_{01}	-		-		-		-24pcs(1-package)	sh	-		-	
2	BF_{02}	-2	Tr	-		-		-1	tr	-		-	
3	EOP_{01}	-		-		-		-		-		-1	Mp
4	EOD_{01}	-		-		-		-		-		-1	Mp
5	EOP_{02}	-		-		-1	tr	-		-		-	
6	EOD_{02}	-		-		-		-		-		-	
7	$EODP_{01}$	-		-		-		-		-		-	
8	EOD_{03}	-		-		-		-		-		-	
9	EOD_{04}	-	Mp Mc	+1	Mp Mc								
10	Total discrepancy	2		1		-1		-25		0		-2	
11	Average number of items in store	150,000		150,000		150,000		150,000		150,000		150,000	
12	Ratio of discrepancy												

no	Item code	Monthly inventory Cycle counting result (stock discrepancy) and cause of in accuracy(COI)											
		Feb 2017		March 2017		April 2017		May 2017		June 2017		July 2017	
		IRI	COI	IRI	COI	IRI	COI	IRI	COI.	IRI	COI.	IRI	COI
1	BF_{01}	-		-		-		-		-		-	
2	BF_{02}	-		-		-		-		-		-	
3	EOP_{01}	+1	Mp Mc	-		-		-		-		-	
4	EOD_{01}	+1	Mp Mc	-		-		-		-		-	
5	EOP_{02}	-		-		-		-		-		-	
6	EOD_{02}	-		-2	tr	-		-		-		-	
7	EOD_{01}	-		-		-		-24pcs (1 package)	sh	-		-	
8	EOD_{03}	-		-		-		-		-		-1	T
9	EOD_{04}	-		-		-		-		-		-	
10	Total discrepancy	2		2		0		24		0		1	
11	Average number of items in store	150,000		150,000		150,000		150,000		150,000		150,000	
12	Ratio of discrepancy					0				0			